MACROECONOMIC DETERMINANTS OF INFLATION IN ETHIOPIA: ARDL APPROACH TO COINTEGRATION

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ABSTRACT

Maintaining inflation rate at optimal level is among important mechanism of balancing macroeconomic volatility to ensure steady economic growth. This study aims to examine macroeconomic determinants of inflation in Ethiopia. The study employed ARDL model using annual data for period 1981–2020. The ARDL bound test was applied to examine the presence of con-integration between inflation and independent variables. The study also uses augmented Dickey-Fuller and Phillips-Perron unit root tests to check stationarity of the variables. The test result reveals that almost all variables become stationary after the first difference. Accordingly, the result from bound test indicated existence of long run relationship between the dependent variable and explanatory variables entered into the model. The estimated error correction model (ECM) with −0.53 coefficient also confirms the existence of co-integration with high speed of adjustment towards the long run equilibrium. In the long run: real GDP, real effective exchange rate, lending interest rate are positive and significant determinants of inflation whereas broad money supply, real GDP, population growth, gross national saving and previous year imports are found to be the short run drivers of inflation. The finding recommends, among others, measures on reducing real effective exchange rate and utilizing broad money supply in productive economic activities along with supply side should be designed to contain inflation in Ethiopia.

KEY WORDS

ARDL model, bound test, co-integration, ECM, Ethiopia, inflation, macroeconomic determinants

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1 INTRODUCTION

Achieving macroeconomic stability is among essential mechanisms that help to ensure healthy functioning of an economy. Like other countries do, an important objective of economic policies in Ethiopia is making macroeconomic variables balanced with steady economic growth and maintaining lower inflation. Stability in level of prices is among factors that highly contribute to and determine growth rate of an economy. In their paper, Yesigat Taye and Nandeeswara Rao (2015) state if inflation is not kept at reasonable level, it adversely affects a social welfare and makes domestic economy not to perform efficiently. They further argue that in investment environment of both foreign and domestic investors, it creates uncertainty and destroys the terms of trade in the country by raising the price of domestic goods and services beyond regional and world market price level. Consequently, the domestic trade become uncompetitive in international market. For this reason, reducing inflationary rate is a main concern in any economic policy agenda.

Over the last two decades, Ethiopia's economy has gone through various phases of inflation and economic progress. Since 1981 to 2000 considerable fluctuation in output growth was seen with minimum growth rate -7.2% in 1991, which could be associated with civil war and agricultural supply shock occurred in the year. However, it has been observed that since 2003/04 the country has continuously performed accelerated real GDP growth than the average growth rate achieved by the continent. The maximum economic growth was documented during 2004 and 2011, which are on average 13.6%, 13.2% per annual respectively. Such consistent performance in real GDP growth made the country among economically better performed countries in sub-Saharan Africa. Again in 2008/09, 11.2% annual growth rate was attained though inflation shock was historically highest during the year. According to the study of EEA (Ethiopian Economic Association, 2018), after two years challenges of macroeconomic imbalance which was caused largely by agricultural supply shock, macroeconomic stability was successfully maintained in 2012/13 as observed by declined inflation from double to single digit. Since then the trend indicates persistency of the output growth although the progress was not as fast as the previous path. However, the country is facing several challenges including the soaring price level, which could potentially hinder national reform agendas like the goal of attaining middle-income earner country by 2025 (UNDP, 2014; Bekele, 2017).

The recent high inflationary situation even relative to lower income earner African countries is among macroeconomic instability challenging the Ethiopian economy. The problem could be partly explained by expansionary monetary and fiscal policies and devaluation that followed by unnecessary accrual of foreign exchange reserves. In its country report, IMF (2018) pointed out that since 2015 inflation has moved up above the NBE single-digit objective (8%) even though growths of monetary aggregates were slow. The report also points that upward trending since 2015 could be, to some extent, due to an accommodative monetary stance which was worsened as a result of devaluation, especially in October 2017. The devaluation action was progressively continued until 2019.

The authority, National Bank of Ethiopia (NBE), only began narrowing the monetary stance in 2018 while broader monetary aggregate credit continued to durably increase due to transmission lags until late 2018. In the next year, inflation surged up with annual average rate 20.8%, mainly driven by food price inflation, which in part has been affected by interruptions of 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). Knowing the underlying source of inflation at macro level is therefore very crucial in an attempt to take stability measures.

In other developing countries, several empirical researches were conducted on macroe-

conomic determinants of inflation in different years. For example, Enu and Havi (2014), Ruzima and Veerachamy (2015), and Lim and Sek (2015) have attempted to discourse the fundamental causes of the price rise at global and national level. In various 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 highlighted as influential sources of CPI growth rate.

When we come back to the case of Ethiopia, recently double-digit inflation has become worrisome for policy makers as well as the society as it reflected by it outstrip beyond the threshold identified by some researchers (Bezabeh and Desta, 2014; Mera, 2018; Gashe, 2017 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%. The second researcher also explained in his analysis of inflation and economic growth for the period 1991 to 2013, the estimated price level growth rate that supposed to be attractive to the economy is 10%. Hence, 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 Jalil and Feridun (2011) or Kahssay (2017), 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: 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 the best knowledge of the researchers the influence of this variable has not been empirically considered while the country is among the most populous countries in the continent. Additionally, empirical researches tried to consider real effective exchange rate as one of the important factors influencing growth rate of inflation in Ethiopia, but there is inconsistency in the effects of this variable. Some researchers (Ruzima and Veerachamy, 2015; Kahssay, 2017) claim that exchange rate depreciation negatively affects consumer price index while others (Getachew, 2018; Gashe, 2017) argue in support of positive association between exchange rate and the variable of interest.

In addition, there is a debate among scholars about impacts of real GDP on inflation growth rate. Respecting theoretical correlation of price and output, some researchers such as Bezabeh and Desta (2014) and Denbel et al. (2016) argue for existence of negative causality between real GDP and price level in Ethiopia. Contrarily, other researchers such as Enu and Havi (2014) and Gashe (2017), 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 has got strong theoretical influence, advocating 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 researchers to conduct the study. Moreover, lack of consensus on factors influencing inflation, which characterized by unpredictability even when considered at quarterly bases of a year, leads to conflicting policy prescription. It is therefore a sound argument that re-identifying those elements behind a rise in price level in the country is paramount important.

This study is significant in the aspect that it tries to carefully identify, after extensive literature reviews, and hypothesizes macroeconomic variables including population size which could play indispensible role in explaining the inflationary situation, but ignored by previous studies. It also applies most reliable and recent ap-

proach to estimate the specified model. Thus, it can have significant importance to government policy makers and other stakeholders in pursuit of providing consistent scientific information on the subject in addition to its contribution in adding more knowledge and insights to the subject's literature. The purpose of this study is therefore to examine the macroeconomic determinants of inflation in Ethiopia using updated time series data spanning over 1981 to 2020.

The next sections of the paper are structured as follow: in section two, the most related theoretical and empirical literature reviews are discussed. The next section presents materials and econometric methods used to organize and process the data. The findings from econometric data analysis are presented and discussed in section four and five respectively. Finally, concluding remarks and policy implications are forwarded in the last section.

2 LITERATURE REVIEW

2.1 Theoretical Literature Review on Inflation

This section briefly discusses an overview of some theoretical backgrounds about inflation. As there are many theories formulated on the macroeconomic problem in different year by different schools of thought, we focus on the most relevant and widely tested theories. Some of them are extension of its preceding school of thoughts' central ideas on causes of inflation while other theories attempt to hypothesis the issue differently. These theories include: Quantity Theory of Money (QTM), the reformulated theory of money (Keynes's version), monetarism theory and structuralism theory. Embedding on their respective proposition on determinant(s) of price growth, the paper also attempts to identify factors contributing to inflation and test the hypothesis in subsequent sections, but in this part we present brief focus points of each theory with their respective hypothesis.

2.1.1 Quantity Theory of Money

The theory essentially gives credit to central bank as key regulator of price level because the huge proportional change in price resulted from monetary expansion. According to the QTM (Quantity Theory of Money), inflation is occurred because of the central bankers' repudiation to control money supply. Hetzel (2007) explains that the theory was later supported, but modified 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 classical theorists' (QTM) fundamental investigation. In this case, P is general price level, Y is real output, V is velocity of money i.e., the average number of times a unit of currency is circulated in a year, and M denotes volume of money supply. The proposition is founded on the assumption of fixed velocity and real output. Under the assumption of flexible wage and price, the theory argues that a change in money supply causes price level to be changed with the same proportion.

2.1.2 Reformulated Quantity Theory of Money

The QTM was later reformed by Keynes which commonly known as reformulated QTM (Keynes's version). The theory states as far as material and human resources' unemployment exist, an increase in level of price resulted from the rise in money supply induces growth of output, income and employment. But, when supply of production inputs are turn into inelastic and full employment is achieved, real inflation will be occurred. Hence, the Keynes's version recommends an intervention when money rises beyond full employment. Nevertheless, effective demand does not respond in the same proportion with quantity of money. Prices also do not change in equal variation in response to changes in effective demand in case the effective demand partially determined by employment and partially by price changes (Klein et al., 2004; Nelson et al., 2007).

Both versions of QTM are however similar after the economy attains its full employment

level, recognizing the full impact of money growth on the general price level. The Keynes's version reveals the elasticity of price with respect to any monetary shock be equal to zero in an economy with idle resources. In such economy, according to him, monetary injections would enable to utilize idle resources and rises employment which in turn increase output in a proportion to changing aggregate demand; hence there would be no impact on prices in the short run (Dutt and Skott, 2005). If the elasticity becomes one given the level of output and employment fixed at full capacity, then 'true inflation' occurs as to the Keynes's version. Thus, any monetary growth while the economy is operating at full capacity induces price to be increased in same proportion.

2.1.3 Monetarism Theory

Monetarists are economists who advocate for monetary policy as a powerful tool to stabilize the economy than fiscal policy, especially price. According them, expansion of money supply beyond the growth of real output causes inflation. For this reason, they state "inflation is always and everywhere a monetary phenomenon that arises from a more rapid expansion in the quantity of money than in total output." (Jalil and Feridun, 2011). As to the explanation of Friedman and Schwartz (1963), price is dominantly (not exclusively) determined by money supply both in short run and long run, but money supply only affects output in short run. Hence, central bank should pursue growth rate of money to optimize economic growth which also maintain price growth fairly at safe level for both consumers and producers.

2.1.4 Structuralism Theory

According to the structuralism economists, inflation is attributed to structure of the developing countries' economy. For them, the industrial sector is more responsive to economic policies than agricultural sector. For example, Baumol (1967) used the coexistence of segmented sectors: a progressive (industrial) sector and a traditional (agricultural) sector to show the link between inflation and income distribution. He argues that growth in aggregate demand results from rising output and employment of the industrial sector in the short run. This increases wages in the industrial sector and consequently the wage increment induces demand for goods, including price of agricultural products (food). The rise in agricultural prices will increase wages of the sector to be raised too. It in turn increases demand for industrial products. This cycle of income distributional conflict pushes prices continuously.

Kalecki (1963) also suggests a related but provides slightly a different explanation 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. He also states equilibrium condition will be restored if real income of the vast proportion of the population is fallen. Further, structuralists argue the level of competition and section of society who owned large share of national income is another hidden source of inflation especially for countries with high investment (Jalil and Feridun, 2011). Therefore, structuralists hypothesize real income and the way national income shared among the society determines inflationary condition.

2.2 Empirical Literature Review

This section discusses the empirical evidences from Ethiopia and rest of the World. 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 incorporated in to their respective model were 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 in fact appropriate that the economy's good performance in terms of price stability can be attained by bringing money supply down and interest rate, and also improving exchange rate and government expenditure in context of the country is vital to ensure macroeconomic stabilization.

An empirical study was undertaken by Lim and Sek (2015) on high and low inflation countries with their paper entitled "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 influence of the 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 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 trends of price level in high inflation countries in long run. This study also indicates that money supply has positive influence on price growth while GDP growth and imports of goods and services have negative and significant impact on price level of low inflation countries.

Using time series data for the period from 1970 to 2013, Ruzima 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, agricultural 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 have insignificant negative and positive effect on the variable of interest, respectively.

By their investigation on macroeconomic factors that have been deriving inflation in Ghana during the period 1990 to 2009, Gyebi and Boafo (2013) found that real output, real exchange rate and money supply were the strongest factors behind the 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 achieved its aim of bringing down inflationary trend in the country. Unfortunately, we criticize this paper 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, on the other hand, is 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.

Applying co-integration approach, Enu and Havi (2014) investigated on macroeconomic factors affecting inflation in Ghana which aimed at examining whether foreign direct investment, population growth, foreign aid, agricultural and service's output have significantly impacted the inflationary experience in the country over 1964 to 2008 years. 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 of 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 makes it peculiar.

Using co-integration analyses, Loua et al. (2018) scrutinized the factors that have contributed to growth of price level 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. Accordingly, money supply and exchange rate positively and significantly affected inflation. The effect of GDP per capita, on the other hand, is found to be negative and significant 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 et al. (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 and electricity generation. According to the finding, 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, in the long run, a negative association between price level and foreign direct investment, electricity generation and population is witnessed by result of the investigation.

Gofere (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 deposit interest rate, average exchange rate, fiscal deficit, international petroleum price index and Bain's monopoly mark-up index were employed. The outcome of his study showed 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 though weak relationship between inflation and foreign prices is detected by the investigation. In fact, some studies confirm both conclusions.

Bedada et al. (2020) 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. They 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 revealed, 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 in the preceding year is the only variable dedicated in explaining current year consumer price index. This study also recommended suitable policy implication, emphasizing on the long run influence of money supply growth and budget deficit in pacing up inflationary situation in Ethiopia. Nevertheless, we criticize the study for it incorporated only limited number of variables in to the specified model. It would have been more sensible if

important variables in affecting inflation like national saving and agricultural output were included.

Kahssay (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, the author employed co-integration test.

The empirical analysis resulted from error correction and co-integration reveals 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". Although 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 Abate (2020). The study aimed mainly at identifying and examining macroeconomic determinants of inflation in Ethiopia using annual data spanning over 1985 to 2018. The author identified economic variables influencing inflationary situation during the study period by specifying both long run and short run version of the OLS econometric 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 time. 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. The study, however, excludes important variables which considered by other researchers such as real GDP. Thus, the conclusion and recommendation forwarded by the researcher may not be reliable in case key variables are not considered.

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 attributed 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, leads 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.

3 MATERIALS AND METHODS

3.1 Source and Method of Data Collection

The research entirely applies secondary data. The data were extracted from published and unpublished materials, and databases of concerned institutions and organizations. The data for both dependent variable (CPI) and independent variables: real GDP, broad money supply, lending interest rate, gross national saving, population size, real effective exchange rate and import of goods and services were

collected from domestic institution namely National Bank of Ethiopia (NBE), and internationally, World Bank and IMF's database websites were accessed. Specifically, data on variables like real GDP, broad money supply, gross national saving and import of goods and services were taken from world development indicator database website of World Bank whereas data on consumer price index (CPI), real effective exchange rate and lending interest rate were received from National Bank of Ethiopia (NBE) in document. Population size data were obtained from online database of World Economic Outlook (WEO) of the IMF.

3.2 Method of Data Analysis

For the purpose of data analysis, the study employed inferential method of data analysis. The bound test of ARDL model of time series econometric method of data analysis was employed to examine the long run and short run relationship between macroeconomic variables and inflation.

In econometric 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 (PP) test. 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 leads 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 lost 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 and Uko, 2016).

3.3 Model Specification

3.3.1 ARDL Model

The study employed autoregressive distributive lag (ARDL) model of 'Bounds Testing Approach' to co-integration which was developed by Pesaran et al. (2001). The 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 efficient when the sample size is small or finite which is suitable to the chosen sample size.

In addition, the researchers selected ARDL procedure of co-integration method because of its several advantages. Firstly, the procedure can be applied whether the regressors are $I(1)$ or $I(0)$ or combination of both. Secondly, the ARDL model is statistically a stronger approach in determining the co-integration relationship between variables when sample size is small, but other techniques like VAR models require large data samples for validity. Thirdly, the ARDL procedure does not restrict variables to have the same optimal lags as other models do. Moreover, endogeneity is less of a problem in this approach since each of the underlying variable 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 and Aham, 2016).

The general form of ARDL model is specified as follow:

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

where y_t is rate of inflation (INF); α_{0i} is the constant, $i = 1, 2, \ldots, k$; X_t is a vector of explanatory variables; γ_i are coefficients of dependent variable lags; β_j 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 uncorrelated error term with zero mean. All variables are expressed in logarithm excluding lending interest rate and dummy variable and data on each variable shall be annual. The fact that interest rate by itself has percentage interpretation; it does not require expressing it logarithmically. By extending the above general equation, the long run ARDL model can be specified to examine the relationship between various explanatory variables and inflation growth rate. Specifically, we run the following long run regression equation.

$$\begin{aligned} \mathrm{LCPI}_t = \alpha_0 &+ \sum_{i=1}^{p} \gamma_{1i}\, \mathrm{LCPI}_{t-i} + \\ &+ \sum_{j=0}^{q_1} \beta_{1j}\, \mathrm{LBMS}_{t-j} + \\ &+ \sum_{j=0}^{q_2} \beta_{2j}\, \mathrm{LRGDP}_{t-j} + \\ &+ \sum_{j=0}^{q_3} \beta_{3j}\, \mathrm{LREER}_{t-j} + \\ &+ \sum_{j=0}^{q_4} \beta_{4j}\, \mathrm{LPOP}_{t-j} + \\ &+ \sum_{j=0}^{q_5} \beta_{5j}\, \mathrm{IR}_{t-j} + \\ &+ \sum_{j=0}^{q_6} \beta_{6j}\, \mathrm{IM}_{t-j} + \\ &+ \sum_{j=0}^{q_7} \beta_{7j}\, \mathrm{LGNS}_{t-j} + \\ &+ \beta_8\, \mathrm{DUM} + \beta_9\, T + \epsilon_{it} \end{aligned} \quad (2)$$

By denoting p and q_i, we are allowing explanatory variables to have different lag orders, where $i = 1, 2, \ldots, k$, 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).

3.3.2 Description of the Variables

Consumer Price Index (CPI): 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' income and thereby affect the society's 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 price reference period (Fitsum et al., 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 advantages over GDP deflator by measuring the price level of all goods and services that domestic consumers buy. 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. Since Ethiopia imports considerable amount products from abroad, using GDP deflator to measure percentage changes in price level can underestimate the cost of living. Therefore, CPI is more suitable when consumers' cost of living is desired to be measured (Zeder, 2018).

Money supply (BMS): Broad money (M_2) is a measure of the domestic money supply which 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 (Mishkin, 2009). Money supply is linked with inflation through financial resources and instruments used by monetary policy. Inflation is occurred if central banks cease regulating 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 (Sbhatu, 2010). Thus, positive relationship between the BMS and CPI growth is expected. The NBE takes the broader definition of money or M_2 as money supply and also in the study this definition was used in United States' Dollar (USD) unit.

Real Gross Domestic Product (RGDP): it is an aggregate measure of the size of an economy adjusted for price changes. Real GDP inflation mainly related to inflation through capital accumulation and progress in the efficiency of factor of production. Feldstein (1996) argues that return on capital could be reduced under complete expectation of rise in inflation, provided that the taxation system of many industrialized countries remains 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 et al., 1993). Therefore, negative relationship between real output and inflation is expected even though there is controversy among the scholars on link between the two variables.

Population size (POP): Lebreton et al. (1992) defines population size as "range of the number of individuals present in a subjectively designated geographic". In case of this study, however, logarithmic form of population size expresses it as population growth rate. Both supply and demand side cause of inflation could be driven by population growth. Accelerated population growth can cause 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 and Förster, 2017).

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 relative trade balance of a country's currency against other countries' currency within the index. The variable is expressed in terms of 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 (Şen et al., 2019). Thus, positive relationship between real effective exchange rate and growth CPI is expected.

Lending interest rate (IR): Interest rate is a worth gained from an asset or wealth either invested or saved. Semuel and Nurina (2015) suggest that both demand and supply side of an economy can be affected by interest rate. Moreover, they argue that returns on wealth, financial assets as well as money can affect the overall price level as it acts as an incentive to save or lend. Based on the Fisher's hypothesis, Ayub et al. (2014) argue that interest rate is negatively correlated with inflation. Therefore, this study hypothesises that there is negative relationship between lending interest rate and inflation.

Imports (IM): is the monetary value of foreign goods and/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 (1979) 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 the 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 purchas-

Tab. 1: Summary of variables' description

Variable	Description	Unit of measurement	Expected relationship
CPI	Consumers Price Index	Price index	Dependent variable
BMS	Broad Money Supply	Millions of USD	+
RGDP	Real Gross Domestic Product	Millions of USD	−
REER	Real Effective Exchange Rate	ETB per USD	+
IM	Import of Goods and Services	Millions of USD	+
POP	Population Size	Millions	+
IR	Lending Interest Rate	In percent	−
GNS	Gross National Saving	Millions of USD	−

ing 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 (Islam, 2013).

Gross national saving (GNS): Domestic national saving measures the amount of income saved by: households, businesses and government of a country during a given quarter, semi annual or a year. Fundamentally, it is calculated as the difference between national income and consumption. It also measures status of a nation's financial health because it is saving that generates investment (Mesfin, 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. Higher level of interest rate encourages the people to save more and vice versa. However, based on Keynes's "Theory of liquidity preference" and Friedman's "Modern quantity theory of money", Abou El-Seoud (2014) argues that there are more two ways in which inflation and saving are related to each other. As to the first theory, inflation can create doubt about the future earning streams and hence consumers may save more for cautionary purpose. But for Friedman, inflation could be correlated with saving through its effect on real wealth. Saving can reinforce inflation if consumers seek to hold certain level of liquid assets or wealth relative to their income. Hence, we can reasonably consider the variable as additional explanatory variable. Nonetheless, negative correlation between gross national saving and inflation is expected in either of the two hypotheses.

Dummy variable: It is a formed variable which serves as a proxy for the effect of changed policy from socialism to market-based economy that happened in 1991. Since policy change has an impact on overall performance of an economy in general and price level in particular, it would be vital to capture if there were shocks in inflation rate resulted from such government action. In Ethiopia, policy shift from command economy to market-oriented economy was undertaken immediately after the Ethiopian People Democratic Republic Front (EPDRF) came to power during the aforementioned year. As price and wage flexibility is inevitable in market-based economy, we expect the general price level to be raised as a result of the policy change. From the sample period 1981–2020, the years between 1991 and 2020 take artificial number one (1), and zero (0) otherwise in order to take the phenomenon in to account.

4 RESULTS

4.1 Lag Length Selection

Prior to undertaking unit root tests and estimating the underlying model, maximum lags length must be determined at early stage. Because the estimation results are highly sensitive to lag length of variables, the optimum number of lags needs to be selected before conducting other tests or estimations. These lag numbers are selected by information criterions:

Tab. 2: Lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	184.2475	NA	1.28E−15	−8.749869	−7.97417	−8.47388
1	402.6830	310.409	1.08E−18	−15.98331	−11.7169*	−14.4654
2	516.3241	107.66*	4.78E−19*	−17.70127*	−9.94428	−14.9414*

Note: * indicates lag order selected by the criterion

Likelihood Ration (LR), Akaike Information Criterion (AIC), Schwartz-Bayesian Information Criterion (SC), Final prediction error (FPE), and Hannan-Quinn information criterion (HQIC). These criterions automatically select the maximum lag length of variables to be incorporated in to the specified model, 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 SC and HQIC better perform for large (greater than 60) sample sizes (Liew, 2004). This study therefore uses AIC due to its better performance comparing to other information criterions when relatively small sample size is applied, i.e., $n < 60$ observations. The Tab. 2 shows the computed result using EViews 10.

From the Tab. 2, the asterisks (*) mark the maximum lag length automatically selected by the criterions. Accordingly, all criterions except SC indicated that the optimum lag length 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 maximum lengths above which lag(s) should not be included. Thus, it is possible for some variables to be lagged lower than the automatically determined. For example, when each of them tested individually, 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.

4.2 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 data because estimation without undertaking unit root test may lead 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. Besides, Newey-West bandwidth automatically selects lag for Phillips-Perron (PP) unit root test. The Tab. 3 summarizes the stationary test results from both methods.

The ADF and Phillips-Perron (PP) unit root tests results reveal that all variables interred into the model are non-stationary at level except logarithm of population size (LPOP), which is stationary under PP unit root test with intercept at 5 percent level of significance. 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 from 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 results of ADF and PP stationarity test provide similar outcome that almost all included variables are $I(1)$, i.e., integrated order one. Having this guarantee from unit root test, we can reasonably estimate the underlying model.

Tab. 3: Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

	At level		At first difference	
Series	**Intercept**	**Intercept & trend**	**Intercept**	**Intercept & trend**
ADF 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 test				
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***

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

4.3 ARDL Model Estimation Results

The study employs autoregressive distributive lag (ARDL) model. The model applies 'Bounds Testing Approach' to co-integration which was developed by 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 are estimated. Tab. 4 reports the parameters' estimates of the 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. The chosen lag structures by the AIC for the above variables are $[p, q_1, q_2, \ldots, q_8]$ $= [1, 2, 1, 1, 0, 2, 2, 0, 1]$ respectively. All 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.

Coming up with such outcome may not be associated to the technique or model employed. Neither had it occurred due to endogeneity effect because such challenge is less problematic in ARDL approach since each of the underlying variable stands as a single equation. Even when the same data are regressed using VAR and Granger causality techniques, no change in sign of these variables is observed. Hence, endogeneity problem is less suspected to affect direction of these variables' impact on dependent variable. Rather we believe that contradiction of the sign to the prior hypothesis has empirical implication about the economy.

Tab. 4: 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	0.91631***	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

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

The economic intuition why coefficients of these variables come out in opposite of the prior expectation was reflected in discussion part.

From Tab. 4 we can infer that the first lag of CPI is significant at 1 percent, implying considerable effect of previous year price aggregates on the current year general price level. All coefficients of LBMS (current level, first and second lags) are also significant at five percent significance level. Both current and lagged coefficients of RGDP are positive, but coefficient of the first lag is statistically 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. Nevertheless, the result displays insignificance of current year 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 subsection presents statistical reliability checks of the model.

4.4 Post Estimation Diagnostics and Stability Tests

The post estimation tests are required to check reliability of the estimated result. The most commonly used tests in dynamic models are: normality, autocorrelation, heteroscedasticity, and model specification and stability tests. Such tests are undertaken to guarantee regression of the model that the obtained results are free from spurious regression. Moreover, they warrant robustness of the model.

As we can see from Tab. 5, the model passes all post estimation diagnostic tests. The Breusch-Godfrey Lagrange Multiplier autocor-

Tab. 5: 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
Heteroscedasticity (BPG)	0.88	$F(19, 18)$	0.60	0.5021
Heteroscedasticity (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

relation 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. The d-statistics also confirms non-spuriousness of the regression since its value exceeds the adjusted R-squared. To check heteroscedasticity problem the conducted Breusch-Pagan-Godfrey test conveys that both standard (0.60) and Chi-squared probability (0.50) values are greater than 5% level of significance. This result leads to accept null hypothesis stating 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, the result supports for absence of heteroscedasticity problem.

Furthermore, the above summary table on diagnostic tests confirms normality of the residuals and correct specification of the model. JB statistics (0.26) is much higher than the standard level of significance (0.05), and probability of obtaining this value is 0.87. Since the residuals are normally distributed, we can claim that hypotheses of the coefficients' estimates are validly tested. Besides, the model specification test checked by Ramsey RESET test shows absence of omitted variable(s) because the RESET test p-value (0.33) highly exceeds the standard significance level. Therefore, these evidences lead us to conclude that the model is correctly specified and the result is robust as well.

Model stability test: The most commonly used to test stability of a model are cumulative sum of recursive (CUSUM) test and CUSUM of squares test. The tests are based on the residuals from recursive estimates and presented by Fig. 1.

Null hypothesis H_0*:* CUSUM distribution is symmetrically 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 is accepted otherwise.

From Fig. 1, we fail to reject null hypothesis that cumulative sum of squares of recursive (CUSUM) is symmetrically distributed at 5% level of significance. At the same level of significance, the CUSUM test also confirms similar result, supporting robust stability of the model[1]. Since the model passed all diagnostic and stability tests, we can proceed to examine co-integration test.

4.5 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

[1]Non-squared version of CUSUM statistics stability test which supports CUSUM of squares result is not included here to avoid redundancy. Its graph is available up on request of the reader.

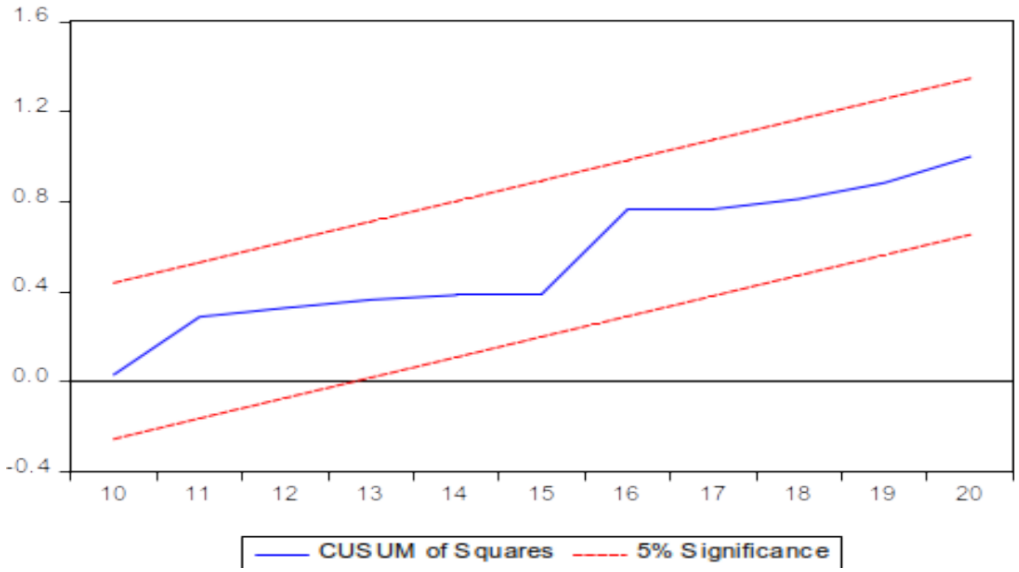

Fig. 1: CUSUM of Squares
Source: Model diagnostics test result using EView 10, 2021.

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 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. Tab. 6 presents result from the bound test.

Tab. 6: ARDL Bound test for long run relationship

Test statistic	**Value**	**Level of significance**	$I(0)$	$I(1)$
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

Notes: F-Bounds Test, null hypothesis: no levels relationship. Asymptotic: $n = 1000$.
Source: own computation using EViews 10, 2021.

F-statistics from Tab. 6 reveals that the F-value (12.71) exceeds the values of upper bound at all levels of significance. Therefore, we can reject the null hypothesis of no level relationship in favour of alternative hypothesis, supporting for the existence of co-integration. This evidence robustly confirms the presence of long run relationship between dependent and right hand variables. Hence, long run and short run models can be reasonably estimated. The estimated parameters' estimates of long run equation of the model are presented by Tab. 7.

Tab. 7 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. As indicated in the preceding section, 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 percentage. The last variable (DUM) takes one (1) artificial number for the policy change since 1991 to 2020 and series years before the liberalization (1981 to 1990) 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

Tab. 7: 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	0.9199189*	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

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

run equation form of the inflation model can mathematically be specified as:

$$\begin{aligned} \mathrm{LCPI} = {} & -0.3 + 0.7\,\mathrm{LBMS} + 2.91\,\mathrm{RGDP} + \\ & + 0.92\,\mathrm{POP} + 0.69\,\mathrm{LREER} - \\ & - 0.44\,\mathrm{LIM} - 0.63\,\mathrm{LGNS} + \\ & + 0.07\,\mathrm{IR} + 0.26\,\mathrm{DUM}, \end{aligned} \tag{3}$$

where −1.77, 1.38, 2.77, 1.96, 3.13, −2.04, −1.8, 2.99 and 2.33 are t-values of the corresponding coefficients.

In this section, we describe each variable in terms of sign and statistical significance, but explanations of interpretations and relative findings are left for the discussion part. In long run, broad money supply (LBMS) is not statistically significant, 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, each variable has inverse and direct association with growth of consumer price index (CPI), respectively. 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 with the dependent variable is examined in the next section.

4.6 The Short Run ARDL Model Estimation Result

Estimating an error correction model would be imperative once the presence of long-run relationship between the variables is confirmed by 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 out that one year lagged coefficient of ECT is negative, and it is also 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. Tab. 8 reports regression result obtained from ARDL error correction model.

Result from error correction model (ECM) in table 8 shows 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 like 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%, but the dummy variable found to be significant only at 10 percent. Regarding direction of these variables' effect on inflation coefficients

Tab. 8: 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)	0.91631***	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
Coint. Eq. (−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 statistics = 2.246313

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

of one year lagged broad 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 signified by the ECM adjusted coefficient of determination.

5 DISCUSSION

Broad money supply (LBMS): As expected, each 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. 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 conducted in Ethiopia such as Gebremeskel (2020) and Kahssay (2017), who suggested that monetary growth is instantly inflationary phenomenon without any long run adjustment toward the equilibrium. Further, the finding partially supports the QTM and monetarist view, but contradicts the reformulated QTM (Keynes's Version) theory, which claims no effect of money expansion on general price level prior to attainment of full employment.

Real gross domestic product (RGDP): The result from both short run and long run dynamics suggests positive and significant effect of real 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 long run real 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 on the effect of this variable. This finding is not limited to the current study, because researchers such as Gashe (2017) 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 price of products rises, 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 hike. 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 (0.92) implies that a percentage increase in population size leads inflation rate to be grown by 0.92 percentages. The elasticity is almost the same in the long run case, but its 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, Pakistan and Rwanda by Enu and Havi (2014); Furrukh et al. (2016), and Ruzima and Veerachamy (2015) respectively, revealed importance of population growth in explaining inflation in context of these countries though its impact in relation to direction and time dimension is different. This study implies the effect of population on price increase is robust in short run than the long run. 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 things 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 IMF (2020) and Abate (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 current year coefficient of import is insignificant, 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 the finding got by Kahssay (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 the variable on consumer price index. Keeping other things constant, a unit increase in percentage of gross national saving reduces consumers price index by 0.066 percent, while its previous year accumulation encourages variable of interest by 0.13 percent, indicating stronger effect of national saving inertial than its current year influence. In long run process, a percent rise in gross national saving diminishes consumer price index by 0.63 percent, other thing remains the same. Nevertheless, the long run statistical significance is weak (at 10 percent level of significance), which reveals strength 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 Gashe (2017) and Kahssay (2017). Generally, we can conclude that gross national saving is among significant determinants of inflation both short run and long run model though it is statistically weak in the latter case.

Lending interest rate (IR): In contrast to theoretical expectation (based on the Monetarists hypothesis), an increase in the lending interest rate by a percent induces consumer price index by 0.07 percent, other things remain constant. This finding suggests positive relationship between lending interest rate and growth of price level though the magnitude is too small. Thus, it would be vital to conclude that Monetarist theory (see Friedman and Schwartz, 1963), of interest rate do not work in the context of Ethiopian economy. Yet, the finding supports the works of Haile and Megerssa (2020), 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 in the country may also moderately elucidate the less importance of the monetary instrument to contain inflation.

Dummy variable: It is a created variable to capture effect of changed policy from socialism to liberal capitalism occurred during 1991/92. The result shows that in the long run, the price policy during the market based economic system has positively affected inflation rate with 0.26 percent contribution. However, effect of the policy change is weak in short run both in magnitude (−0.05) and statistical significance (10%). This may lead us to conclude that the impact of change in price policy undertaken when Ethiopian People Democratic Republic Front (EPDRF) seized power is not forgotten, and it is stronger in long run than short run process.

6 CONCLUSIONS AND POLICY IMPLICATIONS

6.1 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 cause inflationary tendency especially through 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 researchers.

Focusing on the reality 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 was employed to check whether co-integration exist between the inflation proxy variable and the right-hand side variables included by the model. Then both long run and short run (ECM) version of the model were regressed after checking all diagnostic tests. The bound test of co-integration shows the existence of long run relationship between the dependent and independent variables. 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 have moderate and weak effect on 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 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 inflation dynamic. Relative to other macroeconomic variables, elasticity of population size found to have greater effect on short run dynamics of price growth, which may reflect high influence of population size in pushing up the consumer 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.

6.2 Policy Implications

Based on the obtained results 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 supply 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 to 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 accesses 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, partly in 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 thereby 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.

Population size also 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 which 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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