Determinants of Inflation in Ethiopia: Autoregressive Distributed Lag Model

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Abstract
Price stability is one of the major goals of monetary policy and the key indicators of macroeconomic stability. Pursuing of price stability is primary to long-run growth and development; it should be the concern of every economy. This study examine the factors in determining inflation in Ethiopia, using the autoregressive distributed lag (ARDL) model by employing the data series for the period ranging from 1974 to 2017. The ADF Unit root test confirmed that the variables in the model are integrated of order 0 I (0) and order one I (1)). The Bound F-test of co integration has confirmed the existence of long run relationships among the variables entered in the inflation model. ARDL regression result suggest that real gross domestic product, real effective exchange rate and budget deficit variables are important in determining inflation in the short run. In the long run inflation is determined by real effective exchange rate, budget deficit, gross national saving and lending interest rate. The error correction term coefficient is negative and significant at 1 percent level of significance suggesting that inflation adjusts to deviations from its long -term equilibrium. The estimated model passes diagnostic tests and the graphical evidence (CUSUM and CUSUMQ graphs) indicate that the model is stable during the sample period. Finally, investments in food and agricultural sectors could considerably support the process of ensuring price stability. Moreover, a credible and sustained fiscal adjustment, aiming to boost revenue generation can reduce fiscal deficit.

Keywords: Inflation, Gross Domestic Product, Money Supply, Budget Deficit

1. Introduction
1.1. Background of The Study
Price stability is one of the major goals of monetary policy and the key indicators of macroeconomic stability. It is widely accepted that the pursuit of price stability is primary to long-run growth and development; it should be the concern of every economy. Given this scenario, the focus of monetary policy is primarily to be narrowed to the pursuit of moderate inflation rather than output or unemployment (Odusanya I. A. and A.A. Atanda, 2010). Inflation is a sustained rise in general price level of goods and services in a given economy. The definition of inflation concern neither increase in price of particular commodity nor for particular period of time. For an inflation to be happened, the rise in the general price of goods and services should be sustained. Inflation takes a crucial role in the healthy functioning of a countries economic performance. It is commonly recognized that an unpredictable fluctuation in the rate of inflation is considered a major indicator of the instability of economic activity of a country [1].

Inflation is caused by demand pull, cost push or structural factors. Demand pull inflation: is inflation, which is caused by increase in demand due to increased private and government spending. Cost push inflation: also referred to as supply shock inflation caused by reduced supplies due to increased price of

inputs, for example crude oil prices have gone up causing supply constraints which means higher cost of production. Structural inflation: a type of inflation caused by deficiencies in certain conditions in an economy such as backward agricultural sector that is unable to respond peoples increased demand for food, inefficient distribution [2].

Inflation occurs when the total demand for goods and services in an economy exceeds the supply. When the supply is less, the prices of these goods and services would rise. Inflation affects everyone in the economy. Thus, when the price level rises, each unit of currency buys fewer goods and services; inflation is also erosion in the purchasing power of money, a loss of real value in the internal medium of exchange and unit of account in the economy (Walgenbach etal).

In Sub-Saharan Africa (SSA) inflation and inflation volatility have been gradually declining. In the 1980s, monetary policy was subordinated to the objective of financing large fiscal deficits in the region. This led to high inflation and, in combination with fixed exchange rates, overvalued real exchange rates [3]. From the mid–1980s to the late 1990s countries began reform programs, often with exchange rate unifications and movement toward more market-determined exchange rates, notable reductions in central bank financing of government and financial lib-

eralizations. With substantial debt relief and a favorable external environment, fiscal discipline was reestablished in many parts of SSA. This provided support for money-based disinflation programs to bring down inflation to single digits (or near single) by the late 1990s in the context of higher economic growth and higher international reserves, in line with the experience in other developing countries. Nevertheless, managing inflation pressures remains one of the biggest challenges for policymakers in the region. Headline inflation is considerably more volatile in SSA relative to other regions given high share of food in the CPI and more volatile relative food prices (mostly owing to unstable agricultural production). Output and inflation tend to be negatively correlated as a result, making the tradeoff between inflation and output stability potentially more severe. The prevalence of supply-side shocks also reduces the ability of monetary policy in influencing inflation in the short run. At the same time, the weaker relationship between money and inflation over time, at least in countries with low to moderate inflation, limits the role of money targeting regimes commonly observed in SSA in delivering low inflation and managing inflation expectations [4].

In Ethiopia the history and trend of inflation shows that prior to 2002 inflation has remained more or less stable. During the Derg regime, price was controlled by the government, viz, had kept price stable. The government was also rationing goods at fixed price to the public which in turn had contributed to the lower inflation attaining during the Derg regime. In the same case, the country had not suffered from high inflation and annual average inflation was only 5.2 percent during 1980-2002(WB, 2010; NBE, 2010). During the earlier years of the current government, inflation rate was low despite the huge inflow of money by International Monetary Fund (IMF) and World Bank (WB). This happens because of the displacement of former governments and layoffs of workers due to structural adjustment policy (SAP)followed by the country had depressed demand [5].

However, in the post 2002/03, the situations have been dramatically changed. Inflation started to increase. During the same period, the economy has recorded fast growth rate (On average 10.5 percent GDP growth) and continued growing consecutively for the last eight years, according to reports (WB, 2010; NBE, 2010). In 2000 and 2001, the inflation rate was negative 7.2 and 8.5 percent respectively. However, in 2002, the inflation rate had been increased to 15.1 percent. But the recovery of the agricultural production and general economic growth has reduced the inflation rate to 6.1 percent in 2004. In 2004, the inflation rate declined by 60 percent as compared to 2002. After 2004, the inflation rate could not show any sign of declining till 2008. In 2008, the inflation reached its highest 36.4 percent (NBE, 2010).

In 2010 the annual average general inflation at the close of the fiscal year 2010/11 was 18.1 percent, 15.3 percentages point higher than the preceding year level. This was predominantly due to the hike in the prices of food items that contributes the lion's share of 14.1 percentage point of the total annual change in headline inflation while non-food items made up the remaining 1.2 percentage point (NBE, 2010). But the average annual inflation has declined to 8.1 in 2013/14 due to the slowdown in

both food & non-alcoholic beverages and non-food inflation by 6.7 and 3.9 percentage points, respectively.

Inflationary pressure was contained by imports and cross-regional redistribution of domestic market purchases of foodstuffs supported by a restrictive monetary policy stance. From an 11.9 percent peak in 2015, headline inflation receded to 7.5 percent by 2016, driven by food price moderation (IMF, 2016). Though Ethiopia has experienced a low inflation, recently, double digit inflation has become worrisome for policy makers as well as the society. (Nandeeswara R. and Abate Y., 2015) Abate (2015) has studied the optimal level of inflation in Ethiopia around which inflation affect economic growth optimally. The study has applied threshold approach. By doing so on the data from 1974-2012 inflation level of about 9-10 percent is optimal for Ethiopia. Any inflation level, greater or less than the estimated threshold level, may not allow long-term and sustainable economic growth. Thus, it is essential that the government intervene to control the price trend in the country. However, such intervention requires appropriate policies devised from careful observation of the forces behind the price fluctuations. Therefore, studying the possibility of controlling inflation is one of the themes to be addressed in Ethiopia.

2. Statement of The Problem

The Ethiopian economy is highly dependent on agriculture and agriculture by its nature is weather dependent and characterized by fluctuation in output. Agriculture contributes over 36.7 percent of the national GDP of Ethiopia (NBE, 2016) and past histories showed that there exist a direct link between weather condition and agricultural production i.e. good weather conditions leads to good agricultural output With this systematic relationship between GDP (output) and rainfall there followed a systematic price variation i.e. Prices followed the inverse of output trend [6].

Inflation hampers Ethiopia from reducing poverty and hunger. The living standard of urban dweller has been adversely affected by inflation. Inflation also redistributes wealth thereby increasing the number of poor people in the county. Even if it is, said by the government that farmers benefit from rising food prices, something that needs empirical investigation, rise in food prices are causing many to be unable to feed themselves. Most importantly inflation in Ethiopia may misallocate resources from productive to unproductive sectors [5].

Inflation is bad because it affects people adversely. Inflation reduces the real income of people, especially those with fixed incomes, reduce their living standard and reduce saving. The reduction in saving is due to the desire of more money to buy goods and services. This results in lower investment and capital formation. Inflation also hinders foreign direct investment because rising cost of materials and inputs increases production costs which in turn makes foreign direct investment less profitable (Ibid).

Inflation makes investment doubtful for both domestic and foreign investors. Also, it destroys the terms of trade in the country

by increasing the price of domestic goods more than the regional and the world market price. As a result, trade becomes non-competitive to the global market [7]. Accordingly, the non-competitive of trade leads to the deficit in the current account. Over the years, there have been a considerable number of researches in the field of inflation. examined the determinants of inflation in Pakistan by using Vector Autoregressive analysis approach and they found that the growth rate of import prices is the most important determinant of inflation in Pakistan both in the short run and long run, which is followed by the growth rate of output in terms of importance [8]. The effect of Money supply on inflation is negligible and statistically insignificant. employed Error Correction Model (ECM) to examine the short run and long run determinants of inflation in Tanzania. The study used quarterly data covering the period 1992 to 1998 [9]. The empirical result shows that in the short run inflation is influenced by money supply and economic growth. In the long run inflation is determined by exchange rate. While inflation in Tanzania is a monetary phenomenon for both short run and long run. The authors have recommended government to use both monetary and fiscal policies to control inflation in Tanzania. examined the determinants of inflation in Saudi Arabia for the period 1980 to 2009, both in the long run as well as in the short run, using co-integration method developed by Pesaran et al. (2001). The result shows that inflation in world economy, depreciation of domestic currency and supply bottlenecks are the major factors influencing inflation in the long run [10]. In the short run, money supply and supply bottlenecks have been found to be the major factors influencing inflation in the country. used quarterly data from 1997/98 up to 2007/08 by using co integration approach to identify determinants of recent inflation in Ethiopia. The empirical result shows that inflation has been negatively related to real GDP growth and positively related to money supply growth and average lending rate. But, exchange rate has been found to have no significant impact on inflation [5]. He recommended that by avoiding the structural bottlenecks in the economy and by increasing money supply in line with output growth, it is possible to curb inflation.

Using monthly data over the past decade January 2000 to December 2009, to identify the determinants of inflation in Ethiopia they applied general-to-specific modeling and estimate single equation error correction models (ECMs) for the Consumer Price Index (CPI) and three of its major components, and they concluded that the overall inflation in Ethiopia is closely associated with agriculture and food in the economy, and that the international food crisis had a strong impact on domestic inflation used quarterly data from 1998 up to 2010 by employing Granger Causality Model approach to investigate the determinants and impact of inflation dynamics in Ethiopia [11,12]. The empirical result shows that there existed a bi-directional causality between money supply growth and inflation and a unidirectional causality between currency devaluation, oil price volatility and inflation. The empirical result also shows that exchange rate plays an important role in price fluctuations of goods and services in Ethiopia. However, the causality between inflation and economic growth is weak and insignificant i.e. economic growth does not Granger cause inflation.

employed ordinary least square method and Error Correction Model (ECM) to examine the major determinants of inflation in Ethiopia using data for the period from 1975 up to 2014 [13]. The empirical result shows that in the long run inflation has been positively related to real GDP growth and money supply growth and negatively to the gross national saving and import of goods and services. It also shows that in the short run inflation is determine by real GDP growth, money supply growth and gross national saving. He recommended that, it is possible to control inflation by using tight monetary policy and taking measures to increase the public saving while encouraging business firms and households to rise the private saving.

Even though many researchers have undertaken a variety of researches regarding the determinants of inflation in Ethiopia, they did not agree as to the specific variables that causes inflation in the country. This paper will try to fill the gap that has been seen in the above literatures. In addition, this paper is unique from previous literatures with regard to the econometric model that is going to be employed and in using long term annual data and come up with the trends, determinants of inflation in Ethiopia that enables us to design appropriate policy.

3. Objectives of The Study
The general objective of the study is to investigate the main determinants of inflation in Ethiopia. Under the heading of the above main objective, the study addressed the following specific objectives;
• To assess the trend of inflation in Ethiopia.
• To investigate the variables that determines inflation in Ethiopia.

4. Methodology
4.1 Type and Source of Data
The study has employed time series data covering the period 1974-2017. Annual data was extracted from secondary sources (Minister of Finance and Economic Development (MoFED), National Bank of Ethiopia (NBE), Government reports, International Monetary Fund (IMF), World Bank (WB)). The relevant secondary data were collected from the above-mentioned sources by referring appropriate websites.

5. Methods of Data Analysis
After the required secondary data was collected, the researcher used both descriptive and econometric analysis. The descriptive analysis was used to analyze the trend of inflation in Ethiopia while econometric analysis was applied to examine the relationship between inflation and the explanatory variables. In dealing with the econometric analysis, the researcher used Bound F-test co-integration technique to show whether there is long run relationship among the variables. After co integration has been detected between the series, the study employed autoregressive distributed lag (ARDL) model to examine the relationships between the model variables (series) both in the long run and in the short run.

6. Model Specification and Variable Description
In this study, the dependent variable is inflation and the inde-

pendent variables are economic growth (real gross domestic product), broad money supply (M), real effective exchange rate (REER), budget deficit (BD), lending interest rate (LIR) and gross national saving (GNS). In this study, CPI was taken as a proxy to inflation variable and was the dependent variable whose behavior in a relation to other variables has been investigated. No doubt, higher proportion of income in Ethiopia is spent on consumption of final goods and services. According to the Ethiopian 2014/2015 third quarter economic report of UNDP, more than 56% of households' expenditure was made on food, beverages and other final consumable goods and services. Therefore, to use CPI is more appropriate and contextual in the case of Ethiopian economy. GDP-Deflator is inappropriate because it excludes the impact of imported inflation on domestic price owing to the definition of Gross Domestic Product. On the other hand, Producer Price Index (PPI) is not suitable to represent inflation in Ethiopia compared to CPI, since the proportion of income spent on the purchase of raw material is low in the country. Therefore, CPI is the dependent variable in the inflation of model.

Classical Quantity Theory of Money provoking the direct and exact relationship between money supply and general price level. Quantity theory of money is a classical theory that related the amount of money in the economy to nominal income. Nominal income is determined solely by movements in the quantity of money. It states the changes in the quantity of money tend to affect the purchasing power of money inversely, that is, with every increase in the quantity of money, each monetary unit (such as birr) tends to buy a smaller quantity of goods and services while a decrease in the quantity of money has the opposite effect. The relationship is expressed by the identity given by;

$$MV = PY \quad \text{.. (3.1)}$$

Where; M, V, P, and Y are stock of money supply, velocity of money, general price level (measure of inflation) and the real output variables respectively.

Since the intention is to determine P in the model, equation (3.1) can be expressed in terms of price as follows:

$$P = MV/Y \quad \text{.. (3.2)}$$

The natural log of equation (3.2) becomes,

$$lnP = lnM + inV - lnY \quad \text{.. (3.3)}$$

However, it is important to include other potential variables in the model to investigate their impact on inflation. Accordingly, the deterministic relationship between the dependent and all the independent variables employed can be expressed as;

$$P_t = f(RGDP_t, M2_t, REER_t, BD_t, LIR_t, GNS_t) \quad \text{................................... (3.3)}$$

Where , P_t, $RGDP_t$, $M2_t$, $REER_t$, BD_t, LIR_t & GNS_t are price, real gross domestic product, broad money supply, real effective exchange rate, budget deficit, lending interest rate and gross national saving at any time of t respectively.

From the above theoretical discussion and by assuming all other things being constant the econometric model was specified in the following manner:

$$lnP_t = B_0 - B_1 lnRGDP_t + B_2 lnM2_t + B_3 REER_t + B_4 BD_t + B_5 LIR_t + B_6 GNS_t + U_t \quad \text{................. (3.4)}$$

Where; ln value of variables indicates the logarithmic expressions (growth rate of variables); Ut is the error term as usual, and the parameters B_1, B_2..... B_6 are the long run elasticity's of the independent variables; and the constant term B0, is a value that the dependent variable assumes when values of all the independent variables are zero.

7. Variable Description
7.1. Real Gross Domestic Product
it reflects the value of all goods and services produced by an economy in a given year, expressed in base-year prices, which account for changes in price level and provide a more accurate figure of economic growth.

8. Broad Money Supply
it is the total amount of monetary assets available in an economy at a specific time. It is a measure of the domestic money supply that includes M1 plus Quasi-money (savings and time deposits), overnight repurchase agreements, and personal balances in money market accounts. NBE takes the broader definition of money or M2 as money supply.

9. Real Effective Exchange Rate
it 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. When there is devaluation, import price increases which in turn leads to higher price of domestically produced goods.

10. Budget Deficit
it occurs when expenses exceed revenue and indicate the financial health of a country. Inflationary effect of government deficits depends upon the means by which the deficit is financed and the impact of the deficit on aggregate demand.

11. Lending Interest Rate
it is the bank rate that usually meets the short-term and medium-term financing needs of the private sector /the rate of interest that you have to pay to a commercial bank when you borrow money from them.

12. Gross National Saving
it is derived by deducting final consumption expenditure from

gross national disposable income, and consists of personal saving, plus business saving, plus government saving, but excludes foreign saving.

13. Model Estimation Procedures
13.1. The Unit Root Test
The Augmented Dickey-Fuller (ADF) unit root tests will be applied in order to examine the stationarity property of each variable entered the inflation model of the present study.

It is conducted by extending all the equations under consideration by adding the lagged terms of the dependent variables, and requires estimation of the following regression;

$$\Delta yt = \beta'Dt + \phi Yt - 1 + \sum_{i=1}^{s} \Pi j\Delta yt - j + \varepsilon t \dots\dots\dots\dots\dots\dots (3.5)$$

Where, εt; is the usual pure white noise error term; Dt is vector of deterministic terms of the constant term. The S lagged difference terms, Δyt-j are used to approximate the ARMA structure of the error terms. The value of s is set so that the error terms (εt) are serially uncorrelated.

Alternatively, the more general and robust ADF regression, considering both the trend and drift terms can be given as follows;

$$\Delta y_t = \beta 0 + \gamma_{1t} + \delta \Delta y_{t-1} \sum_{i=1}^{s} \Pi j\Delta yt - j + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots (3.6)$$

Where, $\delta = \Phi - 1$ and $\Delta y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, and the like. B_0 is the intercept term, $\gamma 1$ is the trend coefficient, t is the time/trend variable and where; S's are the lag terms.

For this test, the hypothesis would be;
Where, H0: $\delta = 0$; there is unit root; (implying the time series is non-stationary).
H1: $\delta < 0$; No unit root; the time series is stationary
Decision: reject the null hypothesis of ($\delta = 0$), hence the time series is stationary; if the computed t-statistic (in absolute terms) exceed the ADF critical values; the variable under consideration is stationary.

14. Co-Integration and Autoregressive Distributed Lag (ARDL) Model
In this study the autoregressive distributive lag (ARDL) co integration technique or bound testing technique developed by Pesaran (2001) is employed. The autoregressive distributed lag (ARDL) approach is a new co-integration technique for determining long-run relationships among variables under study which is a more statistically significant approach for determining co-integrating relationships in small samples, while the Johansen co-integration techniques require larger samples for the results to be valid (Ghatak and Siddiki, 2001; Pahlavani, 2005).

An advantage of the ARDL approach is that, while other co-integration techniques require all of the regressors to be integrated of the same order, ARDL can be applied irrespective of their order of integration. It thus avoids the pretesting problems associated with standard co-integration tests (Pesaran et al., 2001). Moreover, with the ARDL, it is possible that different variables have differing optimal numbers of lags, while in traditional models this is not possible.

The ARDL bounds test procedure is based on the joint F-statistic (Wald statistic) which tested the null of no co integration against the alternative hypothesis of co integration;
$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$
$H_A: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$
The computed F-statistics from the test is then compared with critical value from pesaran (2001). If the computed F-statistics exceeds upper bound critical value, then the null hypothesis no long run relationship (no co integration) can be rejected at 1% significance level.

According to Pesaran et al. (2001) and Pesaran and Shin (1997) the augmented ARDL model can be expressed in the following form:

$$y_t = a_0 + \sum_{i=1}^{k} B_i \ x_{it} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(3.7)$$

Where yt is the dependent variable, a_0 is the constant term, xit are the independent variables and ε_t is white noise error term.
Rearranging equation 3.7, ECM version of the ARDL model can be obtained in terms of the lagged levels and first difference as follows:

$$y_t = a_0 + a_{1t} + \lambda_{yx} v_{t-1} + \sum_{i=1}^{p-1} \theta_i \ \Delta x_{t-i} + \sum_{i=1}^{p-1} \theta_i \ \Delta x_{t-i} + \varepsilon_t \dots\dots\dots\dots\dots\dots.(3.8)$$

Where Δ, t and θ_i represent first difference operator, time trend and short run movements of the inflation model.

15. Data Analysis and Interpretation
15.1. Descriptive Data Analysis
15.2. Trends of Inflation
Inflation in Ethiopia during 1974-2017 showed a fluctuating behavior characterized by successive ups and downs. Food inflation also showed similar trends with the general inflation indicating its strong impact on it. Non-food Inflation has also showed ups and downs but its impact on influencing the trend of inflation was minimal as shown in figure below.

Historically, Ethiopia has not suffered from high inflation. The annual average growth rate was only 6.9 percent from 1974–2001, and major inflationary episodes have occurred only during conflict and drought. Annual average inflation reached a record of 21.9 percent and 16.4 percent during 1976 and 1985 respectively because of drought, 21.9 percent in 1991 due to political instability, and again 10.9 percent during the 2002/03 drought.
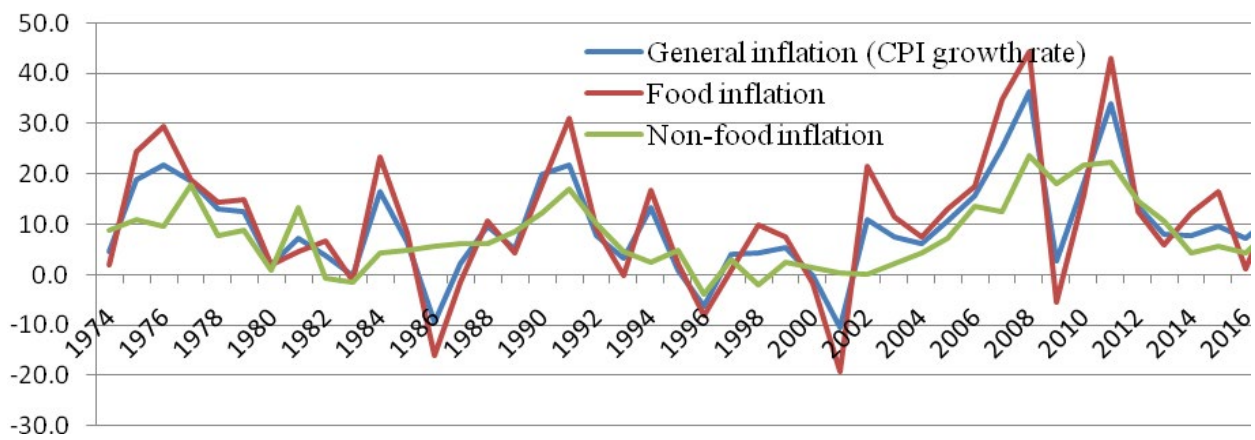

Figure 1: Trends of inflation (General, food and non-food inflation)

In 2001, the inflation rate was negative -10.9 percent due to good harvests and significant amounts of food aid inflows (Yohannes etal, 2010). In 2002, the inflation rate increased to 10.9 percent. But the recovery of the agricultural production and the general economic growth has reduced the inflation rate to 6.1 percent in 2004. After 2004, the inflation rate could not show any sign of declining till 2008. In 2008, the inflation rate reached its highest 36.4 percent due to worldwide economic and financial crises (NBE, 2009/10).

Annual general inflation declined to 2.8 percent at the end of 2009. This was largely attributed to the slowdown in the prices of food items. In 2010 and 2011 the annual average general inflation was 18.1 and 34.1 percent respectively. This was predominantly due to the hike in the prices of food and non food items (NBE, 2011/12). But the average annual inflation has declined

to 8.1 in 2013 due to the slowdown in both food & non-alcoholic beverages and non-food inflation by 6.7 and 3.9 percentage points, respectively (NBE, 2013/14).

16. Econometric Results and Discussion
16.1. Unit Root Test
Since the data set used in this study was a time series data, stationary of the variables is important. First, a regression based on non-stationary time series explains the relationship during the study period only. This means that it is impossible to infer about the long run relationship of the variables. In addition, regression of non-stationary time series on another non stationary time series may lead to spurious regression. Augmented Dickey Fuller (ADF) test has been chosen to test for the existence of unit root because it accounts for correlation and in addition it is also widely used in unit root tests.

Variables	Level	P-value at level	Lag length	Difference	P -value at difference	Lag length
CPI	-5.016***	0.0010***	0	-9.137***	0.0000***	1
RGDP	-6.536***	0.0000***	1	-10.596***	0.0000***	1
M2	-4.907***	0.0014***	0	-7.810***	0.0000***	1
REER	-1.567	0.7893	0	-5.355***	0.0004***	0
BD	-5.585***	0.0002***	0	-7.427***	0.0000***	1
GNS	-2.782	0.2116	3	-8.671***	0.0000***	1
LIR	-2.552	0.3029	0	-7.030***	0.0000***	0

*Note: In value indicates growth rates. ADF critical values are -4.192337, -3.520787 and -3.191277 at 1%, 5% and 10% respectively. *** indicates 1% level of significance and rejection of the null hypothesis of unit root respectively. The lag length in the Augmented Dicky Fuller (ADF) test is based on the Schwarz Information Criterion (SIC). All results are obtained from Eviews 9 econometric package.*

Table 1: ADF tests for unit root with constant and trend.

From the table shown above, consumer price index, real GDP growth, broad money supply growth and budget deficit are stationary at level I(0) at 1% level of significance while real effective exchange rate, gross national saving and lending interest rate are stationary at their first difference I(1). Therefore, one can not apply the traditional co integration tests of Engle and Granger (1987) as well as Johansen (1995) co integration tests. However, this problem can be removed by using the ARDL bound test approach which is developed by Pesaran et al (2001) to observe the long run relationship among the variables. Thus, the co integration method used here, the ARDL method, allows testing for a long-run relationship between variables of mixed order of integration (Pesaran et al., 2001).

17. Co-Integration Test

In this study the existence of the long-run relation between the variables under investigation is tested by computing the Bound F-statistic (bound test for co integration) developed by Pesaran

(2001) in order to establish a long run relationship among the variables. In the absence of co integration among variables, it is impossible to model the long run relationships among them. In practice, testing the relationship between the forcing variable(s) in the ARDL model leads to hypothesis testing of the long-run relationship among the underlying variables. When the computed F-statistic is greater than the upper bound critical value, then the null hypothesis of no co integration is rejected (the variables are co integrated). If the F-statistic is below the lower bound critical value, then the null hypothesis of no co integration cannot be rejected (there is no co integration among the variables). If the computed statistic falls within(between the lower and upper bound) the critical value band, the result of the inference is inconclusive and depends on whether the underlying variables are I(0) or I(1). If the bounds test does not reject the null hypothesis of no longrun relationship, an ARDL model purely in first differences (without an equilibrium correction term) might be estimated.

Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10% 5% 2.5% 1%	2.12 2.45 2.75 3.15	3.23 3.61 3.99 4.43
F- statistic	6.126077	k=6

Note: K- is the number of regressors and critical values are obtained from pesaran et al...(2001).

Table 2: Co integration tests using a bound F- test

From the above, it is clear that there is a long run relationship among the variables Since the calculated F-statistic for co integration test which is F- statistic = 6.126077, exceeds the upper bound of the critical value at all levels of significance. Thus, the null hypothesis of no co integration (i.e. no long-run relationship) between inflation and the explanatory variables is rejected at all significance levels.

18. Autoregressive Distributed Lag (ARDL) Model

Once co integration is established, at this stage, ARDL was estimated and, hence both the short and long run coefficients have already been captured.

19. The Long Run Inflation Model

Long run coefficients (the β's) were exactly estimated using ARDL approach to show the long run response of inflation (consumer price index) to changes in each explanatory variable.

ARDL (2, 3, 3, 3, 2, 2) numbers in the bracket stands for optimal lag length of CPI, LNRGDP, LNM2, REER, BD, GNS, and LIR respectively which is selected based on Schwarz Information Criterion, dependent variable is CPI.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP	-0.408591	0.485657	-0.841316	0.4126
LNM2	0.706026	0.501875	1.406775	0.1786
REER	-0.158338	0.038823	-4.078446	0.0009***
BD	1.749768	1.056389	2.656368	0.0171**
GNS	-0.644567	0.319508	-2.017369	0.0608*
LIR	-3.350230	0.774650	-4.324831	0.0005***
C	74.997358	16.167098	4.638888	0.0003***

R-squared	0.921993	Mean dependent var	9.242964
Adjusted R-squared	0.804982	S.D. dependent var	10.82011
S.E. of regression	4.778248	Akaike info criterion	6.244554

Sum squared resid	365.3064	Schwarz criterion	7.289415
Log likelihood	-103.0134	Hannan-Quinn criter.	6.625035
F-statistic	7.879568	Durbin-Watson stat	1.952401
Prob(F-statistic)	0.000047		

*Note: ***, ** and * indicate that 1%, 5%, and 10% level of significance.*

Table 3: Estimated long run coefficients using the ARDL approach

From the above results, it can be shown that 92.19 % of the variation in consumer price index is explained by the independent variables. The F-test (0.000047) shows that all the independent variables jointly explain the dependent variable remarkably. Thus, over-all significance of the model is good. The Durbin-Watson value of 1.95 which is approximately 2 shows the absence of auto correlation in the model. The value of the constant term, 74.99, which is also significant shows that CPI will have a value of 74.99 units if all the explanatory variables included in the model are zero.

The long run inflation model adopted in this study could be set as follows;
$$CPI = 74.99 - 0.4 \ln RGDP + 0.7 \ln M2 - 0.15 REER + 1.74 BD - 0.64 GNS - 3.35 LIR \quad \dots\dots\dots\dots\dots \quad (4.1)$$
The result of the long-run model revealed that budget deficit has positive and significant impact while, real effective exchange rate, gross national saving, and lending interest rate have negative and significant impact on inflation. But real GDP growth and money supply have negative and positive and insignificant impact on inflation respectively.

As contrary to theoretical expectations, in the long run real effective exchange rate has negative impact on inflation. A 1% increase in real effective exchange rate ceteris paribus will decrease consumer price index by 0.15%. This is due to the ban of the export of agricultural produce of cereals like teff, wheat etc, which have huge share in CPI (56% in 2014/15 UNDP base) has helped in the stabilization of their prices which in turn results in lower consumer price index. In addition, though the devaluation followed by the country after 1992 was expected to increase exports theoretically, research results indicate that the depreciation does not have significant impact on exports. (Paulos, 2008). This implies that exchange rate increase do not lead to much increase in exports. Exports can influence inflation due to the supplies pattern of domestic goods and services to the household consumers.

Budget deficit has positive and significant impact on inflation. A 1% increase budget deficit ceteris paribus will increase consumer price index by 1.74%. This is because to finance this budget deficit, the government resorted to external and domestic borrowing as well as privatization of public enterprises. For the 1997-2007 period external borrowing and domestic borrow-

ing each accounted for around half of the total deficit with the balance slightly swinging towards domestic borrowing, while a very small share (4%) is taken up by receipts from privatization proceeds (Alemayehu and Kibrom , 2008). In the post 2002 period, the means of financing the budget deficit has, shifted from external to domestic bank and non-bank sources, especially following the 2005 election where donors protested over the election by reducing the amount of aid and latter changing modality of its delivery from budget support to provision of basic services. This has led to the monetization of the deficits. The budget deficit and the means of financing it there of might have played a major role in the current inflationary process.

Gross national saving has negative and significant impact on inflation. A 1% increase in budget deficit ceteris paribus will decrease consumer price index by 0.64%. This is due to an increase in the level of gross national saving in general and personal saving in particular will lead to a corresponding decrease in the total disposable or spendable income of consumers. The assumption is that when consumers do not have as much money to spend after the calculation of their net pay, they will make a downward reversal in their spending and consumption habits, reducing the aggregate demand in the economy, and also bringing down the level of inflation.

Lending interest rate has negative and significant impact on inflation. A 1% increase in lending interest rate ceteris paribus will decrease consumer price index by 3.35%. This is due to as interest rates are reduced; more people are able to borrow more money. The result is that consumers have more money to spend, causing the aggregate demand to increase and thereby increasing inflation.

20. The Short Run Inflation Model

Once the long-run co integrating model has been estimated, the next step is to model the short-run dynamic parameters within the ARDL framework. The table 4 below presents the results of the estimated error-correction model of inflation model using the ARDL technique.

The long run and short run estimates are related by the error correction term ECM. A negative and significant coefficient of the error term reveals the economy's convergence to the long run equilibrium.

ARDL (2, 3, 3, 3, 3, 2, 2) numbers in the bracket stands for optimal lag length of CPI, LNRGDP, LNM2, REER, BD, GNS, and LIR respectively which is selected based on Schwarz Information Criterion, dependent variable is CPI.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP)	-0.597535	0.303752	-1.967180	0.0668*
D(LNM2)	0.085654	0.202601	0.422771	0.6781
D(REER)	0.410926	0.068803	5.972491	0.0000***
D(BD)	0.776313	0.424900	1.827049	0.0864*
D(GNS)	0.208898	0.296554	0.704420	0.4913
D(LIR)	-0.887498	0.829653	-1.069722	0.3006
CointEq(-1)	-0.920932	0.178752	-5.152011	0.0001***

*Note: ***, * indicate that 1%, and 10% level of significance.*

Table 4: Estimated short run coefficients using the ARDL approach

The short run model of inflation derived from the above table is computed as follows;
$$DCPI = -0.59DlnRGDP + 0.08DlnM2 + 0.41DREER + 0.77DBD + 0.20DGNS - 0.88DLIR - 0.92ECM \ldots \ldots (4.2)$$
The result of the short-run model revealed that real effective exchange rate and budget deficit have positive and significant impact on inflation while, real GDP growth has negative and significant impact. Broad money supply, lending interest rate and gross national saving are insignificant variables in the short run.

From the short run real GDP has negative and significant impact on inflation. A 1% increase in real GDP model ceteris paribus will decrease consumer price index by 0.59%. The negative impact of economic growth on inflation in Ethiopia during the study period is due to short run shocks like drought and war. In the earlier years the country's economy was affected drought and war which significantly reduced economic growth of the country. For instance, drought in 1985 and 2003 and political instability in the country in 1991/92 which contributes the contraction of the economy (Fekadu, 2012). Economic growth of the country during these periods were severely affected which resulted in high level of inflation.

In contrast to the long run model, in the short run real effective exchange rate has positive and significant impact on inflation. A 1% increase in real effective exchange rate ceteris paribus will increase consumer price index by 0.41%. Real depreciation imediately makes exports cheap and, imports become expensive; so that, higher foreign prices would be reflected in domestic econ-omy in the form of higher inflation. It is consistent with the international trade hypothesis, like Obstfeld and Rogoff (1996). It also is consistent with the works of Durevall et al (2009) in Ethiopia; Holod (2000) in Ukraine; and Gull (2011) in Pakistan.

Similar to the long run, in the short run budget deficit has positive and significant impact on inflation. A 1% increase budget deficit ceteris paribus will increase consumer price index by 0.77%. This finding is in line with the hypothesis of traditional QTM, thereby suggesting that, monetization of fiscal deficit has been important in explaining inflation both in short and the long run.

Another interesting result of the system is that the coefficient of ECM is negative and significant. This implies that there has been significant inflation disequilibrium in the short run. The coefficient measures the rate at which the gap between short run dynamics and long run equilibrium is narrowed. 92% of the gap is adjusted in each year to its long run equilibrium path, and hence the gap minimizes each year.

21. Diagnostic Tests
Essential post estimation diagnostic tests like Jarque–Bera (JB) normality test, Breusch–Godfrey serial correlation LM test for serial correlation, autoregressive conditional hetroskedasticity (ARCH) test for heteroscedasticity, Ramsey RESET test for model specification and CUSUM with CUSUMSQ stability tests are employed to check the validity and the robustness of the estimated model.

Tests	$\mathcal{X}^2$-value	P- value
ARCH Heteroskedasticity Test	0.018658	0.8914
Jarque- Bera test	0.400722	0.8184
Ramsey RESET Test	1.978858	0.1799
Breusch-Godfrey Serial Correlation LM Test	1.813682	0.4038

Table 5: Results of diagnostic tests

From the above table, the information displays the estimated model passes diagnostic tests. Finally, model stability is necessary for prediction and econometric inference. Thus, stability test has been conducted for estimated parameters by using the cumulative sum of recursive residual (CUSUM) and CUSUM of square (CUSUMSQ) tests. The results of the CUSUM and CUSUMSQ tests are reported in Figures 2 and 3 respectively as shown below. The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability.
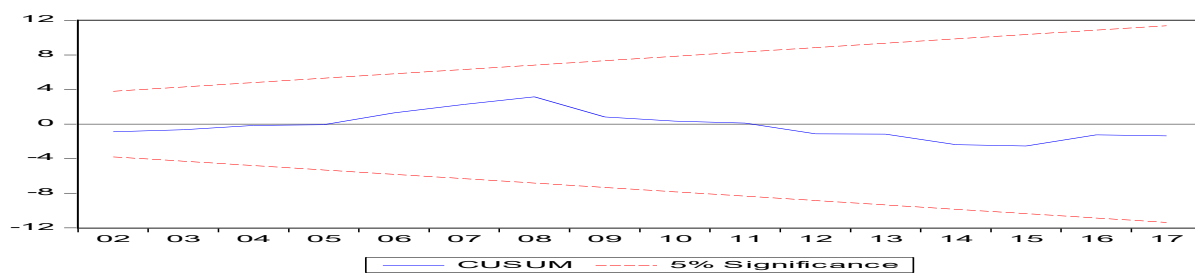
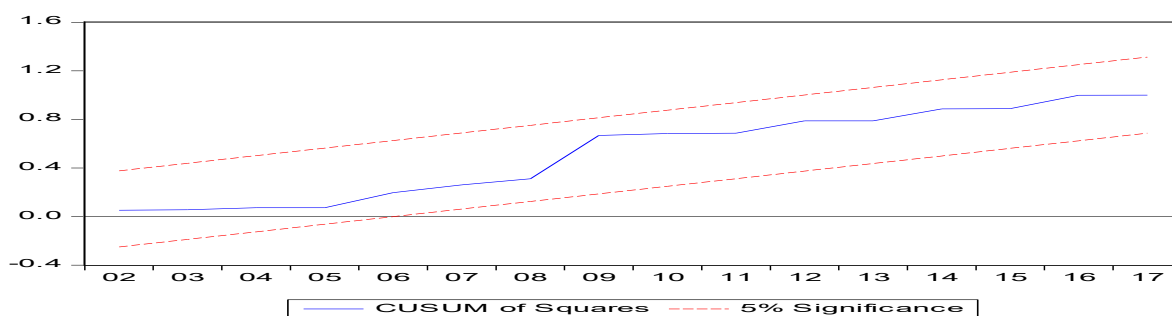**Figure 2:** Cumulative sum of the residual

Figure 3: Cumulative sum of squares

22. Conclusions and Recommendations

In Ethiopia, in the face of series macroeconomic problems, which includes continuously rising money supply, huge debt servicing, persistence current account and budget deficits, and currency devaluation inflationary process is high. Price stability is one of the major goals of monetary policy and the key indicators of macroeconomic stability. Pursuing of price stability is primary to long-run growth and development; it should be the concern of every economy. In this study annual data from 1974 to 2017 is used to investigate the determinants of inflation in Ethiopia by employing co integration and autoregressive distributed lag (ARDL) model. The trends of the inflation in this model have given a brief insight that inflation showed a fluctuating behavior characterized by successive ups and downs during the study period. Inflation in the country is strongly affected by food inflation than non food inflation since it has similar trends with the general inflation.

The results of ARDL model revealed that in the short run real effective exchange rate and budget deficit have positive and significant impact on inflation while, real GDP growth has negative and significant impact. Broad money supply, lending interest rate and gross national saving are insignificant variables in the short run.

On the other hand, the long-run model revealed that budget deficit has positive and significant impact while, real effective exchange rate, gross national saving, and lending interest rate have negative and significant impact on inflation. But real GDP growth and money supply have negative and positive and insignificant impact on inflation respectively.

The error correction term is negative and significant at 1 percent level of significance suggesting that inflation adjusts to deviations from its long term equilibrium. This means that 92 percent of last year's disequilibrium is corrected by changes in inflation. The estimated model passes diagnostic tests and the graphical evidence (CUSUM and CUSUMQ graphs) indicate that the model is stable during the sample period.

Based on the findings of the analyses, the study suggests the following policy implications:
• Since agriculture is the main source of real GDP, measures to boost and stabilize domestic agricultural production and productivity, particularly production of major food staples, have great importance because movement of inflation in the country is highly derived by price of food staples. So increasing productivity of domestically consumed products must be given priority by providing incentives to the agricultural sector and by transforming the sector from rain dependent ways of production to commercial farming system.
• A credible and sustained fiscal adjustment, aiming to boost revenue generation can reduce fiscal deficit. From public finance perspective, therefore, a comprehensive tax reform (expanding the tax base, designing an inflation- proof tax system, and improving tax administration and collection), rationalization of public spending, and privatization of loss making state enterprises are crucial in establishing fiscal policy credibility.
• Since lending interest rate plays a critical role in reducing inflation in the long-run, the central bank should control lending interest rate, even if it needs further study to get the optimal lending interest rate that will consider both inflation and investment.
• Since the gross national saving plays a critical role in reducing inflation in the long-run, the government has to take various measures to increase the public saving while encouraging business firms and households to rise the private saving.

References
1. Mishkin, F. S. (2010). The Economics of Money, Banking and Financial Markets (9th ed.). Addison-Wesley.

2. Ankit, G. (2011). what is Inflation definition and meaning?

3. Berg, A., O'Connell, S., Pattillo, C., Portillo, R., & Unsal, F. (2015). Monetary policy issues in sub-Saharan Africa. The Oxford Handbook of Africa and Economics, 2, 62-87.

4. Nguyen etal. (2015). On the Derivers of Inflation in Sub-Saharan Africa. IMF working paper .

5. Sisay, M. (2008). Determinants of Recent Inflation in Ethiopia. Munich Personal RePEc Archive.

6. T. Deressa and M. Hassan. (2009). Economic Impact of Climate Change on Crop Production in Ethiopia: Evidence from Cross-section Measures, Journal of African Economies. 18, 529–554.

7. Ananias, M. and Valence K. (2012). "Modeling inflation in Rwanda". Economic review.

8. Chaudhry, M. A., & Choudhary, M. A. (2006). Why the State Bank of Pakistan should not adopt inflation targeting. SBP Research Bulletin, 2(1), 195-209.

9. Laryea and Sumaila. (2001). Determinants of Inflation in Tanzania. 1-17.

10. Khathlan. (2011). Inflation in the United Kingdom of Saudi Arabia: The bound test analyses. AfricanJournal of Business Management .

11. Yohannes etal. (2010). Inflation Dynamics and Food Prices in Ethiopia, working papers in economics. University of Gutenber.

12. Temesgen. (2013). Determinant and Impacts of Dynamic Inflation in Ethiopia.

13. Teamrat, K. (2017). Determinants of Inflation in Ethiopia: A Time-Series Analysis. Journal of Economics and Sustainable Development.

14. Ahmed etal. (2013). Determinants of Inflation in Pakistan. Universal Journal of Management and Social Science , 2, 89-96.

15. Ahmed, H. A. (2007). Determinants of Inflation in Ethiopia: Ethiopian Development Research Institute. Addis Ababa.

16. Geda, A., & Tafere, K. (2008). The galloping inflation in Ethiopia: A cautionary tale for aspiring 'developmental states' in Africa. Addis Ababa University, working paper series.

17. Ananias, M. and Valence K. (2012). "Modeling inflation in Rwanda". Economic review

18. Ayalew Birru, Y. (2007). Explaining the current sources of inflation in Ethiopia: A macro-econometric approach. Addis Ababa: National Bank of Ethiopia.

19. Girma, F. D. (2012). Relationship between inflation and economic growth in Ethiopia: An empirical analysis, 1980-2011 (Master's thesis).

20. Goodfriend, M. (1997). A framework for the analysis of moderate inflations. Journal of Monetary Economics, 39(1), 45-65.

21. Jhingan, M. (1997). Monetary Economics (4th ed.). India: Virinda publication.

22. Keynes, J. M. (1936). General Theory of Employment, Money and Interset. McMillan Cy, London.

23. Lutkepohl etal. (2000). Maximum Eigen value versus trace tests for the co integrating rank of a VAR process.

24. M. Mehari and A. Wondafrash . (2008). The Impact of Money Supply on Inflation in Ethioia., (pp. A paper presented on the 7th Multi-disciplinary Conference at Unity University College).

25. McCallum, B. T. (1980). Rational expectations and macroeconomic stabilization policy: An overview. Journal of Money, Credit and Banking, 12(4), 716-746.

26. Rao, P. N., & Yesigat, A. (2015). Inflation and economic growth: inflation threshold level analysis for Ethiopia. International Journal of Ethics in Engineering & Management Education, 2(5), 1-22.

27. Odusanya I. A. and A.A. Atanda. (2010). Analysis of Inflation and Its Determinants in Nigeria. Pakistan Journal of Social Science , 97-100.

28. Olatunji, G. B., Omotesho, O. A., Ayinde, O. E., & Ayinde, K. (2010). Determinants of inflation in Nigeria: A co-integration approach (No. 308-2016-5066).

29. Paulos, B. (2008). The impact of Exchange Rate on International Trade : a Case Study of Ethiopia. 7th Multidisciplinary Conference at Unity University College.

30. Shahadudheen, I. (2012). A co-integration and Error Correction Approach to the Determinants of Inflation in India. International Journal of Economic Research , 3, 105-112.

31. Sims, C. A. (1980). A Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered". Amsterdam, Elsevier Science, and Journal of Economic Review .

32. Totonchi, J. (2011). Macroeconomic Theories of Inflation. International Conference on Economics and Finance Research, Singapore.

33. Veerachamy M. Ruzima and P. (2015). A Study on Determinants of Inflation in Rwanda from 1970-2013. Journal of Management and Development Studies , 4, 390-401.

34. YahyaK, A. (1989). Structural Disequilibrium and inflation in Nigeria.