

SUPPLY AND DEMAND SIDE DETERMINANTS OF INFLATION IN ETHIOPIA AUTO-REGRESSIVE DISTRIBUTED LAG MODEL (ARDL)

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Abstract

Inflation is defined as a persistent increase in general price level of goods and services. Even though Ethiopia has experienced a low inflation until 2008, recently, double digit inflation has become troublesome for policy makers as well as the society. So, this study tried to examine the supply and demand side determinant of inflation in Ethiopia by employing the techniques of Auto-Regressive Distributed Lag Model (ARDL) for 32 years' data spanning from 1985 to 2016. The study included macroeconomic determinant that alter or change inflation level measured by consumer price index such as money supply, real gross domestic product, world oil price, budget deficit and real effective exchange rate. The results of bound test confirmed that the long run relationship between explanatory variables and consumer price index in Ethiopia. The empirical results implied evidence of a long-run positive impact of money supply, world oil price, budget deficit and real effective exchange rate on inflation in Ethiopia whereas as real gross domestic product insignificantly affect price level. Finally, from the finding of our study in the short run, real effective exchange rate, money supply budget deficit and world oil price are the main determinant of inflation in Ethiopia. Given these findings, the effectiveness of fiscal deficit and exchange rate as well as contractionary monetary policy as a mechanism of price stabilization in the long run and short run is recommendable for policy inference.

Keywords: ARDL, Bound Test to Cointegration, Inflation, Supply Side, Demand Side

1. Introduction

According to (Acharya, 2010) when the principal pointer of a country's macroeconomic performance measured by economic growth, inflation comes next for almost every countries macroeconomic objective. Hence, price stabilization is considered as an imperative macroeconomic goal for sustainability of economic growth. Regardless of development status of countries, nobody questioned about cross-border transmission of inflationary forces and one of the foremost and dynamic macroeconomic concerns provoking most economies across the globe. Understanding inflation dynamics has received due attention in the recent years due to the high inflation levels occurred in developing countries. Theoretical justification of Keynesian macroeconomic of positive relationship between inflation and unemployment was disproved by different empirical studies that suggested an insignificant relationship between inflation and unemployment inferring the breakdown of the Phillips Curve and no possibility of trade-off between the two macroeconomic variables (Kaur, 2017).

Generally agreed definition is that inflation is a continuous and persistent rise in general price level of goods and services or continual weakening in the purchasing power of money, caused by a rise in available money and credit beyond what the economy produced at all. The definition of inflation cannot be an indication of particular commodity price and not for particular period of time. For an inflation to be happened, the rise in the general price of goods and services should be sustained. A normal functioning of any economic activities in a given country is retained by the level of domestic price. In other words, majority of continuous instability of economic activity of a country is explained by erratic fluctuation in domestic price of goods and services (Mishkin, 2009). Hence, the

national bank realized price stabilization as the focus of attention of monetary policy. This is because monetary policy of a country was mostly intended by giving attention toward responsible factors for raising the inflation rate. Inflation in the long run is always and everywhere a monetary phenomenon (Friedman, 1963).

Inflation in Ethiopia has been low relative to other country over the last 30 years at the earlier time. As study of Habtamu (2000) worked out it averaged about 7.3 percent during the 1967 to 1999 which is far below an average inflation rate of 10.3 percent, 39.8 percent 13.4 percent, 90 percent and 19 percent for Asia, Europe, Middle East Western Hemisphere and Africa respectively. Additionally, according to Yohannes (2009) in 1980, in most cases the Ethiopian economy experienced rate of in inflation that is below 7.5 percent except for year at which a sudden shot in price where registered. The supply decrease specially related to agricultural sector, which determines food prices, was responsible for the spur inflation particularly in 1984/85 during which serious famine took surged to 18.4 percent. However, in the post 2003 inflation began to become visible problem because of the government plan and strategy towards adopting expansionary monetary and fiscal policy and huge government intervention so called developmental state in the economy. During this period, Ethiopia economy registered as a fast growth, remarkable expansion of export revenue as well as generation of domestic tax revenue prevailed in the economy. Due to expansionary fiscal policy emanated from huge Government expenditures, the economy experienced by fast growing money supply (Kibrom, 2008).

To the best of our knowledge, there were few scholars conducted their study on the factors that determining of inflation in Ethiopia. The descriptive analysis done by Teklebirhan (1990) found the growth of money supply is an important cause of inflation in the country whereas Samuel (2007) found that the monetarist model of interaction does not explain the inflation in Ethiopia. Both of them used the variables of money supply, real GDP, expected inflation and lagged real money balances factors determining inflation in the country. Other latter study by Kibrom (2008) suggested that the determinants of inflation differential between sectors (food and non-food) and found that most influential variable that affect food inflation in the long run were real GDP, money supply, inflation expectation and international food price. Similar study done by (Hagos, 2014) found that food inflation in the long run explained by broad money supply, narrow money supply, food consumption price index, non-food consumption price index, interest rate, real GDP and nominal GDP whereas non-food inflation determined by broad money supply, narrow money supply, food consumption price index, non-food consumption price index, interest rate, real GDP and nominal GDP variables. Similar study conducted by (Kashay, 2017) employed OLS and found that GDP, money supply and national saving were significantly and positively contributed to inflation rate both in the short and long-run.

In our study, we concerned an evidence oriented investigation to identify and examine the main driving factors of inflation in Ethiopia in recent years. The aforementioned empirical literature on inflation in Ethiopia stress basically on the demand-pull factors of inflation and failed to incorporate the supply side factors. Previous studies considered only the variable world price as a as a measure of external supply shock for cost-push factors in their estimation and come up with insignificant result. Moreover, one of the critical variables that have not been addressed is the effect of budget deficit from demand side and world oil price and real effective exchange rate from supply side factor on domestic price level. Furthermore, to fill the methodological gap, this study used an auto regressive distributed lag (ARDL) model as the core methodological framework due the fact that it provides consistent and efficient estimators as compared other any estimation method regardless of stationary and non-stationary properties series (Pesaran, et al. 2001).

The investigation is anticipated to offer the current policy issue in Ethiopia with a consistent, precise and concrete result-based investigation on the major source of inflation. As long as price stabilization concerned as one of the pillar targets of the policy plan for current and the future, this study expected to dig out the problem and add to the macroeconomic policy formulation process. Besides, we believe that the study will append essential outcome to fill existing knowledge gap and instigate for further study in the area due the fact that there is no clear cut solution on the causes of the rise in inflation.

2. Literature Review

2.1 Theoretical Literature Review

Inflation is still an arguable word which has gone through different adjustments over theoretical and empirical literature across the world. The first definition of inflation is forwarded by the neo-classical economists. According to them, inflation is defined as a sustainable rise in prices due to having too much rise in the quantity of money. As of Keynesians' argument, the main cause for the occurrence of inflation is in a situation where the rise in money supply is greater than the level of full employment in a given economy (Jhingan, 1997). Nevertheless, plenty of economists describe inflation in diverse ways; there is a general consensus that inflation is an unremitting rise in the general price level. Despite the fact that inflation is a continuous rise in prices, its magnitude is differently explained. When the rise in prices is inconsequential like that of a snail or a creeper, it is called creeping inflation. It is said to be creeping when the inflation rate is less than 3 percent per year. Such an increase is considered as secure and indispensable for economic growth. When the average rise in price level is beyond 3 but less than 10 percent per annum, it is known as walking inflation. Walking inflation is a forewarning hint for the government's need to intervene through designing policies to control inflation prior to its turning into running inflation. An annual rise in prices at a rate of 10 to 20 percent is categorized as running inflation. When the inflation rate climbs beyond 20 percent, it is called hyperinflation (Jhingan, 1997).

2.2 Theories on Causes of Inflation

2.2.1 Demand Pull Theory

Demand pull inflation theory is the conventional and most frequent categorization of inflation (Jhingan, 1997). According to this theory, the main source of demand pull inflation is a rise in aggregate demand which sums up consumption, investment, and government expenditure. When the economy experiences a large imbalance between aggregate demand and supply in which excessive demand is manifested, the faster is the inflation (Totonchi, 2015).

As mentioned in Keynesian General Theory of Employment, Interest, and Money, a policy issue that targeted towards a reduction in each section of aggregate demand is successful in decreasing the pressure on demand and inflation.

Government tax increment is one of the policy instruments in which expenditure is reduced and to control the size of money alone or jointly, can be efficient in dropping effective demand and in controlling inflation as well (Keynes, 1936).

2.2.2 Cost Push Theory

The main cause of cost-push inflation is a rise in wages bargained by unions and pursued by employers to increase the level of profit. The emergence of this type of inflation has not been a current issue; rather, it goes back to a medieval period. However, to consider it as a chief cause of inflation, different scholars put pressure in reviewing and investigating its cause, which started in the 1950s and again later in the 1970s, so-called "New Inflation" (Totonchi, 2015).

The fundamental cause of cost-push inflation is that nominal wages grow faster relative to labor productivity. Labor unions enforce employers to subsidize remarkable wage increments so that it is increasing the cost of production of goods and services. Consequently, employers in turn charge higher prices for their products. Higher wages allow employees to purchase as much as before, despite higher prices. In contrast, the rise in prices associated with higher wage demands by unions leads to cost-push or wage-push inflation. In other words, cost-push inflation may be further provoked by upward alteration of wages to compensate for adverse effects caused by an increase in the cost of living. Moreover, another cause of cost-push inflation is profit-push inflation, in which oligopolist and monopolist firms charge the price of their products so as to compensate for the rise in wages and other costs of production to make higher profits. This is known as administered-price inflation or price-push inflation (Totonchi, 2015).

2.2.3 Quantity Theory of Money

Quantity theory of money is one of the earliest existing economic theories. The theory states that general level of prices change is mainly caused by changes in the quantity of money circulated at the hand of public. The quantity theory of money created the main dialogue issues of classical monetary analysis of 19th century, in line with offered the leading conceptual framework for infer in modern financial events and emergence of different scholars towards mainstream policy instruction intended to safeguard the gold standard.

David Hume (1711-76) came up with the first dynamic process analysis in which dissemination channel of monetary change across different economic sector, varying relative price and quantity simultaneously. He provided substantial modification, explanation and extensive investigation to the quantity theory of money. Moreover, David Ricardo (1772-1823), the most dominant of the classical economists, thought such disequilibrium effects short-lived and irrelevant in long-run equilibrium analysis. According to him, Ricardo asserts that inflation in Britain was exclusively the consequence of the Bank of England's negligent over the printing of money. Under the pressure of the Napoleonic Wars, Britain missed the gold standard for a less liquid paper standard. He depressed discussions on likely valuable output and employment consequence of monetary injection (Ricardo, 1817).

In its rudimentary definition, quantity theory of money indicates that any prices change must be overwhelmed by the same proportional vary in the Quantity of money. Irving Fisher (1876-1947) came up with his well-known equation so called fishers" equation of exchange which is $MV = PT$, Where M refers to the nominal stock of money, V refers to its velocity money in circulation; T refers to the Total number of transactions undertaken over period and P is the average general price level. The equation of exchange is obliged to grasp of the prerequisite because MV and PT are two ways of obtaining the same thing. Accordingly, the aggregate value of all transactions undertaken over given Period of time was the similar (Jackman et al., 1981). All Irving fisher as well as other classical quantity theorists did not supposed that V and T were constant rather their debatable issues is that in equilibrium Velocity was affected by taste and preference of people and the technology of exchange, whereas T was determined by adjustment supply and demand by market force. Moreover, monetarists superiority over Keynesian in policy effectiveness could be approved by employing the common identity of exchange equation of Fisher (Totonchi, 2015).

2.3 Empirical Literature

We have seen various studies conducted in developing countries, particularly in Africa, where the inflationary upsurge threatened their development endeavor. In Africa, both structural and monetary factors determined inflation, although specific factors differ from country to country. In theory, it is believed that when regressed inflation opens, it results in to observation increase in the general price level (Habtmu, 2000). This situation has been seen in transition economics in the study of study (Fischer, et.al, 2003).

In Ethiopia, one of the earliest works that of Teklebirhan (1990) by considering variables such as broad money supply, import value index, pavement tax revenue, real GDP, rainfall, all velocity of money in his descriptive analysis, found that the existence of chronic drought has some impact in determining inflation in the country. Money supply took by (Teklebirhan, 1990) as an important cause of inflation in the country this study covers, however, the period when most prices are controlled, during the Derg regime. Moreover, the methodology he employed was only descriptive statistics which doesn't explore the long-run and short- run dynamics of variable of interest.

Another study done by Dejan (2007) used factor forecasts for the general inflation and the disaggregated inflation namely Energy inflation, industrial goods inflation, services inflation, processed food and the Non-processed food inflation in the case of Slovenia. The result from forecasts of the factor model was compare to autoregressive (AR) and vector autoregressive (VAR) models in terms of the Root Mean Squared Error (RMSE). In his study, the factors were recognized so as to offer analysis to the forecasting. Accordingly, Results show that the factor model was significantly superior over the AR yardstick forecasts and is not poorer from the VAR forecasts for all disaggregated inflation and the headline inflation, which gives it an excellent apparatus for inflation forecasting in the case of Slovenia.

Kibrom (2008) has studied the "Sources of the Inflationary Experience in Ethiopia whose study aimed to understand the forces behind the recent inflationary process in Ethiopia. He used vector autoregressive (VAR) and single error

correction models to estimate inflation dynamics. This estimated model allows comprehending the long run as well as short-run dynamics of inflation in Ethiopia between 1994/95 and 2007/08. The study reveals that the determinants of inflation for food and non-food are different, and depend on the time span under deliberation.

3. Research Methodology

3.1. Data Type and Sources

To conduct this investigation, the researcher used annual and time series data for the time starting from 1985/86-2016(17) that is 32 years' data have been employed. This study was limited to macroeconomic variables determining inflation in Ethiopia. So as to achieve study objective, secondary data was employed and the necessary data required to this study are obtained from different secondary data sources such as publications, annual bulletins and reports by concerned institutions like Ministry of finance and Economic Development (MOFED, 2016) for variables like real gross domestic product and budget deficit , Ethiopian Economic Association (EEA, 2016) for world oil price ,National Bank of Ethiopia (NBE, 2016) for variables like inflation and real exchange rate, Central Statistical Authority (CSA, 2016) for real exchange rate and others.

3.2 Econometric Model Specification

The model specification to undertake the study, the theoretical guideline was classical quantity theory of money. According to the classical economists, quantity theory of money implied that there are direct and indirect relationship between inflation and money supply because inflation is monetary phenomena. They expressed variable relationship given by the following identity

$$MV = PY \text{ ----- 3.1}$$

Where M is nominal money supply, V is velocity of money in circulation, P is general price level and Y is real output

The equation can be expressed in terms of price to show the determinant

$$P = \frac{MV}{Y} \text{ ----- 3.2}$$

Taking natural logarithm to both sides the equation can be rewritten as

$$\ln P = \ln M + \ln V - \ln Y \text{ ----- 3.3}$$

It is important to include other variables so as to investigate macroeconomic determinant of inflation. Accordingly, the deterministic relationship would be given by:

$$\ln CPI = \beta_0 + \beta_1 \ln M_2 + \beta_2 \ln BD + \beta_3 \ln REER + \beta_4 \ln WP + \beta_5 \ln RGDP + U_t \text{ --- 3.4}$$

Where, CPI is consumer price index; M2 -is broad money supply; BD- is budget deficit; REER - is real effective exchange rate; WP- is world oil price and RGDP- is real gross domestic product

All the variables in the model are in the log form which is interpreted as elasticity. Based on theoretical justification provided in literature part, the long run model of inflation is expected to vary positively with all variables.

3.3. Model Estimation Procedure

3.3.1 Unit Root Test

It is fundamental to check for the statistical properties of variables while discussing with time series data. Time series variables are hardly stationary in level forms. The necessary condition for testing unit root test when we applying

ARDL model is to check whether the variables enter in the regression are not order two (I.e. I(2)), which is Precondition in ARDL model. Therefore, it is prerequisite to test for time series variables before running any sort of regression analysis. Augmented Dickey-Fuller (ADF) test can be used to Non-stationary proprieties of variable so to guarantee consistent outcome of test for stationarity. This test is carried out by supplementing the different equations by summing-up the lagged value of the dependent variable say ΔY_t .

$$\text{That is } H_0 =: \delta = 1, H_1: \delta < 1$$

If the t value or t-statistic in absolute value greater than the critical values, the first hypothesis (I.e. H_0) is rejected and the conclusion is that the series is stationary. Conversely, if the t-statistic in absolute value less than the critical values, the second hypothesis (H_1) is rejected

3.4.2 The Autoregressive Distributed Lag Model (ARDL)

There are numbers of advantages of using ARDL model also called 'Bound Testing Approach' instead of the conventional Engle-Granger two-step procedure (1987), Maximum likelihood methods of cointegration (Johansen, 1988) and Johansen and Juselius (1990).

First, the ARDL model is the more statistically significant approach to determine the cointegration relation in small samples as the case in this study (Pesaran et al., 2001; Narayan,2004). A second advantage of the ARDL approach is that while other cointegration techniques require all of the regressors to be integrated of the same order; the ARDL approach can be applied whether the regressors are purely order zero [I(0)], purely order one [I(1)], or mixture of both. Third, with the ARDL approach it is possible to capture different optimum number of length for different variables (Nasiru, 2012 as cited in Tsadkin, 2013). Finally, Applying the ARDL technique we can obtain unbiased and efficient estimators of the model (Narayan, 2004), (Harris and Sollis, 2003; Pesaran, 1995) as cited in Tsadkin 2013. Therefore, this approach becomes prevalent and appropriate for investigating the long-run relationship and extensively applied in empirical research in the recent years.

Hence, ARDL model can be specified as:

$$\begin{aligned} \Delta LNCPI_t = & \beta_0 + \beta_1 LNCPI_{t-1} + \beta_2 LNM2_{t-1} + \beta_3 LNREER_{t-1} + \beta_4 LNWOP_{t-1} + \beta_5 LNRGDP_{t-1} \\ & + \beta_6 LNRBD_{t-1} + \sum_{j=1}^p \alpha_j \Delta LNCPI_{t-j} + \sum_{j=1}^q \alpha_j \Delta LNM2_{t-j} + \sum_{k=1}^r \alpha_k \Delta LNBD_{t-k} \\ & + \sum_{l=1}^s \alpha_l \Delta LNREER_{t-l} + \sum_{m=1}^v \alpha_m \Delta LNWOP_{t-m} + \sum_{n=1}^y \alpha_n \Delta LNRGDP_{t-n} + U_t \end{aligned}$$

- Where the symbol Δ is the first difference operator; p, q, r, s, v and y are the lag length with their respective variables and U_t error term which is assumed to be serially uncorrelated.
- $\beta_1, \beta_2, \beta_3, \beta_4$ & β_5 indicates coefficients that measure long run elasticities between the variable whereas $\alpha_1, \alpha_j, \alpha_k, \alpha_l, \alpha_m$ & α_n indicates coefficients that measure short-run elasticities among the variable.

The first step involved in ARDL model is to test the null hypothesis of no cointegration relationship which is defined as $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ against the alternative hypothesis of $H_1 = \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ of the existence of co integrating relationship between the variables. According to Pesaran et al. (2001), there are two sets of critical value bounds for all classifications of regressors' namely upper

critical bound value and lower critical bound value. The critical values for I (1) series are referred to as upper bound critical values; while the critical values for I (0) series are referred to as lower bound critical values. If the calculated F statistic is greater than the upper bound critical values, we reject the null hypothesis of no long run relationship among the variables. If the calculated F statistic is less than the lower bound critical values, we can't reject the null hypothesis rather accept the null hypothesis of no co integration among the variables. However, if the calculated F statistic is between the upper and lower bound critical values, inference is inconclusive and we need to have knowledge on the order of integration of underlying variables before we made conclusive inference (Pesaran et al., 2001).

Accordingly, with the existence of cointegration, the short run elasticities can also be manipulated through building the error correction of the series as stated the follows.

$$\Delta LNCP I_t = \beta_0 + \sum_{j=1}^p \alpha_j \Delta LNCP I_{t-j} + \sum_{j=1}^q \alpha_j \Delta LNM2_{t-j} + \sum_{k=1}^r \alpha_k \Delta LNBD_{t-k} + \sum_{l=1}^s \alpha_l \Delta LNREER_{t-l} + \sum_{m=1}^v \alpha_m \Delta LNWOP_{t-m} + \sum_{n=1}^y \alpha_n \Delta LNRGDP_{t-n} + \theta ECM_{t-1} + U_t$$

Here all variables are as previously defined. The order of the lags in the ARDL Model is selected by either the Akaike Information criterion (AIC) or the Schwarz Bayesian criterion (SBC) automatically, before the selected model is estimated by ARDL model.

4. Results And Discussion

4.1 Results of Unit Root Test

When we check stationarity of variable by ADF, all variables is non-stationary at level so they are differenced. From the augmented dickey fuller test, the variables are integrated at different order and none of the variables are integrated of order two.

Table 1. Augmented Dickey-Fuller (ADF) Test

S no	Variable	With intercept			With intercept and trend		
		At level	1 st difference	Order of integration	At level	1 st difference	Order of integration
1	INF	-0.610064	-3.876628*	I(1) at 1%	-2.008248	-3.781685	I(1) at 5%
2	LNM2	-1.788559	-5.187734*	I(1) at 1%	-0.991645	-5.542462*	I(1) at 1%
3	LNREER	-0.606138	-3.598664*	I(1) at 5%	-2.718510	-3.543776	I(1) at 5%
4	LNBD	2.365709	-3.839873*	I(1) at 1%	-1.242459	-4.305291*	I(1) at 1%
5	LNWOP	-0.268000	-7.224346*	I(1) at 1%	-3.270220***	-7.078391*	I(1) at 1%
6	LNRGDP	0.324345	-3.926183	I(1) at 1%	-2.054471	-4.276035	I(1) at 1%

Source: Author's computation of E view 9 result, 2018

Notes: The sign of ***, ** and * represents the rejection of the null hypothesis of non-stationary at 10%, 5% and 1% significant level respectively. The null hypothesis is that the series is non-stationary or the series has a unit root against alternative hypothesis that the series are stationary. Akaike info criterion (AIC) is used to determine the lag length while testing the stationarity of all variables.

4.2. Model Stability and Diagnostic Test

To check the verifiability of the estimated long run model, some diagnostic test is undertaken. Priority in doing any analysis, we required to check the standard property of the model. In this study, we carried a number of model stability and diagnostic checking, which includes Serial correlation test (Brush & God fray LM test), Functional form (Ramsey's RESET) test, Normality (Jaque-Bera test), and Heteroscedasticity test. In order to reject or accept the null hypothesis, we can decide by looking the p-values associated with the test statistics. That is the null hypothesis is rejected when the p-value are smaller than the standard significance level (I.e. 5%).

Table 2: Long run ARDL Diagnostic Tests

Test statistics	LM version	F version	Description
A. Serial correlation	CHSQ(2)= 0.0454	F(2,15)= 0.3398	Lagrange multiplier test of residual serial correlation
B. Functional form	CHSQ(2)= 0.9597	F(1,10)= 0.9597	Ramsey's RESET test using the square of the fitted values
C. heteroscedasticity	CHSQ(17)= 0.3577	F(17,11) = 0.4224	Based on the regression of squared residuals on squared fitted values

Source; own computation from EViews 9.5

The above table indicates that the long run ARDL model estimated in this study passes all the diagnostic tests. This is because the p-value associated with both the LM version and the F version of the statistic was unable to reject the null hypothesis specified for each test. Therefore, based on the result of the test the null hypothesis of no serial correlation (Brush Cod fray LM test) is failed to reject for the reason that the p-values associated with test statistic is greater than the standard significant level (I.e. $0.3398 > 0.05$). Here LM test for testing serial correlation is applied because unlike the traditional Durbin Watson test statistic which is totally inapplicable when the lagged dependent variable appears as a regressors, LM test avoid such limitation of DW test.

We could not reject the null hypothesis test for Ramsey's RESET test, which tests whether the model suffers from omitted variable bias or not. As the test result indicates that we can't reject the Ramsey's test, which means that the model is correctly specified. Lastly, diagnostic test for heteroscedasticity seen from the above table, we cannot reject null hypothesis at 5% significant level due to its p-value associated with the test statistics are greater than the standard significance level (I.e. $0.05 < 0.4224$)

4.2.1 Test of Parameter Stability

The stability of the model for long run and short run relationship is detected by using the cumulative sum of recursive residuals (CUSUM) which helps as to show if coefficients of the parameters are changing systematically and the cumulative sum of squares of recursive residuals (CUSUMSQ) tests which is useful to indicate if the coefficient of regression are changing suddenly. Accordingly, if the blue line cross redline which is critical line and never returns back between two critical line, we accept the null hypothesis of the parameter instability whereas the cumulative sum goes inside the area (can returns back) between the two critical lines, then there is parameter stability in the short run and long run.

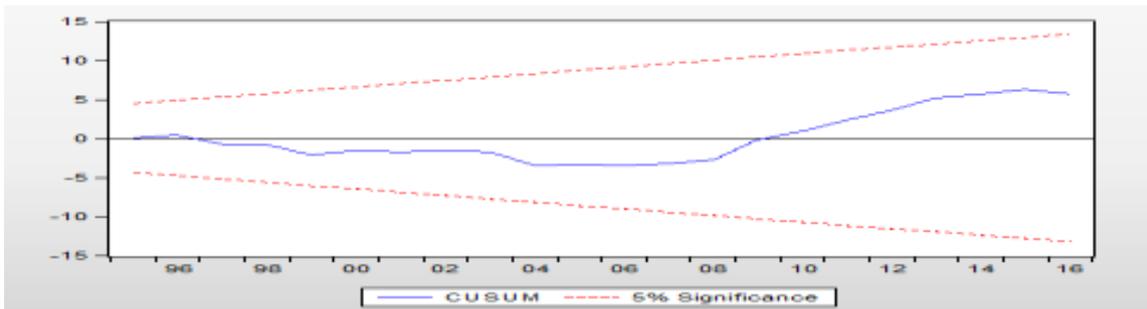


Figure 1: Plot of Cumulative Sum of Recursive Residuals (i)

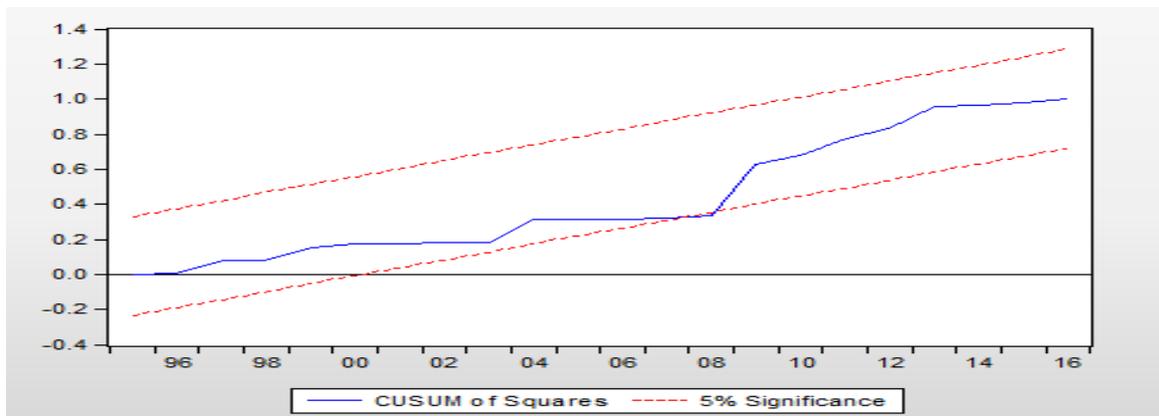


Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals (ii)

As the result seen from the figure, the plot of CUSUM test did not cross the critical limits. In the same manner, the CUSUMSQ test shows that the graphs do not cross the lower and upper critical limits. So, we can conclude that long-run estimates are stable and there is no any structural break.

In addition to the confirming model stability by employing CUSUM and CUSUMSQ test mentioned in above figure, we can look at goodness of fit statistics of the model containing the explanatory variables that was proposed actually explain variations in the dependent variable because it is important to have some measure of how well the regression model actually fits the data. Accordingly, adjusted R² was 81 percent of the model has been explained by the regressors respectively. Hence the results of the estimated model are consistent and efficient.

4.3. Long Run ARDL Bounds Tests for Co-integration

Since we determined the stationary nature of the variables, the next task in the bounds test approach of co-integration is estimating the ARDL model specified in equation (3.7) using the appropriate lag-length selection criterion. According to Pesaran and Shine (1999), as cited in Narayan (2004) for the annual data are recommended

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to choose a maximum of two lag lengths but for small data it is advisable to use 1 lag because when the lag length increases the observation fail to show the appropriate long run relationship among variables because to show the long run relationship the number observation must be greater than 30.

As we discussed so far, the F-test through the Wald-test (bound test) is performed to check the joint significance of the coefficients specified in equation (3.7). The Wald test is conducted by imposing restrictions on the estimated long-run coefficients of real GDP, real effective exchange rate, money supply, budget deficit, world oil price. The computed F-statistic value is compared with the lower bound and bound critical values provided by Pesaran et al. (2001) and Narayan (2004)

Table 3 Bound Test

Lags	F statistics	Decision
1	7.9551	Co integration
Significance	Lower bound	Upper bound
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source; own computation from EViews 9.5

From the above table calculated F statistics (7.9551) is higher than both the Pesaran et al. (2001) and Narayan (2004) upper bound critical values at 1% level of significance. This implies that the null hypothesis of no long -run relationship is rejected; rather accept the alternative hypothesis (there is long-run relationship) based on critical values at 1% level of significance. Therefore, there is cointegration relationship among the variables in long run.

4.4 Long Run ARDL Model Estimation

After confirming the existence of long-run co-integration relationship among the variables, the next step is running the appropriate ARDL model to find out the long run coefficients, which is reported in table below.

Table 4: Long Run Coefficients Co Integrating Equation

Variable	Coefficient	Stan.error	t-statistics	Probabilities
LBD	0.764	0.273	2.79	0.013*
LGDP	0.1169	0.209	0.5581	0.587
LM2	0.5012	0.1864	2.689	0.021*
LREER	0.491	0.348	4.276	0.0013*
LWOP	0.342	0.3029	7.733	0.000*
C	9.708	2.173	4.466	0.0010

Source; own computation from EViews 9.5, 2018

Note: the sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively. The result of the above table indicates that all the variables entered in the regression have the expected signs regardless of their significant level. As we have discussed in the theoretical and empirical literature parts money supply, budget deficit, real effective exchange rate, world oil price, budget deficit and real domestic product have positive impact on Ethiopian inflation rates. Moreover, real gross domestic product has positive relationship and insignificantly affects inflation in Ethiopia.

As expected from economic theory, money supply has positive and significantly affect inflation in Ethiopia which is evidenced with 1% significance level in the long run. This coefficient shows that assuming other things held constant, a percentage change in money supply would increase consumer price index by on average 0.5012 percent in the long run. The result supports the arguments of classical economists so called the theory of quantity theory of money which stated that an increase in money supply always come up with higher price levels. The classical economist monetary transmission channel to inflation implies that as money supply increase, economy investment encouraged through available credit and thereby high employment creation. Aggregate demand automatically increases because of expanded investment and employment. Finally, the economy experienced by increased inflation.

As the result reveals that in the long run, the most significant variable that affects the rate of inflation is world oil Price which possessed a direct positive relationship between world oil price and inflation. The long run coefficient of the variable shows that, holding other things constant, a one percent change in world oil price (wop) which is proxy by general world oil price of dollars leads to on the average 2.342 percent increase in CPI. As it is known that Oil is major source of energy which affects almost every sector of the economy which manifested in an increase in cost of production. As result, prices rise in international market increase domestic price of goods and services due the fact that Ethiopia energy demand is fully imported. This result confirms with the study of Saleem, and Ahmad (2015).

As the result predicted that there is a positive real exchange rate (depreciation) and inflation measured by CPI which evidenced by conventional significance level; This indicates that, in the long run, holding other things constant, a one percent increase in real effective exchange rate (depression of domestic currency) lead to 1.491 increase in consumer price index. The rational justification behind this relationship is that exchange rate volatility can affect on price level their effect on both aggregate supply and demand. Demand side; increase in exchange rate push up foreign demand for domestic goods and services, causing raise in net exports and hence aggregate demand. The boosted aggregate demand further accelerates the price of input, there by bid up domestic price level. On the supply side, exchange rates could affect prices paid by the domestic buyers of imported goods directly. Developing countries like Ethiopia categorized as an international price taker experienced by the domestic currency depreciation leads to higher cost of imported inputs which will raise marginal cost and come up with increased domestic price. This result confirms with the finding of Vinh and Fujita (2007) in Vietnam and Monfared and Akin (2017) in Iraq.

Another long run determinant of inflation that we observed from estimation is the budget deficit which has found positive relationship with consumer price index and statistically significant at 1 percent significance level. Its coefficient in long run equation is 0.764 it means that in the long run taking other factors constant or negligible one percent increase in budget deficit causes increase in consumer price index by 0.764 percent. The result confirms with the study of Akcay et.al, (1996) who proposed two possible channels in which higher deficit leads to higher inflation. First possibility is that the government's debt requirements drive up demand of credit in the economy, rise the interest rates and as result, private investment is crowded out. The declining of national income will lead to a decrease in the supply of good and service for a given level of cash balances and hence, come up with increase in the domestic good and services. Second proposed justification for positive relationship is that when national bank refused to monetize the debt while the private sector monetizes the deficits. The implication of this channel indicates that when high interest rates encourage the financial sector to develop new interest bearing assets which are risk free asset and equivalent to liquid money. As result, government borrowing not monetized by the national bank is monetized by the private sector and consequently, higher price level experienced by higher deficit.

4.5. Short Run Error Correction Model

After the acceptance of long-run coefficients of the inflation equation, the short-run ECM model is estimated. The error correction term (ECM), as we discussed in chapter three, indicates the speed of adjustment to restore equilibrium in the dynamic model. It is a three lagged period residual obtained from the estimated dynamic long run

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model. The coefficient of the error correction term indicates how quickly variables converge to equilibrium. Moreover, it should have a negative sign and statistically significant at a standard significant level (i.e. p -value should be less than 0.05)

Table 5: Short Run Coefficient

Variable	Coefficient	Standard error	t-statistics	Prob.
D(LBD)	3.656	0.942	3.879	0.026**
D(LBD(-1))	-1.648	0.843	-1.842	0.0924**
D(LGDP)	0.201	0.383	0.524	0.610
D(LM2)	0.859	0.649	1.321	0.213
D(LM2(-1))	1.223	0.715	1.711	0.115
D(LREER)	3.651	0.914	-3.994	0.0021**
D(LWOP)	1.623	0.579	2.802	0.017**
D(LWOP(-1))	-1.775	0.705	-2.516	0.028**
COINEQ(-1)	-1.72	0.423	-4.064	0.019**

Source; own computation from Eview 9.5

Note: the sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively. R2=0.9765 ADJ R2=0.948 F-STA=31.54(0.0001) DW STAT= 1.71

The coefficient of determination (R-squared) is high explaining that about 97 % of variation in the inflation is attributed to variations in the explanatory variables in the model. In addition, the DW statistic does not suggest autocorrelation and the F-statistic is quite robust. The large number F-statistic implies overall jointly significant the independent variables in the model. Furthermore, the results also reveal that budget deficit, money supply, real exchange rate and world oil price are positive and significant determinant of the inflationary spiral in Ethiopia in the short run Ethiopia. Surprisingly, real RGDP is not significant at least in the short run. This result justifies that emphasizing the importance of monetary policy and fiscal policy in the inflationary process could have immediate impact on real sector.

The error correction coefficient, estimated at -1.72 is highly significant, has the correct negative sign, and implies a very high speed of adjustment to equilibrium. According to Narayan and smith (2006) the highly significant error correction term further confirms the existence of a stable long-run relationship even though most economists recommend that $ECM < -1$. Moreover, the coefficient of the error term (ECM-1) implies that the deviation from long run equilibrium level of inflation in the current period is corrected by 172 % in the next period to bring back equilibrium when there is a shock to a steady state relationship but higher than 100% ECM means that it has oscillating type of convergence to long run equilibrium and it takes less than one year to return to its long run equilibrium.

5. Conclusion

This research has been undertaken to assess the macroeconomic determinant of inflation in the country from 1985/6-2016 by ARDL Model bound test to co-integration. The result of the above table indicates that all the variables entered in the regression have the expected signs regardless of their significant level. As we have discussed in the theoretical and empirical literature parts, money supply, budget deficit, real effective exchange rate, world oil price and budget deficit have positive and statistically significant impact on Ethiopian inflation rates. However, real

gross domestic product has positive relationship and insignificantly affects inflation in the long run. Regarding to short run dynamics, the results also reveal that budget deficit, money supply, exchange rate and world oil price are positive and significant determinant of the inflationary spiral in Ethiopia in the short run. Surprisingly, real RGDP is not significant at least in the short run. This result justifies that emphasizing the importance of monetary policy and fiscal policy in the inflationary process could have immediate impact on real sector.

Therefore, concerned body should give care of in policy formulation to control inflation such as using alternative energy sources including using hydroelectric power, solar energy and other important energy sources; to reevaluate or appreciate domestic currency not by direct intervention of government but by providing subsidies for those who produce exportable goods and imposing high tax rate for imports; to use contractionary monetary policy to fix the growing inflation and to keep budget deficit at low level by balancing budget revenue with corresponding expenditure are recommendable.

References

- Persan m.h,shin.y &smith, 2001. bound testing approach to the analysis of level of relationships. journal of applied econometrics,vol16, pp. 289-326.
- Abebayew, T., 1989. The monetarist explanation of inflation. Journal of conomic studies, vol 16.
- Acharya, S., 2010. Macroeconomic Performance and Policies, 2000-2008. In S. Acharya and R. Mohan (Eds.), India's economy, performance and challenges:. Essays in honour of Montek Singh Ahluwalia). New Delh, pp. (pp.39-81.
- Cambell j.y and shiller r.j, 1998. interpriating cointegrated models. journal of economic dynamics and control, pp. 505-522.
- Chibber, a., 1991. africans rising inflation cause consequence and cures, washington dc usa: world bank working paper.
- Degen, K., 2007. short term inflation projection for slovenia ,comparing factor model with AR and VAR model, slovenia: Bank of slovenia.
- Emirta, a., 2013. inflation and economic growth:an estimate ofthershold level of inflation fpr ethiopia, addis abeba ethiopia: ethiopian economic assosation.
- Ethiopia, N. B. o., 2015. annual reports, s.l.: s.n.
- Fekadu, k., 2005. cause of imported inflation in ethiopia, addis abeba ethiopia: s.n.
- Gujarati., 2004. Basic econometrics. s.l.: McGraw-Hill Companies, 4th edition.
- Habtamu, d., 2000. the cause of low inflation in ethiopia , Addis abeba ethiopia: AAU.
- Hagos, 2014. DETERMINANTS OF RECENT INFLATION, Mekele : Unpublished Masterhis thesis,MEKELLE UNIVERSITY,COLLEGE OF BUSINESS AND ECONOMICS DEPARTMENT OF ECONOMICS.
- jingham, m., 1997. montary economics 4th edition. virinda india: virinda publication press.
- Johansen, S. and Jtiselius, K., 1990. "Maximum Likelihood Estimation and Inference on Co integration – with Applications to the Demand for Money". Oxford Bulletin of Economics and Statistics. Vol. 52, No. 2, pp. 169-210.
- Johansen, S., 1988. "Statistical Analysis of Cointegration Vectors". Journal of Economic Dynamics and Control Vol. 12, , pp. 231-254 [http://dx.doi.org/10.1016/0165-1889\(88\)90041-3](http://dx.doi.org/10.1016/0165-1889(88)90041-3).
- Kashay, T., 2017. Determinants of Inflation in Ethiopia: A Time-Series Analysis. journal of Economics and Sustainable Development Vol.8, No.19, pp. 1-6.
- Kaur, 2017. THE RELATIONSHIP BETWEEN FISCAL DEFICIT AND INFLATION IN INDIA: A COINTEGRATION ANALYSIS. Journal of Business Thought vol.8, pp. 24-41.

- Keynes, J. M., 1936. *The General Theory of Employment, Interest, and Money*. London: Macmillan Publication.
- Kibrom, t., 2008. the source of recent inflationary expriance in ethiopia, addis abeba ethiopia: addis abeba university department of economics.
- Kotowal, o., 1987. *theories of inflation*. cambridge: cambridge university press.
- mekonen mehari and abera wondafrash , 2008. the impact of money supply on inflation in ethiopia, addis abeba ethiopia: unity university college.
- Mishkin, F. S., 2007. *The Economics of Money and Financial Markets*. s.l.:Pearson/Addison Wesley.
- Monfared.S. and Akin F., 2017. The Relationship Between Exchange Rates and Inflation: The Case of Iran. *European Journal of Sustainable Development* vol.4 issue 4, pp. 329-340.
- narayan, k., 2004. reformulating critical values for bound test f-statistics approach to cointegration, victoria ,australia: monash university.
- Nayaran, K., 2004. Reformulating Critical Values for the Bounds F-statistics Approach to Co integration: An Application to the Tourism Demand Model for Fiji”. Discussion Papers No 02 Monash University, Victoria, Australia.
- Pesaran, H. and Shin, Y., 1999. *An Autoregressive Distributed Lag Modeling Approach to Co-integration Analysis*. UK: Cambridge University Press..
- Pesaran, H. M., & Shin, Y., 1995. *Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis*. Working Paper, No. 95/14. Department of Economics, University of Cambridge, DAE.
- Ricardo, D., 1817. *Principles of Political Economy and Taxation*. London: Murrary Publication.
- Samuel, k., 2007. nature of inflation in ethiopia, gonder,ethiopia: gondar university.
- Tadele, c., 2008. forecasting model of inflationary process in ethiopia , addis abeba ethiopia: addis abeba university.
- Teklebirhan, g., 1990. galloping inflation in ethiopia, addis abeba ethiopia: national bank of ethiopia.
- Tewodros, A., 2015. The determinant of economic growth in Ethiopia: A time series analysis, Addis Ababa university: unpublished Master thesis.
- Totonchi, J., 2015. *Macroeconomic theory of inflation*. International Conference on Economics and Finance Research IPEDR vol.4.
- Vinh N. and Fujita S., 2007. Impact of Real Exchange Rate on Output and Inflation in Vietnam: A VAR approach, s.l.: Discussion Paper No.0625.
- Yazdani, S., 2008. Financial Market Development and Agricultural Economic Growth in Iran. *American Eurasian Journal of Sustainable Agriculture* , Volume 2, pp. 338-343.
- Yohhanis a&dick d, 2009. inflation dynamics and food prices in agricultural economy in case of ethiopia. working paper in economics.