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Determinants of agricultural output in Ethiopia: ARDL approach to co-integration

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ABSTRACT

Agricultural output in Ethiopia plays an essential role in generating foreign exchange and feeding the largest share of the population, due this identifying determinant of agricultural output at macro level is important. This study investigated determinants of agricultural output at macro level by using time series data starting from 1980-2018.The ARDL approach to co integration is applied to investigate the long run and short-run determinants of agricultural output. The result reveals that Rainfall, Fertilizer input import, Trade openness, inflation rate affect positively and significantly in the long run whereas Drought affect negatively and significantly. In the short run Fertilizer input import and labor force affect positively and significantly while Rainfall affects positively and insignificant. Also besides to this, in a short run, drought affects negatively and significantly agricultural output. Therefore the study recommends government policies should focus on proper uses of resources like expenditure on agriculture should be used properly, Drought-resistant agriculture, and reduces the dependency on rainfall by adopting different technology at the macro level and micro level.

Keywords: Agricultural output, determinants, drought, ARDL, co-integration, Ethiopia.
JEL classification: E3, Q1, O1.

1. Introduction

The main issue of developing countries is sustaining and accelerating economic growth by diversifying into different sector (SazanTaher and Hatem, 2017). The agriculture sector in developing countries plays an important role where foreign earning and employment is generated from this sector. The agricultural sector is predominant in most Sub-Saharan Africa economies, contributing more than one-third of the regional GNP and employing more than two-thirds of the labor force (World Bank, 2010).

Agricultural sector In Ethiopia serves as primary sources for the livelihood for more than 85% of the population for those who participate in crop production, livestock production and related activities (ATA, 2017).This sector plays a vital role in generating an income, employment for the mass of the population and it is the main livelihood of the majority of the population in addition, the sector is the basis of the national economy in Ethiopia (Tadele et al, 2016). Even if the contribution of agriculture to

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gross domestic product is decline from time to time the sector has significant effect on the Ethiopian economy, contributing 34% to Gross domestic product, 75% total export earnings and 71%total employments. From these Crop production makes up 72 % percent of the total agricultural GDP, whereas livestock accounts for 20%, and other areas contribute 8.6%(ATA, 2017). This shows economic growth of the country is highly correlated with agricultural output.

Growth of all other sectors and the whole national economy is determined by the agricultural sector, which directly serves the country population as a source of income in providing primary goods to the urban population (Ahmed, 2019). The sector provides an input to industry, services sectors, and another sector in the country. Government adopt a policy ADLI in(2012) as a policy and implementing it to achieve a middle income country by increasing agricultural output that led into industrialization in the country by providing raw material for industry sector, however agricultural output was declined from time to time without scoring the goal of ADLI strategy. Even though agricultural output in Ethiopia main source of foreign exchange by exporting agricultural commodities to different countries in the world market due to this agricultural sector is an engine of the economy.

As of increase in agricultural output have a multiplier effect in the economy by boosting export earning, by increasing backward and forward linkage among sectors in the economy, and can reduce dependence on imported agricultural output and poverty. Thus can be achieved only if appropriate policy at macro level and micro level are developed and implemented properly throughout the country. This shows country has no other choice but to employ these resources soundly and efficiently in order to bring rapid and sustainable development(FAO, 2019).

The share of Agricultural GDP in Ethiopia is declining from time to time (NBE, 2017). For instance share AGDP in 2012 is 42% and in 2017 share became 34.9% (NBE, 2017). Agricultural output can be affected by different factors at macro level and micro level which would in turn affect its contribution to economic growth of country. for instance at micro level land-labor ratio, use of fertilizer, use of pesticides, manure, and household size area affect agricultural labor and labor productivity which in turn affect agricultural output(Tessema, 2015). Despite micro studies macro studies focuses on factors affect performance of agricultural export for instance Belayneh and Wondaferahu (2014) studies on factor affect agricultural export performance his finding shows agricultural export is affected by real effective exchange rate, openness, RGDP of home country, infrastructural development and private credit as a ratio of GDP (financial development), to best of the researcher knowledge there is no study on determinants of agricultural output in Ethiopia. It is important for a country studying factors that determine agricultural output to make a useful policy recommendation, to sustain and increase agricultural productivity of a country. Thus an increase in agricultural productivity would result in increase in income, employment, export and can maintain earning of foreign exchange to the country.

The aim of this study is to identify determinants of agricultural output under the period of 1980-2018 for Ethiopia case and the study used ARDL approach to co integration to examine short run and long run determinants of agricultural output. Neoclassical production function is used as the base for model formulation that leads to identifying determinants of agricultural output in Ethiopia by including macro-economic variables. This study is organized in this way: Section two deals literature review including theoretical and empirical. Section three about methodology of the study, section four explains research analysis and results, while section five presents conclusions and recommendations.

2. Literature review

Increasing productivity of agriculture by promoting new technology and ensuring optimum use of resource is one of the objectives of agricultural policy. A sustainable growth of agricultural sectors and their productivity is an important goal of governments. Different studies have been conducted by different people to analyze the determinants of agricultural output.

Abdul et al (2019) studies Major factors affecting agricultural productivity in Pakistan. investigate the relationship between agricultural gross domestic product (AGDP) and variables such as cropped area, fertilizer consumption, credit distribution and water availability that span from 1978-2015. The study used Cobb-Douglas Production Function to examine the impact of these major factors on agricultural productivity in Pakistan and OLS estimation technique is used. They found that fertilizer

consumption, improved seed distribution, and credit distribution had a positive and significant influence on AGDP, whereas water availability had a negative but insignificant influence on AGDP.

Brownson et al (2012) established the empirical relationship between agricultural productivity and some key macroeconomic variables in Nigeria by using time series data that span from 1970 to 2010. The short-run and long-run elasticity of the agricultural productivity with respect to some key macro-economic variables determined by using the techniques of co-integration and error correction models. The results reveals that in the short and long run periods, the coefficients of real total exports, external reserves, inflation rate and external debt have significant negative relationship with the agricultural productivity in the country; whereas industry's capacity utilization rate and nominal exchange rate have positive association with agricultural productivity in both periods.

Muhammad (2018) Investigated Determinants of Agricultural Sector Growth in Pakistan by using timesereis data that span from 1976 to 2014. The study used Rolling regression

to estimate explanatory variables justified by the use of Kalman filtering approach. The results indicate that gross fixed capital formation, permanent cropland and remittances receipt adversely affects agricultural sector growth, Whereas, gross national expenditure is directly related to agricultural sector growth. These findings recommend enlarging gross national expenditures and motivating investors to make investments in agricultural sector.

Tessema (2015) studies on Determinants of Agricultural Productivity and Rural Household Income in Ethiopia at micro level. He used Three econometric models namely Pooled ordinary least square (POLS), fixed effects (FE) and random effects (RE) model to examine the relationship between productivity and income. The Results showed that, Land-labor ratio, use of fertilizer, use of pesticide, manure and household size are found to be the most significant variables that affect agricultural labor and land productivity. However, drought has statistically significant and has negative effect on both labor and land productivity by the same magnitude. Labor productivity, non-farm income and land productivity are found to be the most determinants of household income.

Belayneh and Wondaferahu (2014) studies on factor affect export performance by using timesereis data and VAR model analysis his finding shows The findings of the study shows that in the long run export performance has found to be positively influenced by real effective exchange rate, openness, RGDP of home country, infrastructural development and private credit as a ratio of GDP (financial development). As the empirical reviews shows agricultural output is affected by different factors at micro level and macro level. This study is to investigate determinants of agricultural output by using macro-economic variables.

3. Data and methodology of the Study

3.1 Model specification and theoretical framework

In order to identify determinants of agricultural output in Ethiopia the study the study starts with the important work of neo-classical growth model developed by Solow (1956).Which is specified in terms of input and output. Neoclassical production function provides a functional relationship between inputs and output. the advantage of using Cobb douglas production function is it explicitly controls for inputs and its disadvantages lies in it doesn't consider method used in order to minimizes effects that reduces agricultural output (Deschenes and Greenstone, 2004).

Model specified based on neoclassical production function which can be formulated as the following

$$\mathrm{Yt} = \mathrm{f(Lt\ Kt)} \ldots\ldots (1)$$

Where Yt is aggregate real output, Lt is labor and kt is capital inputs we can extend the model by including main variables to equation number [1].

AGDP=f(RF, GE,IFL, TO, FI, LF,D)…… (2)

Where AGDP is agricultural gross domestic product, RF is Rainfall, IFL is Inflation rate, TO is Trade openness, LF is Labor force, GE is government expenditure, FI is Fertilizer input and Drought(D) as dummy. Capital is ignored from the model because agricultural output in Ethiopia is more labor intensive. Then converting equation number [2] into natural logarithm the model is

$$\log(RAGDP) = \beta o + \beta 1 \log(RF) + \beta 2 \log(IFL) + \beta 3 \log(TO) + \beta 4 \log(LF) + \beta 5 \log(FI) + \beta 6 \log(GE) + Dummy\ Dr + \varepsilon t \ldots\ldots (3)$$

Where logRAGDP=natural logarithm of Real agricultural growth domestic product
Log LF=natural logarithm of labor force
LogTO= natural logarithm Trade openness
LogAR= natural logarithm of Mean Annual rainfall
LogIFL=natural logarithm of Inflation rate
Log FI=natural logarithm of fertilizer input import
Log GE= natural logarithm of government national expenditure
Dummy for recurrent drought 1 if there is no drought and 0 otherwise.

et=error term and $\beta 0$ are constant term while $\beta 1, \beta 2, \beta 3, \beta 4, \beta 5,$ and $\beta 6$ are parameter of independent variable to be estimated.

3.2 Data

This study used annual time series data covering the period from 1980 to 2018. The following variables were considered for the study agricultural gross domestic product(AGDP), labor force(LF), government national expenditure(GE), Trade openness(TO), Inflation rate(IFL) Annual Rainfall (RF),and Fertilizer input import(FI). The first five variables were obtained from the World Bank Development Indicators database, Rainfall obtained from Climate Change Knowledge Portal data base and Fertilizer input import were taken from National Bank of Ethiopia(NBE).

3.3 Estimation procedure

3.3.1 Unit root test

Most macroeconomic variable are non stationary variable. Thus leads to inaccurate result or so called spurious regression problem. Often, non-stationary variables become stationary after differencing. Such a variable is said to have difference stationary process. Due to this it is important for a timesereis data to be checked for a unit root before proceeding to further estimation process. To test unit root there are a number of varying approach have been developed. Among the methods of testing the presence of a unit root in a series the common ones includes Dickey-Fuller (DF), Augmented Dickey Fuller (ADF), and Phillips-Perron (PP) tests. Error term in the Dickey-Fuller test usually has autocorrelation, The ADF and Phillips-Perron (PP) unit root test is used to overcome this limitation of DF test.

3.3.2 Autoregressive Distributed Lag Model (ARDL) approach to co-integration testing

A large number of past studies have used the Johansen co integration technique to determine the long-term relationships between variables of interest. In fact, this remains the technique of choice for many researchers who argue that this is the most accurate method to apply for I(1) variables. Recently, however, a series of studies by Pesaran et al (1996) have introduced an alternative co integration technique known as the Autoregressive Distributed Lag (ARDL) bound test. This technique has a number of advantages over other co integration techniques. First, the ARDL model is the more statistically significant approach to determine the co integration relation in small samples and ARDL approach can be applied whether the regressors are I(1) and/or I(0)variables(Pesaran and Pesaran 1997).Due to its advantage this study applied ARDL approach to co integration to test long run co integration among variables under the study. In addition, ARDL model can estimate the long-run and short-run dynamics simultaneously by using bounds testing procedures. Equation (3) is re-arranged into ARDL form to estimate both short-run and long- run relations and error correction term (ECT), is derived from long run relation. The new equations became as follows.

$$\Delta lnAGDP = a + \sum_{i=0}^{n} b1i\,\Delta lnAGDPt - i + \sum_{i=0}^{n} b2i\,\Delta lnFIt - i + \sum_{i=0}^{n} b3i\,\Delta lnGEt - i + \sum_{i=0}^{n} b4i\,\Delta lnIRt - i + \sum_{i=0}^{n} b5i\,\Delta lnTOt - i + \sum_{i=0}^{n} b6i\,\Delta lnLFt - i + \sum_{i=0}^{n} b7i\,\Delta lnRFt - i + b8\,lnAGDPt - 1 + b9lnFIt - 1 + b10lnGEt - 1 + b11lnIRt - +b12lnTOt - 1 + b13lnLFt - 1 + b14lnRFt - 1 + e1t$$

where Δ is the first difference operator, Ln is the natural logarithm, b1i, b2i, $\beta 3i$, $\beta 4i$, $\beta 5i$, $\beta 6i$ and $\beta 7i$ indicate the short-run dynamics of the model, whileb8, b9, b10, b11, b12, b13and b14 denote the long-run association and n is the optimal lag lengths and et are error term.

F-statistic is computed to test the null hypothesis whether there is a long run relationship exists among variables or not. By conducting an F-test for the joint significance of the coefficients of the lagged level variables. $Ho = \beta_8 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = 0$ against the alternative$H1 \neq \beta_8 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq \beta_{12} \neq \beta_{13} \neq \beta_{14} \neq 0$

The Decision rule for long run co integration is as follows. If the computed F-statistic exceeds the upper bound I(1), the null hypothesis of no cointegration can be rejected. This shows that there exist long run associations among all the series. However, if the F-statistic falls between the upper and lower bounds, no conclusive inference can be made. If the computed Wald or F-statistic falls below the lower bound I(0), the null hypothesis of no cointegration cannot be rejected, which means there is no long run relationship among series.

Moreover, The Error Correction Model (ECM) can be derived from ARDL model through a simple linear transformation, which integrates short run adjustments with long run equilibrium without losing long run information. A dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation (Banerjee et al. 1993).General form of error correction model (ECM) to be estimated for agricultural output in Ethiopia as follows.

$$\Delta lnAGDPt = \beta_0 + \sum_{i=0}^{n} \beta\, 1\Delta AGDPt - 1 + \sum_{i=0}^{n} \beta 2\, \Delta Xt - 1 + \beta 3 ECMt - 1 + \delta DR + \epsilon t$$

Where Xt represents independent variables that determine agricultural output, β's are the coefficients associated with short-run dynamics of the model coverage to equilibrium; ECT-1 is the error correction term and ϵt is stochastic error term.

4. Result and discussion

4.1 Unit Root result

Time series should be checked for stationary before conducting or estimating a model. To examine whether the data series under study is stationary at levels or stationary at first differences. The study employed ADF unit root test and PP unit root test to check the order of integration for all series. The results indicate that test of unit root test with intercept levels and first difference for each series is presented in the table 1. Both test indicate that the series log(RAGDP), log(LF), log(FI), log(GE), log(IR) and log(TO) at levels contain a unit root, but they are stationary at first difference and log(RF) are stationary at levels.

Table 1.

Augmented Dickey Fuller and PP Unit root test results at level and First difference

Variable	ADF unit root test		PP unit root test		
	At levels	First difference	At levels	First difference	Order of integration
	t-Statistic	t-Statistic	t-Stat	t-Stat	
Log(RAGDP)	0.587285	-5.58281***	1.125649	-5.593117	I(1)
Log(RF)	-4.788112***		-4.87066***		I(0)
Log(LF)	-3.296354**	-5.958327***	-2.082112	-6.76066***	I(1)
Log(FI)	-0.312565	-11.30860	-0.966148	-11.30860	I(1)
Log(GE)	0.655709	-5.172605***	0.802300	-5.16774***	I(1)
Log(TO)	0.237716	-7.560153***	0.694117	-7.45517***	I(1)
Log(IR)	0.726758	-4.59937***	0.489919	-4.62406***	I(1)

*, ** and *** represents significance level at 1%, 5% and 10% critical values, respectively

Source: own computation Eviews 9 result

It is critical to choose the order of the model that yields a good model and hence precise forecast. The order of the VAR model refers to the optimal number of lags that should be included in the model. Hence, specifying the lag order has strong implications for subsequent modeling choices. For the selection of the lag order, there are different types of lag selection criteria,

which includes the sequential modified likelihood ratio (LR), Akaike information criteria (AIC),Final prediction error (FPE),Schwarz information criterion(SC) and Hannan-Quinn information criterion(HQIC). Based on these selection LR, FPE, AIC and HQ suggest two lag for the variables. Two lag length is selected for this particular study. The following table shows the lag length chosen by different information criteria.

Table 2.

Lag selection criteria

Lag	logL	LR	FPE	AIC	SC	HQ
0	45.56533	NA	1.81e-11	-2.030559	-1.682252	-1.907764
1	262.0786	327.6958	5.16e-15	-10.27452	-7.139761*	-9.169371
2	367.5222	113.9931*	9.19e-16*	-12.51471*	-6.593503	-10.42721*

Source; author calculation, Eviews 9 *indicates the lag length selected by the criteria

LR: Sequential Modified Likelihood Ratio, FPE: Final Prediction Error, AIC: Akaike information Criteria, SBIC: Schwarz Information Criterion, HQIC: Hannan-Quinn Information Criterion

After identifying the order integration and lag length, the next step is examining the existence of long run co-integration. To know whether a all variables have a long run relationship the study employed ARDL model through bounds test. The result of the bounds tests is reported in the following table. As the table shows rejection of null hypothesis which says that no co integration among variables included in the model. F-statistics 10.40257 which exceed the upper bound at 1%, 5%, and 10% critical value and this implies there is a long run relationship among variables in the model.

Table 3.

Result of bound test

Variable	F-statistics	Co integration
F(RAGDP, LF, RF, FI,TO,GE, IR)	10.40257***	Co integration
Critical value	Lower bound	Upper bound
1%	2.96	4.26
5%	2.32	3.5
10%	2.03	3.13

Source: E-Views 9 result 2019 *** rejection of null hypothesis at 1%, 5%, and 10% significance level.

4.2 Long run equation

The result shows that Fertilizer input import, inflation rate, Rainfall, trade openness, and labor force has a positive significant impact on agricultural output, while Dummy variable Drought have a negative impact on agricultural output and Government expenditure have insignificant and negative impact on agricultural output. Specifically Fertilizer input import have a positive impact and significant at 5% significance level, which show other thing remain constant on the average one percent increase in Fertilizer input import increase agricultural output by 0.12 percent.

Trade openness has a positive and significant impact on agricultural output at 5% level, a one percent increase in trade openness increase agricultural output by 0.12% other thing remaining constant. Trade openness leads to many economic benefits, including increased technology transfer, skill transfer, increased labour and total factor productivity and agricultural growth(Shobande, 2019). Where agricultural activities is dependent on labour intensive Trade openness is important to increase agricultural output by transferring technology and this finding goes in line with (Silva et al 2013). Trade openness leads to the expansion of exports, in turn, intensifies the income of the inputs used in the production process thus increasing the demand for the factors of production to produce more goods and services. This would result in technological change and brings about better opportunities for investment (Shivneil and Chand, 2017). As more technology is introduced in economy there may be an addition in agricultural output by minimizing cost of production.

Drought have a negative and significant impact on agricultural output at 5% level. This due to agriculture is dependent on rainfall. When drought occurred agricultural output reduced by 0.11 percent. Where agriculture contributes large share to the economy the occurrence of Drought have a negative impact on agriculture in particular and economic of a country in general.

Table 4.

Long run ARDL estimation result

Long run coefficient				
variable	Coefficient	Std. Error	t-Statistic	Prob.
lnFI	0.129616	0.033443	3.875789	0.0019**
LnGE	-0.029539	0.060784	-0.485962	0.6351
LnIFR	0.322411	0.047969	6.721287	0.0000*
LnRF	0.557508	0.229383	2.430465	0.0303**
DR	-0.119132	0.029164	-4.084859	0.0013**
LnTO	0.123895	0.050736	2.441977	0.0297**
LnLF	0.001716	0.072989	0.023513	0.9816
C	16.46786	1.718031	9.585313	0.0000*

Note: The sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively.

Source: EViews 9

Rainfall has a positive and significant at 5% level. A one percent increase in rainfall increase agricultural output 0.55% percent, this shows Rainfall is a main determinants of agricultural output in Ethiopia which is more dependent on rainfall. This finding goes in line with Muraya (2017) and Aragie (2012).

Inflation rate which is measured by consumer price index have positive impact and significant at 1% level. Other thing remain constant one percent increase in inflation rate measured by consumer price index increases agricultural output by 0.322 percent.

4.3 Short run equation

Table 5.

Short run equation

Dependent variable AGDP				
Selected model ARDL		(2, 2, 2, 2, 2, 2, 2, 2)		
Co-integrating form				
variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDP(-1))	0.683984	0.12312	5.555428	0.0001
D(FI)	0.056119	0.0286	1.962206	0.0715***
D(FI(-1))	-0.049504	0.024549	-2.016554	0.0649
D(GE)	-0.018279	0.075578	-0.241855	0.8127
D(GE(-1))	0.010464	0.096162	0.108818	0.915
D(IFR)	-0.08357	0.092022	-0.908153	0.3803
D(IFR(-1))	-0.141216	0.102981	-1.371287	0.1935
D(LF)	0.609911	0.258707	2.357532	0.0347**
D(LF(-1))	0.901768	0.2967	3.039323	0.0095
D(TO)	0.082008	0.062789	1.306097	0.2142
D(TO(-1))	0.064303	0.06625	0.970611	0.3495
D(DR)	-0.044216	0.022466	-1.968182	0.0707***
D(DR(-1))	0.023938	0.015688	1.525919	0.151
D(RF)	0.133859	0.165076	0.810894	0.432
D(RF(-1))	-0.116607	0.131453	-0.887056	0.3912
CointEq(-1)	-1.250493	0.172	-7.270309	0.0000*

Note: The sign *, ** and *** indicate that the variables are significant at the level of 1%, 5% and 10% respectively.

Source: Eviews 9

In short run model fertilizer input import has positive and significant impact at 10 percent level. Which is in a short run other thing remaining the same a one percent increase in fertilizer input import increases agricultural output by 0.05611 percent. This shows fertilizer play an important role in boosting

agricultural output. In addition to fertilizer, Labor force also has positive and significant impact on agricultural output at 5 percent level. One percent increase in labor force increase agricultural output by 0.60991 percent. The coefficient of estimated lagged ECT is negative and statistically significant at 1% level of significance which shows that deviation from the long-term agricultural output due to certain shock is adjusted by 125.09% over the next year.

4.4 Model diagnostic test

In order to check the robustness of the long-run and short-run estimation in the ARDL model, diagnostic tests such as Normality (Jaque-Bera test), Heteroscedasticity test (Breusch and Godfray LM test), Functional form (Ramseys RESET), multicollinearity Test and Serial correlation test (Brush &Godfray LM test), test were performed.

Table 6.

Long run ARDL diagnostic Tests

	LM version		F-version	
Test	Statistic	P-value	Statistic	P-value
Normality: Jarque-Bera test	x^2 (2)0.272349	0.87269	not applicable	
Serial Correlation: Breusch-Godfrey serial correlation LM test	x^2(2)14.8009	0.0006	F(2,11) 3.66687	0.0602
Heteroskedasticity:Breusch-Godfrey test	x^2(23)22.87996	0.4678	F(23,13)0.91587	0.5882
Ramsey RESET test	x^2(12)0.749108	0.4682	F(1,12) 0.561163	0.4682

Source: Author's calculation from E view 9 results, 2019

As the table shows normality test was conducted by using Jarque-Bera test shows that p value is greater than 5 percent, serial correlation was conducted by using Breusch-Godfrey serial correlation LM test and shows p value is greater than 5 percent which shows there is no serial correlation which reject the null hypothesis. Hetroskedasticity test was conducted by using Breusch-Godfrey test and the result shows no hetroskedasticity p-value is greater than 5 percent which shows absence of hetroskedasticity and errors are homoskedasticity. Last but not least Ramsey reset test were conducted to check whether there is omitted variable or not. As of the p value shows that P-value 0.4682 is larger than 0.05. Therefore the model has no omitted variables and reject the alternative hypothesis which state that Model has omitted variables. Thus it indicates that there are no omitted variables or no specification error in the model.

4.5 Model stability test

In addition to the above diagnostic tests, the stability of long run estimates has been tested by applying the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) test. The results of both CUSUM and CUSUMSQ test are reported in Figures 1 and 2. As can be seen from the first figure, the plot of CUSUM test did not lie out of the critical limits. Similarly, the CUSUMSQ test shows that the graphs do not cross the lower and upper critical limits.

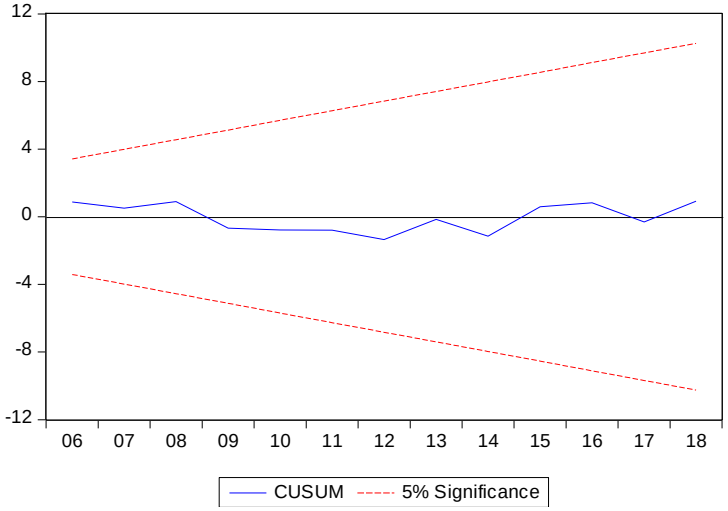

Figure 1. Plot of cumulative sum of recursive residuals. Source: Author Calculations, 2019

Note: The straight lines represent critical bounds at 5% significance level

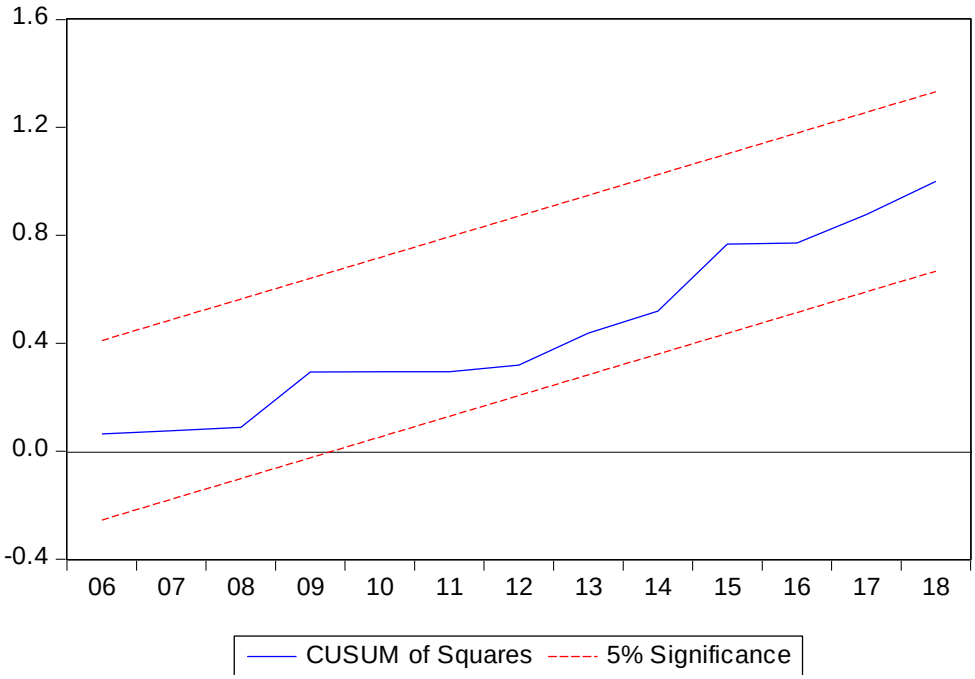

Figure 2. Plot of cumulative sum of squares of recursive residuals. Source: Author Calculations, 2019

Note: The straight lines represent critical bounds at 5% significance level

So the estimated long and short runs estimates including error correction model are stable which shows there is no any structural break. Hence the results of the estimated model are reliable and efficient.

5. Conclusion and recommendation

The study examined determinants agricultural output in Ethiopia by including variables like Rainfall, labor force inflation rate, Trade openness, Government National expenditure Fertilizer input import and drought as Dummy variable in Ethiopia using time series data from 1980 to 2018. To my knowledge there is no research conducted on determinants of agricultural output at macro level. The study used Cobb–Douglas production function for the formulation of a model. Where data was analyzed by using econometric method of data analysis. Based on integration level of variables Autoregressive Distributed Lag (ARDL) model was used forestimation of the long run and short run econometric model. Bound test show that there a long run relationship among a variables included in the model. In addition to bound test long run estimation shows that Rainfall, fertilizer input import, trade openness, inflation rate affect positively and significantly, while Drought affect negatively and significantly affect agricultural output, where as labor force and government expenditure have insignificant effect on agricultural output. In the short run labor force and fertilizer input import affect positively and significantly, where asdrought affect negatively and significantly. Other variable are insignificant effect on agricultural output. The study recommends government policies should focuses on proper uses of resources like expenditure on agriculture should be used properly that would result in increment in agricultural output and promote Drought resistant agriculture and reduces the dependency on rainfall by adopting different technology at macro level and micro level. In addition government should stabilize inflation rate even if it have positive impact on agricultural output and increase the availability of fertilizer input by reducing its price and in the future replacing it with natural fertilizer because overlong time period agricultural land losses its productiveness, as we use it more and more of fertilizer input.

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