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The Nexus of External Debt and Governance in East African Countries: A Cross-national Analysis

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Abstract

The connection between external debt, governance and economic growth remains a controversial topic in both academia and politics. This study empirically examines the relationships between external public debt and governance in Ethiopia, Kenya and Uganda from 2000 to 2020. To achieve the stated objective, the study used the Autoregressive Distributed Lag (ARDL) co-integration modeling approach. The results show a long-term and short-term relationship between the variables. Effective governance has a positive effect in the long term but has a negative effect on external debt in the short term. Economic growth has positive effects in the short term and negative effects in the long term, similar to how it affects national debt. Governance is crucial to reduce the misappropriation of resources and improve the effectiveness of resource allocation to minimize the long-term constraints of a government dependent on external debt. Similarly, economic growth can limit the accumulation of external debt in two ways: first, it increases revenues, and second, higher GDP could help reduce the debt ratio. Therefore, while maintaining economic growth, emerging market governments should prioritize improving their governance structure and effectiveness.

Keywords: Debt, governance, economic growth, co-integration, ARDL

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1. Introduction

Good governance is a widely discussed topic at the international level and has been touted since the late 1980s as one of the emerging factors central to economic growth in developing countries (Seyedsayamdost & Vanderwal, 2020). It is also the basis for the framework of fiscal prudence, proper use of public resources and an accountable system that allows to mitigate poor governance and rent-seeking tendencies and ensure that resources are used efficiently and effectively for economic development (Cust, 2017). In addition, it promotes human rights, empowers citizens and ensures that democratic principles are respected and promoted (Monaghan & Spreen, 2017).

Good governance has been endorsed by development partners such as the World Bank and the IMF as a condition of most external aid (Hernandez, 2017). This creates an enabling environment for donor support and builds confidence among investors at home and abroad, leading to economic growth. Governments are the key players in controlling, regulating and adjudicating the corporate sector. They pass economic regulation laws that help create a competitive environment for businesses. By enforcing such regulations, the government can effectively combat corruption.

National debt has increased significantly in recent decades (Kharusi & Ada, 2018; Kose, Nagle, Ohnsorge, & Sugawara, 2021; Maris, Sklias, & Maravegias, 2022; Pegkas, 2018), and numerous researchers have sought to understand and explain the potential negative effects of government debt on economic growth (Ahlborn & Schweickert, 2018; Kharusi & Ada, 2018; Ono & Uchida, 2018; Pegkas, 2018). The main results of their work indicate a non-linear effect of external debt on growth, along with its deleterious effects when the debt-to-GDP threshold is exceeded.

The East African Community (EAC) is one of the fastest growing regions in the world. Per capita income growth reached 3.7% per year in the EAC, compared to 3.2% in the SSA as a whole (Kharunda & Tinyinondi, 2018). Part of the recent high growth is “catching up” after years of very weak growth. However, the total external debt of East African countries has reached more than 50% of the countries' current gross domestic product (GDP), while in some countries this ratio is close to 100% (Senadza, Fiagbe, & Quartey, 2017). The fundamental purpose of imperative borrowing is to fill the gaps in internal and external economic capital and thus increase output inflows. This was seen as a fundamental justification for the government's huge borrowing, which

negatively impacts economic growth and restricts savings and country imports. In this vein, Turan and Yanıkkaya (2021) and Senadza et al. (2017) argued that high debt negatively affects development in developing countries.

Several previous studies found that higher debt affects not only capital accumulation but also GDP growth through higher interest rates and future taxes (Bexheti, Sadiku, & Sadiku, 2020; Blanchard, 2019). Therefore, public debt has become an ongoing political debate not only for developing countries but also for emerging economies. High public debt limits the possibilities for countercyclical fiscal policy and therefore leads to higher volatility and a reduction in future growth (Bahadir Karaca, 2020). Abubakar and Mamman (2020) also found a positive temporary (short-term) effect and a negative permanent (long-term) effect of public debt on the economic growth of OECD countries. Thilanka and Ranjith (2018) also pointed out that public debt has both a crowding-in and crowding-out effect on private investment

Despite the severe foreign debt crisis in the East African countries (Dawood, Horsewood, & Strobel, 2017; UNICEF, 2021). Most studies have focused on the impact of economic growth (Kharusi & Ada, 2018; Moh'd AL-Tamimi & Mohammad, 2019; Shangai & Ochieng, 2019). However, external debt can be influenced by the governance structure and effectiveness of loan recipient countries. While few works have examined the relationship between governance and public debt, their methodological estimation lacks clarity. For instance, Mehmood, Mohd-Rashid, Aman-Ullah, and Zi ong (2021) examined the connection between public debt and governance at the national level by presenting a more comprehensive understanding of national governance, particularly by proposing harsh market conditions for the management of a current public debt of the country, but used least squares to explain the relationship, which could lead to inconsistent estimates.

Tarek and Ahmed (2017) attempted to show the relationship between governance and public debt using fixed effect and general method of moments (GMM) approaches, both of which are inappropriate for long panel data. Previous results have failed to explicitly demonstrate the long-term and short-term effects of governance and economic development on external debt using the appropriate analytical method. To date, no convincing case has been presented for studying the influence of governance and economic growth on external debt accumulation, given the unique characteristics of each East African economy. This study attempts to fill this gap by examining whether the effects change depending on time horizon. It examines three East African

countries with a common debt limit but does not distinguish between short- and long-term consequences. The problems led to the following crucial hypotheses: Governance and external debt are positively related in the short and long term. Economic growth has a negative impact on external debt in the short and long term.

Government spending and foreign debt are positively related in the short and long term.

2. Theoretical Framework

The theoretical basis for this analysis was the tax smoothing theory and traditional government budget constraints introduced Barro (1979) and Roubini and Sachs (1989). The main point of this groundbreaking article is that when government spending fluctuates, deficits rather than tax rates fluctuate. This maintains stable tax rates that are less volatile than changes in government spending. The tax smoothing theory on which the model is based states that changes in economic growth, interest rates on previously acquired debt, the inflation rate and changes in government spending can lead to changes in the level of government debt. The study therefore applied the tax smoothing and optimization approach to the fiscal deficit as shown in the equation (1):

$$D_{it} = G_{it-1} + T_{it-1}(1 - R_{it})B_{it-1} \quad \textbf{(1)}$$

Where D_{it} represents the national debt in period t, G_{it-1} represents the total public expenditure in period t , T_{it-1} represents the total government revenue in period t , and $(1 - R_{it})$ the gross interest rate for the national debt in period t. Equation 1 can be rewritten in another way that takes into account all variables expressed in shares of GDP as follows:

$$\frac{D_{it}}{Y_{it}} = \frac{(1+r)}{(1+g)} * \frac{D_{it-1}}{Y_{it-1}} + \frac{G_{it}-T_{it}}{Y_{it}} = \left[\frac{1+r}{1+m+\delta}\right] * \frac{D_{it-1}}{Y_{it-1}} + \frac{G_{it}-T_{it}}{Y_{it}} \quad \textbf{(2)}$$

Where δ is the inflation rate and m is the growth rate of real output. According to equation (2) it is clear that debt to GDP ratio at time t depends at the same time on debt ratio at time t-1 and on primary deficit $(G_{it} - T_{it})$. Similar to the study by Woo (2003), the latter term is a function of real GDP growth, GDP per capita and the inflation rate. To better understand the behavior of the debt

ratio, the study includes a governance indicator in the model. The final form of our empirical model is given by equation (3). It expresses debt as a function of lagged value, governance index, economic growth and general government spending.

3. Methods

3.1. Model Specification

The study focused on East African countries and used econometric techniques to assess the long- and short-term dynamics of the relationships between foreign public debt, governance and economic growth. The study used the panel developed by ARDL M. H. Pesaran and Smith (1995) and M. H. Pesaran, Shin, and Smith (1999) to evaluate the short- and long-term relationships.

Panel Autoregressive Distributed Lag (ARDL) is performed when no co-integration was found using the previous methods. This method is superior regardless of whether the underlying repressors have I(0), I(1), or a mixture of both H. H. Pesaran and Shin (1998) with a period of over 20 years. Although popular, the Generalized Method of Moments (GMM) is by Arellano and Bond (1991) does not work well in this situation with small samples . If N is greater than T, the GMM approach is suitable (Blundell & Bond, 1998). Otherwise, the technique may be biased with small samples and lose degrees of freedom as the number of observations increases. Given the large T (20 years) and small N (3 nations) of the panel, the autoregressive distributed lag model (ARDL) would be appropriate. Following the extensive literature on dynamic panel data, the study implements various estimators to assess the relationship between external public debt, governance and economic growth using Mean Group (MG) and Pooled Mean Group (PMG) estimators (M. H. Pesaran et al., 1999; M. H. Pesaran & Smith, 1995).

The main model of the panel ARDL approach is to identify the relationship between external public debt, governance and economic growth:

$$debttogdp_{it} = \beta_0 + a_i gee_{it} + \gamma_i gdpgrowth_{it} + \psi_i govtexpend_{it} + \mu_{it} \qquad \textbf{(3)}$$

Where ‘debtogdp’ indicates external public debt as percentage of GNI and ‘gee’ stands for governance effectiveness, ‘gdpgrowth’ denotes economy growth rate

and 'govtexpend' represents government final expenditure as percentage of GDP. The parameters β , , γ and ψ are the parameters to be estimated 'it' i is represent county's and t is the time period and μ_{it} is the white noise error. By reparametrizing eq. (3)

$$\Delta debttogdp_{it} = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta debttogdp_{it-i} + \sum_{i=1}^{q} a_i \Delta gee_{it-i} + \sum_{i=1}^{q} \gamma_i \Delta gdpgrowth_{it-i} + \sum_{i=1}^{q} \delta_i \Delta govtexpend_{it-i} + \lambda ECT_{it} + \mu_{it} \quad \textbf{(4)}$$

Where λ is coefficient of ECT_{it-i}

The PMG requires that the long-term balance between nations be homogeneous while allowing for short-term variability. The short-term context focuses on country-specific heterogeneity, which may be caused by different responses to stabilization measures, external shocks or financial crises across countries. The MG estimator takes into account both short-term and long-term relationship heterogeneity. To be consistent, this estimate is applicable to a wide range of nations. For a small number of N, this technique is sensitive to permutations of the non-large model and outliers (Favara, 2003).

The DFE estimator, on the other hand, limits the adjustment speed, the slope coefficient and the short-run coefficient to ensure non-heterogeneity across nations. Acceptance of this estimate as a primary analytical tool requires a strong assumption that countries' responses are the same in the short and long term, which is less convincing. Another disadvantage is that in a small sample situation, this strategy may suffer from simultaneity bias due to the endogeneity between the error term and lagged explanatory factors (Baltagi, Griffin, & Xiong, 2000). The study used the Hausman test to confirm the significance of each estimate. A critical point in ARDL estimation, especially PMG and MG estimators, can alleviate the endogeneity problem by including appropriate lags for all variables (M. H. Pesaran et al., 1999).

3.2. Preliminary tests

The panel unit root test is performed to test the stationarity of the variables used. Research shows that panel data exhibit non-stationary tendencies and therefore false correlations can occur between variables that are non-stationary over time (Granger & Newbold, 1974; Phillips, 1986). Therefore, the LLC test was used to validate the standard panel unit root in the data (Levin,

Lin, & Chu, 2002). The Bayesian Information Criterion (BIC) is used to determine the lag duration.

Based on the results of preliminary non-stationarity tests, panel co-integration tests are also used When the variables are non-stationary, Pedroni's co-integration tests are used to verify co-integration (Pedroni, 1996). These co-integration tests are intended to demonstrate the existence or failure of a long-term connection. Pedroni (1996) presents seven different panel co-integration tests to verify the absence of co-integration. In the seven-factor test, three between-dimension methods and four within-dimension strategies are used. Another test used by the study is the Cross-Sectional (CD) M. H. Pesaran (2015), which explains the presence of cross-sectional dependence. The estimation of panel data assumes that disturbances are cross-sectional independent; nevertheless, given the cross-national effects on the population, the question of a cross-sectional connection may arise. This dependence can arise from comparable geographical locations and political or economic incentives (Gaibulloev, Sandler, & Sul, 2014). Therefore, the presence of cross-sectional dependence needs to be tested. The CIPS and CD tests were also used in the study to check the residual qualities.

3.3. Data Source

The three countries of East Africa – Ethiopia, Kenya and Uganda – are the focus of this study, which covers the years 2000 to 2020. The World Bank (World Databank) and Worldwide Governance Indicators (WGI) databases provided the data sets for this empirical study. The definition and measurement units for the variables used in the study are listed in Table 1.

Table 1: Definition of regressor variables, measurement unit and expected sign

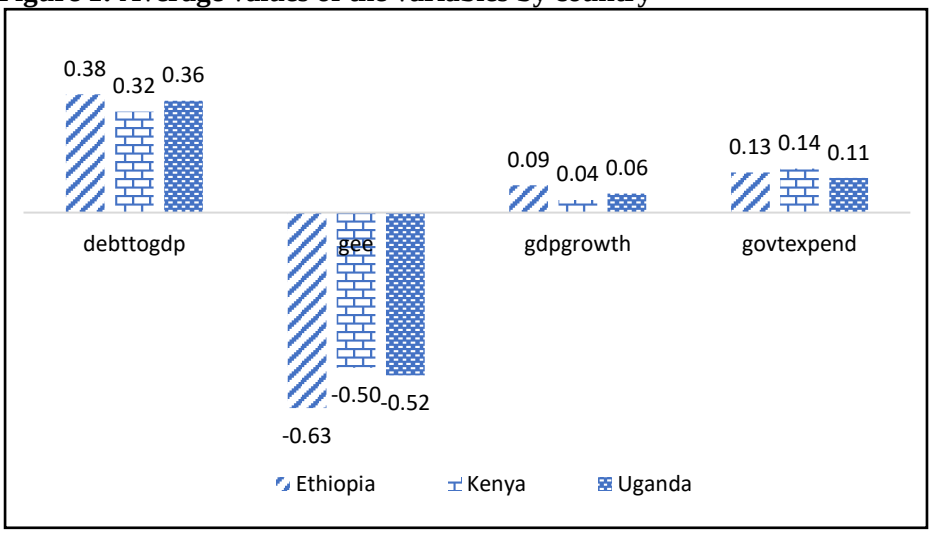
Variables	Definition	Measurement unit	A prior sign
debttogdp	External debt stock	% of GNI	
gee	Government effectiveness	Numbers between -3 and 3	+/-
gdpgrowth	GDP growth rate	%	+/-
govtexpend	Government final consumption expend	% of GDP	+/-

4. Result and Discussion

4.1. Preliminary Findings

Ethiopia is the largest debtor in East Africa, with average debt over the past 20 years being 38% of GDP. Kenya and Uganda have the second and third highest percentages of total external debt, at 36% and 32%, respectively.

Figure 1: Average values of the variables by country



Kenya, the country with the best governance, has an average governance effectiveness of -0.50 over a 20-year period, while Ethiopia, the country with the worst governance, has an average effectiveness of -0.63. Uganda (-0.52) has the second best structures of good governance. The governance effectiveness of states in East Africa is generally below average. Ethiopia recorded the highest average economic growth rate of 9% during the study period, with the majority of growth being in the double digits. Kenya recorded the lowest economic growth at 4%. Uganda recorded the second highest economic growth rates (6%) over the 20-year period. The Kenyan government had the highest expenditure at 14% and the Ugandan government had the lowest expenditure at 11% during the study period. Ethiopia's government is the second largest spender at 13%.

Figure 2: Trend analysis of external debt

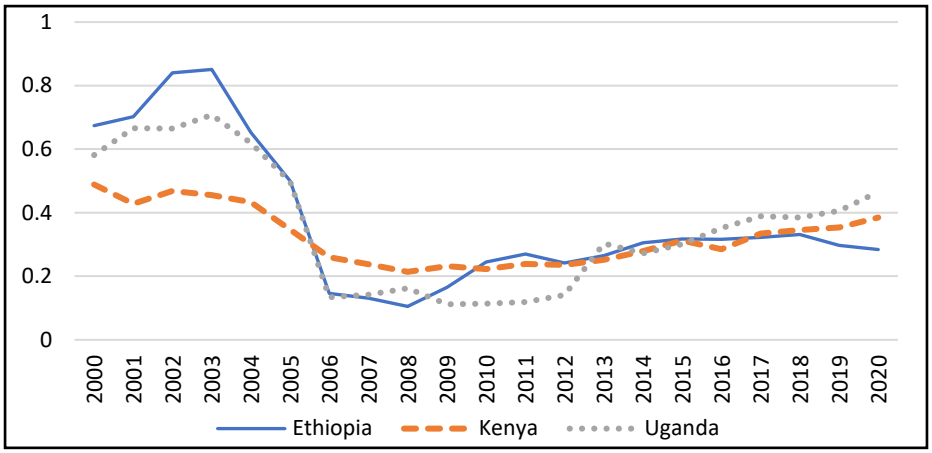
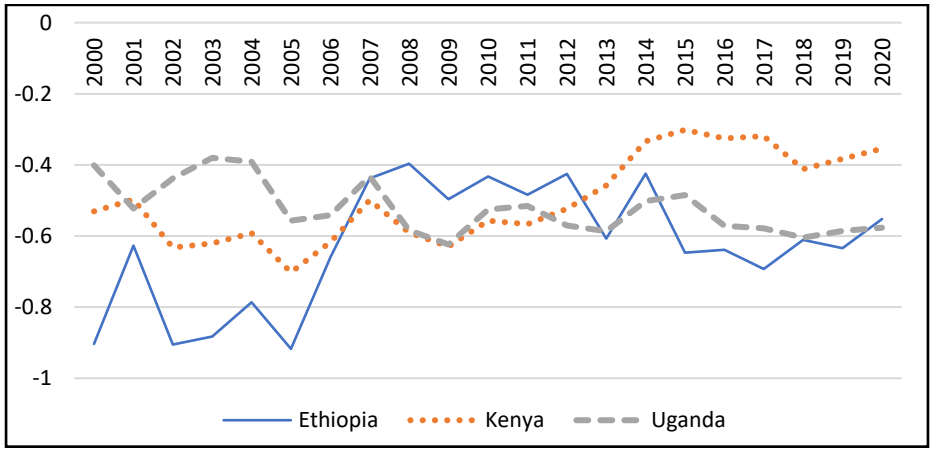


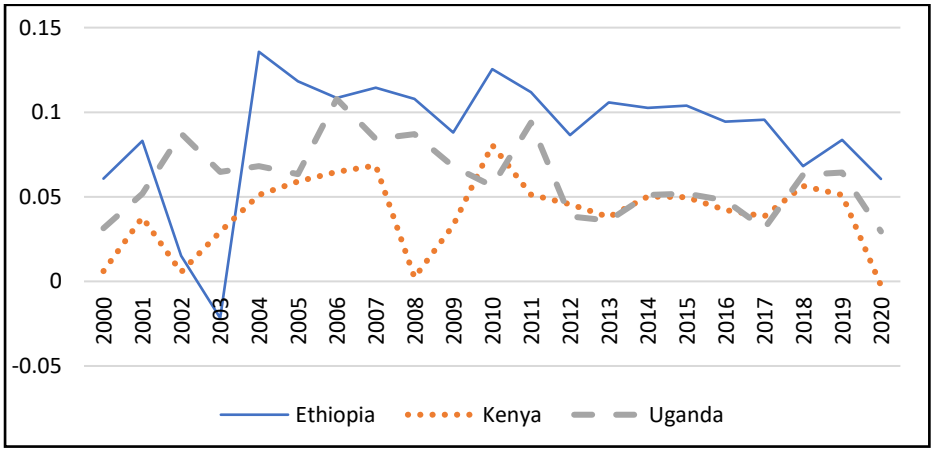
Figure 2 also shows external debt trends in East African countries. During the period 2000-2020, all countries experienced a steady decline in external debt relative to GDP. This could be due to either a significant increase in the GDP of most East African countries or a decrease in external debt. This rate showed a continuous decline, particularly from 2005 onwards. The fall in public debt in 2005/2006 came after the G7 finance ministers agreed on debt relief for low-income countries (Ams, Baqir, Gelpern, & Trebesch, 2019). This led to a decline in external debt in many countries, including East Africa. The 2005 agreement in London resulted in $130 billion in debt relief for 36 countries (Ferry & Raffinot, 2019).

Figure 3: Trend analysis of governance effectiveness



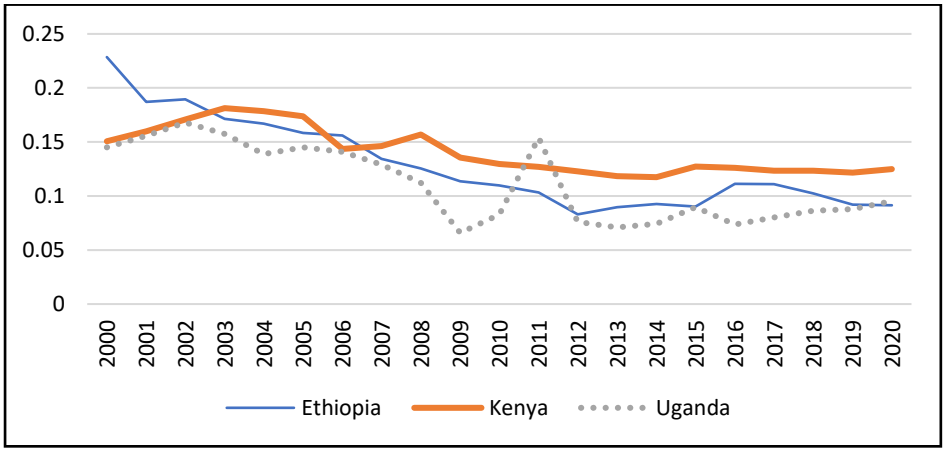
Ethiopia's government effectiveness has improved since 2000, whereas before 2007 it was extremely poor. In contrast to Kenya and Uganda, Ethiopia had the worst government system until 2007. However, Ethiopia had an improvement in government effectiveness from 2007 to 2013, but Ethiopia's governance became worst from 2013 onwards. Kenya's governance system, on the other hand, showed a steady improvement from 2000 to 2020, while Uganda's governance system showed a declining trend. In general, governance efficiency in the three countries is below average, indicating a weak governance framework.

Figure 4: Economic growth trend analysis



Ethiopia's GDP growth rate was the highest since 2004, occasionally reaching double digits, while Kenya's GDP growth rate was the lowest until 2010. Later, Kenya and Uganda's growth rates alternately occupy second and third place as Ethiopia's growth rate dominated from 2004 onwards. The growth rates of the three nations show a tendency to slow down from 2018 onwards.

Figure 5: Trend analysis of government spending



For all three nations, the share of government spending decreases over the course of the study; this could be due to either an increase in GDP over time or domestic fiscal constraints. In terms of average national budget expenditure in the years studied, Kenya was the front runner, with Ethiopia's expenditure leading before 2003. Later, excluding the years between 2010 and 2012, the Ethiopian government spent the second highest amount of money from the budget. On the other hand, with the exception of the years between 2010 and 2012, the Ugandan government spent the least amount of its budget for most of the period.

4.2 Model Estimation

Unit root testing is the first step in ARDL analysis. It indicates the degree to which each variable is integrated. Additionally, the unit root test is performed to ensure that the variables used are stationary. Over time, panel data with non-stationary tendencies and thus false correlations can arise between non-stationary variables. The results of the unit root test intercept and trend are shown in Table 2. Since all LLC[2] test statistics are significant at the first difference, the results suggest that each of the time series variables is integrated in the first order. The ARDL model and ECM were run after the LLC test showed that the series variables were stationary of orders 0 and 1.

[2] LLC is Levin-Lin-Chiu test

Table 2: Stationarity, unit root and order of integration

	At level	1st difference	Order
debttogdp	-0.564 (0.286)	-1.987 (0.023) **	I (1)
gee	-2.346 (0.009) ***	-5.272 (0.000) ***	I (0)
gdpgrowth	-2.3681 (0.009) ***	-5.846 (0.000) ***	I (0)
govtexpend	(-0.284) 0.3881	-3.141 (0.0008) ***	I (1)

Next, the Pedroni co-integration test was used to determine the co-integration between the study variables. The result shows that the seven test statistics reported provide strong evidence that all panels in the data are co-integrated (see Table 3); Thus, the null hypothesis (that there are no long-term associations) is rejected. It can be estimated that ECM shows long-run Granger causality between exogenous variables and the dependent variable of external debt. Therefore, ARDL models can be estimated for these variables. According to Asteriou, Pilbeam, and Pratiwi (2021), the panel ARDL method can be used to consider long-term and short-term relationships, even for the case of non-stationary variables, but without co-integration.

Table 3: Pedroni co-integration test results

Test	Stats.	Panel	Group	Panel	Group
v				-0.253	
rho				0.767	1.65
t				1.753	1.64
adf				1.677	3.239

Third, the study calculated the lag length for the ARDL model and ECM. The lag length was determined in this study using the Bayesian Information Criterion (BIC). The results showed that the lag lengths for debt to GDP, governance, economic growth, and government spending were 1, 0, 0, and 0, respectively. As a result, the ARDL model and ECM predictions were influenced by these delay lengths. The appendix shows the result of determining the delay length using the Bayesian Information Criterion (BIC).

Table 4: Estimation of the effect of governance on public debt

Variables	PMG		MG	
	Coffe.	**P-value**	**Coffe.**	**P-value**
gee	-1.941***	[0.006]	1.783*	[0.100]
gdpgrowth	-12.461***	[0.000]	-12.758***	[0.000]
govtexpend	2.040	[0.160]	2.470	[0.442]
SR				
ECT	-0.196***	[0.005]	-0.207***	[0.001]
gee	0.237**	[0.043]	-0.212	[0.105]
gdpgrowth	0.511***	[0.000]	0.647***	[0.000]
govtexpend	-0.196	[0.687]	0.220	[0.673]
Constant	0.386***	[0.007]	0.362***	[0.000]
Hausman chi2 (3) =0.40		Prob>chi2 =0.9398		
Observations=60				

*** 1%, ** 5%, * 10%

Table 4 shows the results of the estimated relationship between external public debt and governance effectiveness by both the pooled mean group and mean group estimators of the panel ARDL model. Due to the different results of the two estimators, it is imperative to select the preferred model using the Hausman test. The null hypothesis examined is that of slope homogeneity, if we fail to reject the null hypothesis, it means that PMG is the preferred estimator, where the estimator constrains the long-run equilibrium between variables to be homogeneous across all countries or a subset of them. The Hausman test with an h-statistic of 0.4 and a p-value of 0.9398, which corresponds to a significance level of more than 5%, implies that slope homogeneity exists and that PMG is the preferred estimation model. An important note here is that the error correction term coefficient (ECT) of -0.196 is statistically significant at the one percent significance level and indicates that imbalance in the previous period was corrected to a steady state at a rate of 19.6 % to reach.

The effectiveness of governance is statistically significant in both the short and long term. Specifically, there was an inverse relationship between governance and external debt in the short run, while there was a positive relationship in the long run. This is consistent with the findings from Manasseh et al. (2022); Shittu, Ismail, Abdul Latiff, and Musibau (2020) and supports the a priori assumption . It can be argued that the long-term effects of governance, such as: Such as loan repayments, tax increases, the impact of successful project implementation and the removal of bureaucratic obstacles, will attract more

foreign lenders in the future and may increase the flow of foreign debt and aid. The finding dictates that governments in East Africa should improve their governance structure to obtain more loans to finance needy projects that will enable them to eradicate poverty in the region

In addition to the governance and external public debt relationship, Table 4 provides other interesting insights. For example, the economic growth rate is statistically significant in both the short and long run but is negatively related to government debt in the long run and positively related to the short run at the one percent significance level. An increase in economic growth reduces public external debt in the long term and increases it in the short term. Intuitively, it is expected that external debt will increase as a result of short-term economic expansion. The result is consistent with the findings of Sharaf (2022); Shkolnyk and Koilo (2018) who found a similar positive relationship between GDP growth and public debt. This suggests that government debt will fall as the economy grows and financial markets develop. Faster economic development can help reduce debt accumulation in at least two ways. For example, faster development leads to more income, and faster development improves the economy's ability to carry debt. In another context, when debt is measured as a percentage of GDP, higher GDP can help lower the debt ratio, just as lower monetary debt can lower the ratio.

5. Conclusion and Policy Implication

Governance and its impact on external debt are hotly debated topics among academics and policymakers. This study adds to the literature on external public debt by focusing on a group of East African countries with higher external debt to GDP ratios. Overall, the three countries' external debt-to-GDP ratios indicate a declining trend, while governance improved in all three countries throughout the sample period. The basic conclusion of this paper on the relationship between governance and the accumulation of public debt is that the worse the governance in a country, the higher the ratio of external debt to GDP. These results have particularly strong policy implications for developing countries in general and for East African countries in particular. East African countries that want to reduce their external debt in the long term should particularly strive to improve the quality of their institutions as well as their governance structure and effectiveness, as this variable contributes to the reduction of external debt. At the same time, they must increase the growth of their economy by developing their own economic system.

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Determinants of Inflation in Ethiopia: An Autoregressive Distributed Lag (ARDL) Modelling Approach

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Abstract

Inflation brings an economic instability and aggravates poverty level of countries if it has not been controlled properly. Ethiopia had double digit inflation in the previous two decades, which result in creating socioeconomic problems. Thus, this paper tried to identify the major determinants that affect inflation in Ethiopia using 41 years' time series data over the period 1980 to 2020. The study used an Auto-Regressive Distributed Lag (ARDL) model to analyze the long- and short-run determinants of inflation in Ethiopia. Findings of the study revealed that in the long-run, gross domestic product, broad money supply and terms of trade are positively determining inflation while government expenditure has negative and significant effect on inflation. Similarly, money supply and exchange rate determine inflation positively and significantly in the short-run, while government expenditures, interest rate and terms of trade determine the inflation negatively and significantly. Given this, the speed of adjustment, error term, has a value of 0.7195 with negative sign, which indicates the convergence of macroeconomic disturbance towards the long run equilibrium that is more than a fiscal year. Hence, enhancing the volume and diversity of export and ensuring appropriate fiscal and monetary policies are the major policy recommendations to manage the inflation in Ethiopia.

Keywords: Consumer price index, Auto-Regressive Distributed Lag (ARDL) model, Ethiopia.

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1. Introduction

1.1. Background

Inflation is a sustained and persistent rise in general price level of goods and services. It has been emanated with the time of using money as a medium of transaction (Tadesse, 2020). It has been increased at an alarming rate during and after World War II since governments financed the war, which is an unproductive direction of expenditure. Inflation can be categorized as walking (moderate), running, and jumping (hyperinflation). A mild and manageable form of inflation is moderate inflation. It takes place when inflation is low, less than ten percent per year, or in the single digits and prices are rising gradually. However, running inflation arises when the rate of price change increases significantly. Double-digit yearly inflation rates are referred to as running inflation. It was taken as an indication that hyperinflation was imminent. As a result, inflation occurs when prices increase by more than 10 percent on an annual basis (Mithani, 1984). In contrast, there is no maximum limit to the rate of price rise during hyperinflation, where prices ascend with every movement. The enormous inflation in Germany following World War I and the great inflation in China following World War II are two classic examples of hyperinflation.

From the theoretical aspects, classical economists developed five main theories regarding the causes of inflation. The first is demand pull theory, which argued that the main source of inflation is the raise in aggregate demand over that of supply (Totonchi, 2015). However, the second theory, cost push theory, argued that inflation rises due to costs of production increment. Given this, the third theory, quantity theory of money, argued that inflation rises due to an increase in money supply. Having this in mind, the fourth theory, the structuralists theory of inflation, argued that as the economy develops, rigidities arise, which could result into structural inflation. The structuralist further identified the three commonly observed basic constraints that lead to inflationary process, which are agricultural, trade and budget constraints (Teslim, 1982). Most developing countries are characterized by high population growth rate that results in increasing demand for food, which may force to increase the foreign demand in turn, which pushes the food price up ward. Similarly, in most least developed countries, export receipts are slowly increasing while import expenditure is rapidly increasing. This is often ascribed

to the falling demand for LDC's export items and rapidly rising demand for imports by in the LDC's. This results in foreign exchange constraints and persistent balance of payment deficit. The final type of theory of inflation is Phillips theory of inflation. According to the Phillips Curve; there exists a negative, or an inverse, relationship between unemployment and inflation rate in an economy (Mankiw and Gregory, 2016). Whenever unemployment is low, inflation tends to be high. Whenever unemployment is high, inflation tends to be low.

Although an increase in inflation brought instability, the average inflation rate is still higher in Ethiopia due to money supply increment (Teamrat, 2017; Mebtu, 2020; Tadesse, 2020), real exchange rate (Mebtu, 2020; Tadesse, 2020) and gross domestic product (Teamrat, 2017; Mebtu, 2020). Thus, price stability and sustainable economic growth are considered as an essential macroeconomic goal. Moreover, the average inflation rate in Ethiopia is 34.5 percent (WB, 2020), which is very high compared to the world and African average rate of inflation in the same year, which were 8.8 and 12.2 percent, respectively (IMF, 2022). Similarly, as the same source pointed out that the Ethiopian average rate of inflation is higher than all African countries except that of Sudan and Zimbabwe. Thus, double digit inflation has become troublesome for policymakers as well as the society and hence, need to be reduced.

In Ethiopia, recently some researchers and scholars likes; Teamrat (2017), Tekeber et al. (2019), Mebtu (2020) and Tadesse (2020) conducted their study on determinants of inflation. Specifically, study by Teamrat (2017) tried to identify the major determinants of inflation in Ethiopia using 39 years time series data covering the period from 1975 to 2014. Similarly, the study by Tekeber et al. (2019) tried to identify the supply and demand side determinants of inflation in Ethiopia by using only a 32 years' data spanning from 1985 to 2016. Hence, both studies cover a shorter time span and do not reflect the current situations on determinants of inflation in Ethiopia. Besides, Mebtu (2020) and Tadesse (2020) also conducted their study on determinants and macroeconomic determinants of inflation in Ethiopia, respectively. However, study by Mebtu (2020) used only 30 years' time series data covering the period between 1986 and 2016, which still did not reflect the current situation. Besides this, the author did not take into account the importance of variables likes; terms of trade and interest rate in determining inflation in Ethiopia. Moreover, study by Tadesse (2020) also tried to identify the macroeconomic determinants of

recent inflation covering only 33 years' data ranging from the year 1985 to 2018. Likewise, the author ignored the importance of terms of trade and government expenditure in determining inflation in Ethiopia. Hence, to fill this gap, this paper tried to incorporate the consequences of important variables such as terms of trade, government expenditure and interest rate on inflation.

Furthermore, to understand the trend of inflation over a period of time, this paper used a 41 years' time series data covering the period from the year 1980 to 2020 G.C. Besides, majority of the study conducted so far in Ethiopia were tried to analyze the impacts of inflation on other economic variables than determining the major determinants of inflation. Thus, to fill these gaps, this paper aimed to identify the major determinants of inflation in Ethiopia by using a more recent data and variables. The major research questions of the study were; what are the major determinants of inflation in Ethiopia? Is there a long run relationship between inflation and its determinants and if so, how long does it take to adjust itself toward the long run equilibrium? Thus, the study tried to identify the major determinants of inflation in Ethiopia.

2. Methodology of the Study

2.1. Types and Sources of data

This paper has used 41 years' time series secondary data that was collected from four different sources covering the period from 1980 to 2020 G.C. Specifically, the data for consumer price index (CPI), Gross Domestic Product (GDP) and Broad Money Supply (BMS) were obtained from National Bank of Ethiopia (NBE) while the annual data for Exchange Rate (ER) and Terms of Trade (TOT) were collected from World Bank (WB). Finally, the data for Interest Rate (IR) and Government Expenditure (TGE) were collected from International Financial Statistics (IFS) and Ministry of Finance and Economic development (MOFED), respectively.

2.2. Methods of Data Analysis

In this paper, prior to estimate Bound Tests for Co-integration, a unit root test was conducted by using Augmented Dickey-Fuller (ADF) test to identify order of integration. Then, an Auto-Regressive Distributed Lag (ARDL) bounds testing approach developed by Pesran et al. (2001) to modeling

the long run determinants of inflation were used. This model is selected mainly since it does not require pre-testing of the series, correct for serial correlation and endogeneity problems (Pesaran and Shin, 1999; Jalil et al., 2008), due to its sample properties (Nayaran, 2004), its possibility to capture different optimum number of length for different variables and its appropriateness for different level of integration as opposed to Engle and Granger (1987) and maximum likelihood based approach of Johansen and Juselius (1990) and Johansen (1991) co-integration techniques.

Therefore, an ARDL model can be specified as follows:

$$\Delta \mathrm{LnCPI}_t = \alpha_0 + \sum_{1=1}^{p} \alpha_1 \Delta \mathrm{LnCPI}_{t-i} + \sum_{1=1}^{q} \alpha_2 \Delta \mathrm{LnGDP}_{t-i} + \sum_{1=1}^{q} \alpha_3 \Delta \mathrm{LnBMS}_{t-i} + \sum_{1=1}^{q} \alpha_4 \Delta \mathrm{LnER}_{t-i} + \sum_{1=1}^{q} \alpha_5 \Delta \mathrm{LnTGE}_{t-i} + \sum_{1=1}^{q} \alpha_6 \Delta \mathrm{LnIR}_{t-i} + \sum_{1=1}^{q} \alpha_7 \Delta \mathrm{LnTOT}_{t-i} + \gamma_1 \mathrm{LnCPI}_{t-1} + \gamma_2 \mathrm{LnGDP}_{t-1} + \gamma_3 \mathrm{LnBMS}_{t-1} + \gamma_4 \mathrm{LnER}_{t-1} + \gamma_5 \mathrm{LnTGE}_{t-1} + \gamma_6 \mathrm{LnIR}_{t-1} + \gamma_7 \mathrm{LnTOT}_{t-1} + \mu_t \quad \textbf{(1)}$$

Where, Δ refers the first difference of a variable, Ln is the natural logarithms, α_0 is a constant p and q are the maximum lag order for dependent and independent variables, $\alpha_{1,}$…….. α_7 refers the short run coefficient, γ_1,…… γ_7 correspond to the long-run relationship, i refers time trend, and μ_t is the white noise error.
The short-run error correction form of the series can be specified as follows:

$$\Delta \mathrm{LnCPI}_t = \alpha_0 + \sum_{1=1}^{p} \alpha_1 \Delta \mathrm{LnCPI}_{t-i} + \sum_{1=1}^{q} \alpha_2 \Delta \mathrm{LnGDP}_{t-i} + \sum_{1=1}^{q} \alpha_3 \Delta \mathrm{LnBMS}_{t-i} + \sum_{1=1}^{q} \alpha_4 \Delta \mathrm{LnER}_{t-i} + \sum_{1=1}^{q} \alpha_5 \Delta \mathrm{LnTGE}_{t-i} + \sum_{1=1}^{q} \alpha_6 \Delta \mathrm{LnIR}_{t-i} + \sum_{1=1}^{q} \alpha_7 \Delta \mathrm{LnTOT}_{t-i} + \partial ECM_{t-1} + \mu_t \quad \textbf{(2)}$$

Where ∂ the speed of adjustment process and ECM is the residuals obtained from equation (1) while other variables remain as defined above. The coefficient of the lagged error term is expected to be negative and statistically significant to further support the existence of a co-integrating relationship.

Descriptions of Variables and their Hypothesis

After a thorough a review of the work of previous researchers and scholars on determinants of inflation, the following variables were hypothesized to affect inflation in Ethiopia.

Dependent variable

Consumer Price Index (LnCPI):- It is proxy for inflation and a dependent variable for the model. It is also referring to the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.

Independent Variables

Gross Domestic Product (LnGDP): It is proxy for market size. It is the log-value of nominal GDP in millions of Birr. It is also used to capture the aggregate demand conditions in the economy. In another way, although there is a need to increase production to meet an increase in demand, an increase in production further cause to lowers unemployment rate and higher inflation. Similar arguments were made by Teamrat (2017) and Jonse (2018). Hence the expected sign of GDP on inflation was positive (+).

Broad Money Supply (LnBMS): It is the sum of currency outside banks, narrow money, net demand deposit and quasi money in millions of Birr. Quantity theory assumed that an increase in money supply leads to a rise in price levels due to a simultaneous increase in investment, the level of employment and an aggregate demand. Similar arguments were also made by scholars and researchers such as Neumann and Ssozi (2016), Teamrat (2017), Jonse (2018) and Tekeber et al. (2019). Hence, with an increase in money supply, the people will have much money to pay for higher prices, which further leads to higher inflation. Thus, the expected sign of money supply on inflation was positive (+).

Exchange Rate (LnER): It is the value of domestic currency needed to buy a unit of foreign currency. The volatility of exchange rate affects price level of aggregate demand and supply. The increase in exchange rate push up foreign demand for domestic goods and services, causing volume of export and aggregate demand to move up. The increased in aggregate demand further made the domestic price to bid up. Similarly, it also raises a cost of imported inputs which will raise marginal cost and domestic price. Thus, due to this fact the effect of exchange rate on inflation was argued positively (Monfared and Akin, 2017; Tekeber et al., 2019). Hence, exchange rate was expected to have a positive (+) effect on inflation.

Government Expenditure (LnTGE): It is the value of total government expenditure in millions of birrs. Hence, an increase in government expenditures raises the volume of money injected to the public, which leads to

higher inflation. Similar argument was made by the study of Mebtu (2020). Thus, for this paper, the government expenditure hypothesized to determine inflation positively.

Interest Rate (LnIR):- It is the Proxy for cost of capital. Since interest rate is a measure of the opportunity cost of capital, inflation would expect to increase with a decline in interest rate. Besides, as interest rates are increased, consumers tend to save more because returns from savings are higher. Hence inflation decline with an increase in interest rate due to the slowdown in the economy. Similar argument was made by Tadesse (2020). Thus, interest rate would have expected to affect inflation negatively.

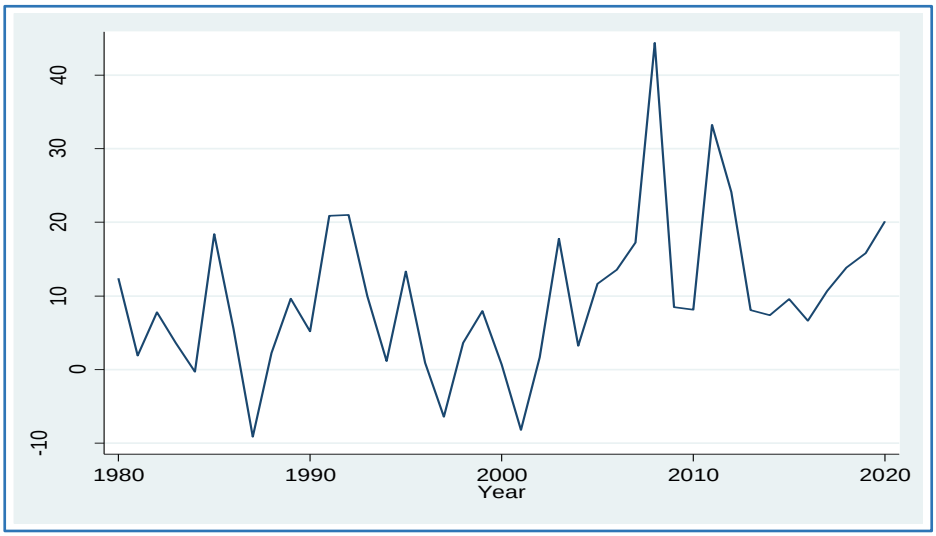
Terms of Trade (LnTOT):- It is proxy for economic openness. It is obtained by dividing the export price index by the import price index. According to Prebisch-Singer hypothesis, emerging market and developing countries experienced a decline in terms of trade due to a decline in price of export relative to price of manufactured goods. Similarly, in most developing countries due to currency devaluation and scarcity of exports, more capital is leaving the country than entering to the country and hence, reduces terms of trade. Hence, exchange rate response to a change in the terms of trade is crucial to the inflation outcome. Besides, inflation decreases with an increase in terms of trade due to rise in export price over that of import. Hence, terms of trade would have expected to affect inflation negatively.

3. Results and Discussions

3.1. Trends of Inflation in Ethiopia

Inflation in Ethiopia is distinguished by the successive ups and downs, which result in upward moving trend (Figure 1). The minimum and maximum average rates in between 1980 and 2020 were negative 9.15 and positive 44.37 percent, respectively. The maximum inflation in 2008 was mainly due to a rise in food and non-food prices, international prices of oil and emergency of worst droughts. However, the minimum average inflation registered in 1987 mainly due to the presence of command economic systems that possess a direct control of the monetary authorities.

Figure 1: Trends of average inflation in Ethiopia



Source: Model Output, 2020

3.2. Model Diagnostic Tests

Prior to estimation of the model to be used for the final analysis, a unit root, co-integration, diagnostic and parameter stability tests were conducted.

3.2.1. Unit root tests

It is essential to determine the optimal lag length of each variable included in the model. Hence, an optimal number of lags were estimated and summarized in the following Table 1.

Table 1: Optimal lag length selected by AIC

Variables	Optimal Lag Length
LnCPI	1
LnGDP	1
LnBMS	2
LnER	2
LnGE	2
LnIR	1
LnTOT	1

Source: Model Output, 2020

According to Lutkepohl (2006) the dynamic link among the series can be captured if proper lags are identified and used. In this paper, the optimal lag length for each variable is determined by using the Akaike Information Criterion (AIC) so that the selected model is ARDL (1, 1, 2, 2, 2, 1, 1). Thus, for unit root test and ARDL approach, a maximum lag of order one was used for the analysis.

Table 2: Result of unit root test using ADF

Variables	ADF results at their level form		ADF results at the first difference form		Order of integration
	With constant only	With constant and trend	With constant only	With constant and trend	
LnCPI	0.0200	-0.0723	-0.759091***	-0.9151***	I(1)
LnGDP	0.0409**	-0.0202	-0.4835**	-0.8883***	I(1)
LnBMS	0.0081	-0.0268	-0.2826**	-0.4898**	I(0)
LnER	0.0076	-0.2196**	-0.6074**	-0.6308***	I(1)
LnGE	-0.0319	-0.5071**	-0.8302***	-0.9964***	I(1
LnIR	-0.2459**	-0.2842**	-1.0341***	-1.0387***	I(1)
LnTOT	-0.3515**	-0.3608**	-1.43292***	-1.4323***	I(1)

Note:** and *** represents significance at 5% and 1% level of significance respectively
Source: Model Output

The result of Augmented Dickey-Fuller (ADF) test in Tables 2 above reveled that except LnBMS, all variables are found to be non-stationary at level and stationary at first difference at the conventional 1% and 5% level of significance. Thus, while LnBMS is found to be I(0), the other variables are found to be I(1). Hence, an ARDL bounds testing approach, which do not require same order of integration for all variables, were used as opposed to Johansen co-integration test.

3.2.2. Bound Tests for Co-integration

Co-integration test is applied to examine the existence of long run equilibrium relationship among variables included in the model. Results of bound test procedure for co-integration analysis between inflation and its determinants are presented in Table 3 below. The test under ARDL involves the comparison of the F-statistics against its critical values.

Table 3: ARDL bounds test for Co-integration

		Critical value bounds			
Test statistic	**Value**	**I(0) bound**	**I(1) bound**	**Significance (%)**	**Inferences**
	4.659	2.12	3.23	10	Exist Relationship
		2.45	3.61	5	Exist Relationship
		2.75	3.99	2.5	Exist Relationship
		3.15	4.43	1	Exist Relationship

Note: H0: No long run relationships exist
Source: Model Output, 2020

The null of no co-integration is tested against the alternative using the F-test with critical values tabulated by Pesaran et al. (2001). Hence, since the calculated F-static (4.659) is greater than the upper bound critical values 4.43 at 1% level of significance, the null hypothesis of no co-integration is rejected (Table 3). Therefore, there is a long run co-integration relationship between inflation and its determinants.

3.2.3. Test Parameter for Stability

The parameter stability of the model for long run and short run relationship is detected by using the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Square (CUSUMSQ) tests.

Figure 2: Cumulative sum of recursive residuals

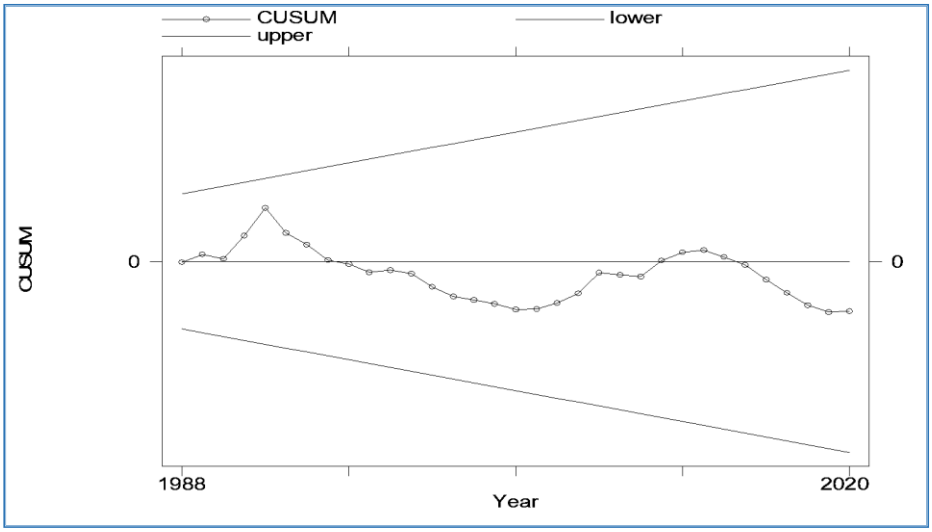
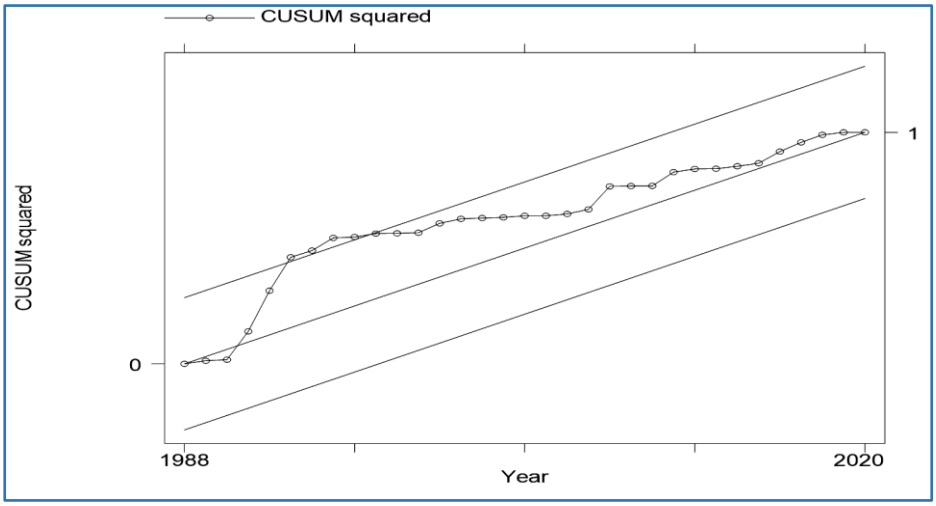


Figure 3: Cumulative sum of squared test



As it has been seen from the above two figures, the plot of CUSUM test did not cross the critical limits. Similarly, the CUSUM squared test also shows that the graphs don't cross the lower and upper critical limits. Hence, the parameters of the model are stable in long-run estimates and there is no any structural break.

3.2.4. Summary of Diagnostic Test

The selected model is well specified if it passes the diagnostic tests. Hence, prior to estimating the long- and short-run model, the following diagnostic tests were conducted.

Table 4: Diagnostic tests of the ARDL inflation model

Tests	Statistics	P-value
Ramsey RESET test (F-statistic)	1.60	0.2104
Breusch-Godfrey LM test for autocorrelation	1.572	0.2099
White's test	40.00	0.4256
Normality test of the residual-Jarque-Bera test	0.8796	0.6442
Durbin Watson d-statistic		2.2142

Source: Model Output

The results of diagnostic tests in Tables 4 above indicate that there is no problem of omitted variables, autocorrelation and heteroskedasticity. Besides,

the value of Jarque-Bera test indicates as errors are normally distributed. Thus, all the assumptions are satisfied indicating that the models are reliable.

3.3. Econometric Model Results

3.3.1. Long run ARDL model

Having established long run co-integration relationships between inflation and its determinants, the long-run parameters of the ARDL are estimated and the results are presented in the following table.

Table 5: Estimated result of long run ARDL model

ARDL (1, 1, 1, 1, 1, 1, 1) selected based on AIC				
Variables	**Coefficient**	**Std. Err.**	**t-statistics**	**P-value**
LnGDP	0.2238**	0.1106	2.02	0.053
LnBMS	0.4573**	0.1370	3.34	0.003
LnER	-0.0622	0.0958	-0.65	0.522
LnTGE	-0.1111**	0.0535	-2.08	0.048
LnIR	-0.0443	0.0581	-0.76	0.453
LnTOT	0.4740**	0.2106	2.25	0.033

Where ** represents level of significance at 5%
Source: Model Output

From Table 5 above, except LnER and LnIR, the remaining explanatory variables have statistically significant effect on inflation in the long-run. Thus, the discussions of each significant variable are presented as follows:

GDP (LNGDP): The coefficient on nominal GDP is statistically significant at 5 percent level of significance suggesting that 1 percent increment in this variable will increase the consumer price index by 0.22 percent in long run. The result is in line with the predefined hypothesis. Hence, an increase in GDP can lead to inflation because aggregate demand for goods and services will increase faster than supply. This result is also consistent with the finding of Shahadudheen (2012), Teamrat (2017) and Jonse (2018). However, it contradicts with the finding of Almahdi et al. (2018) and Mebtu (2020).

Broad Money supply (LnBMS): The coefficient for broad money supply is also positive and statistically significant at 5 percent level in the long run. Hence, an increase in broad money supply by one percent, ceteris paribus,

will increase consumer price index by 0.457 percent on average in the long-run. It in line with the hypothesis made. This result is also in line with classical economists' view of quantity theory of money. Accordingly, an increase in money supply leads to a rise in price levels. Thus, with an increase in money supply, the people will have much money to pay for higher prices which further leads to higher inflation. This result is also consistent with the finding of Alemayehu and Kibrom (2011), Durevall and Sjo (2012), Nguyen et al. (2012), Shahadudheen (2012), Assefa (2013), Durevall et al. (2013), Uddin et al. (2014), Jiang et al. (2015), Nguyen et al. (2015), Ojede (2015), Neumann and Ssozi (2016), Teamrat (2017), Jonse (2018), Almahdi et al. (2018), Mohamed and Hatem (2019), Tekeber et al. (2019), Mebtu (2020), Syed and Akhtar (2020) and Tadesse (2020). However, it contradicts with the finding of Sasmal (2015).

Government Expenditure (LNTGE): The coefficient for government expenditure is negative and statistically significant at 5 percent level in the long run. Hence, an increase in government expenditure by one percent, ceteris paribus, will decrease consumer price index by 0.11 percent on average in the long-run. However, it is contradicted with hypothesis made may be due to demand pull inflation theory. Thus, an increase in government expenditure on developmental project leads to more investments which further cause a rise in production of goods and services and hence lower inflation rate. This result is also consistent with the finding of Narayan et al. (2011), Lin and Chu (2013), Solomon (2013), Almahdi et al. (2018) and Jonse (2018). However, it contradicts with the finding of Tekeber et al. (2019), Syed and Akhtar (2020) and Mebtu (2020).

Terms of Trade (LNTOT): The coefficient for terms of trade which refers to the ratio of export price to import price at time t, is also positive and statistically significant at 5 percent level in the long run. This indicates that, in the long run, holding other factors constant, a one percent increase in terms of trade lead to a 0.47 percent increase in consumer price index. It is against the hypothesis made may be due to devaluation of domestic currency as a result of increase in exchange rate. This result is also consistent with the finding of David and Jacqueline (1996) which demonstrates a threshold for exchange rate response. According to their finding, the rise in terms of trade raises inflation if the rise in exchange rate is less than about 1/3–1/2 of the rise in the terms of trade. Therefore, in long run a rise in terms of trade, ceteris paribus, rises consumer price index on goods and services.

Short run ARDL model of Inflation in Ethiopia

The results of error correction of the ARDL model and the short-run relationships of the variables were presented in Table 6 below. The first difference of LnTOT is negative and statistically significant at 10 percent level of significance while the first difference of LNTGE is positive and statistically significant at 5 percent level of significance in short run. Besides, in level form similar to long run, four variables out of six explanatory variables are also statistically significant in the short run. Among them, LnTOT are negative and statistically significant both at level and first difference form.

The result of lagged error term ECT (-1) is also negative and statistically significant at 1% level of significance confirms the existence of long run relationship between the variables. The value of the coefficient for the error correction term is found to be negative 0.7195. Hence, the deviation from the long-run equilibrium is corrected at the speed of 71.95 percent over each year implies that there is "an over correction" toward long run equilibrium after a short run shock.

Table 6: Result of Short Run Model using the ARDL Approach

ARDL (1, 1, 1, 1, 1, 1, 1) selected based on AIC				
Variables	**Coefficient**	**Std.Err.**	**t-statistic**	**P-value**
D(LnGDP)	0.15032	0.1341	1.12	0.273
D(LnGDP(-1))	0.05944	0.1612	0.37	0.715
D(LnBMS)	0.4600*	0.2628	1.75	0.092
D(LnBMS(-1))	0.0436	0.3357	0.13	0.898
D(LnER)	0.2598*	0.1445	1.8	0.084
D(LnER(-1))	-0.0648	0.2063	-0.31	0.756
D(LnTGE)	0.0366	0.0237	1.55	0.134
D(LnTGE(-1))	0.3133**	0.1486	-2.11	0.045
D(LnIR)	-0.1151*	0.0587	-1.96	0.061
D(LnIR(-1))	-0.0533	0.0585	-0.91	0.371
D(LnTOT)	-0.2616*	0.1535	-1.7	0.100
D(LnTOT(-1))	-0.2948**	0.1606	-1.84	0.078
C	-4.4430**	2.0072	-2.21	0.036
ECT(-1)	-0.7195***	0.2016	-3.5	0.001

Source: Model Output

The discussions of each significant variables are presented as follows:

Money Supply (LNBMS): Like in long run, in short run the coefficient of money supply is positive and statistically significant at 10 percent level of significance. Hence, assuming other factors remain constant, an increase in money supply by one percent will increase consumer price index by 0.46 percent on average in the short run. The short run result also supports the arguments of quantity theory of money which stated that an increase in money supply always raises price levels. Hence, increased in money supply, increased the average rate of inflation in Ethiopia. This result is also consistent with the finding of Solomon (2013), Nguyen et al. (2015), Ojede (2015), Teamrat (2017) and Jonse (2018). However, it contradicts with the finding of Sasmal (2015).

Exchange Rate (LnER): The coefficient for exchange rate is also positive and statistically significant at 10 percent level of significance in the short run. Hence, keeping other factor constant, an increase in exchange rate by one percent will increase consumer price index by 0.259 percent on average in the short-run. Since the volatility of exchange rate affects price level of aggregate demand and supply, the raise in exchange rate raises the level of inflation. In another words, a raise in exchange rate push up foreign demand for domestic goods and services, causing volume of export and aggregate demand to raise. The increased in aggregate demand further made the domestic price to bid up. Similarly, exchange rates could also affect prices paid by the domestic buyers for imported goods. Hence, it brought higher cost of imported inputs which will raise marginal cost and domestic price. This result is also consistent with the finding of Monfared and Akin (2017), Tekeber et al. (2019), Tadesse (2020) and Mebtu (2020). However, it contradicts with the finding of Almahdi et al. (2018).

Government Expenditure (LNGE): The coefficient for government expenditure is positive and statistically significant at 5% level at first difference in the short run. Positive and statistically significant result reveals that keeping other factors remain constant, an increase in government expenditure by one percent will increase consumer price index by 0.31 percent on average in the short run. This result is also consistent with the finding of Tekeber et al. (2019), Mebtu (2020) and Syed and Akhtar (2020). However, it contradicts with the finding of Narayan et al. (2011), Lin and Chu (2013), Solomon (2013) and Jonse (2018).

Interest Rate (LnIR): The coefficient for interest rate is also negative and statistically significant at 10 percent level of significance in the short run

suggesting that keeping other factors remain constant, an increase in interest rate by one percent, on average, will decrease consumer price index by 0.11 percent. It is also in line with the hypothesis made. Hence, as interest rates are increased, consumers tend to save more because returns from savings are higher. Hence inflation declines with an increase in interest rate due to the slowdown in the economy. This result is also consistent with the finding of Syed and Akhtar (2020) and Tadesse (2020). However, it contradicts with the finding of Solomon (2013) and Jonse (2018).

Terms of trade (LnTOT): In short run, the coefficient for terms of trade is also negative and statistically significant at 10 percent and 5 percent level of significance both at level form and first difference respectively. It is consistent with the hypothesis made. This may be due to the rise in export price index which may happen because of an increase in the volume and diversity of exported commodity over that of import price index. Similarly, according to David and Jacqueline (1996), the rise in terms of trade reduces inflation if the rise in exchange rate is greater than about 1/3–1/2 of the rise in the terms of trade at least in the short run. Hence, in short run, keeping other factors remain constant, an increase in terms of trade reduces inflation.

4. Conclusion and Policy Implications

The rises in inflation bring an economic instability in many countries including Ethiopia. Thus, price stability and sustainable economic growth are considered as an essential macroeconomic goal of any country. The recurrent inflation in Ethiopia aggravates poverty the level and necessitates an identification of the root causes of inflation. Therefore, this paper aimed to identify the major determinants of inflation in the country using a 41 years' time series data that has been collected from 1980 to 2020 G.C.

The finding of the study revealed that in the long run, gross domestic product, broad money supply and terms of trade have positive and statistically significant effect on the successively increasing of inflation in Ethiopia. Hence, in long run, an increase in gross domestic product, money supply and terms of trade raises the level of inflation.

Contrary to this, government expenditure of the country has negative and significant effect on the inflation This indicates that an increase in

government expenditures on valuable developmental projects decreases the level of inflation in Ethiopia.

In the short run, money supply, exchange rate and government expenditures fuel the inflation significantly while interest rate and terms of trade have negative and significant effect. Hence, inflation is a monetary phenomenon in Ethiopia. However, even though terms of trade determine inflation positively in the long run, it determines negatively both at level form and first difference in short run.

The result of lagged error term ECT (-1) is also negative and statistically significant as expected, which confirms the existence of long run relationship between the variables. Moreover, the value of its coefficient is found to be negative 0.7195. Thus, the deviation from the long-run equilibrium is corrected at the speed of 71.95 percent per year implies that there is "an over correction" toward long run equilibrium after a short run shock.

To reduce the level of inflation in Ethiopia, the following policy implications that emanated from the results of the study are forwarded.

The positive and significant coefficients of GDP in the long run, suggests the need for macroeconomic policy reforms and hence, there should be successive increment in the supply side of the economy to reduce the successive inflation.

Money supply determine inflation positively both in the short- and long-run. Hence, it is required from the government to reduce the volume of money supply without influencing economic growth through appropriate monetary policy.

Exchange rate determines inflation positively and significantly. Hence, it is advisable to the National bank of Ethiopia to focus on exchange market, which adds value to the real sector. Besides, to control inflation due to currency devaluation, it is expected from the NBE to work on fixing the exchange rate in collaboration with its trading partner.

Interest rate has also negative and significant coefficient in the short run. Hence, to reduce inflation, the rate of interest has to be increased through appropriate fiscal policy.

Unproductive expenditures like expense on defense should be reduced in short-run.

Finally, to fully exploit from the benefits of terms of trade and promote economic growth, the government should attempt to diversify and promotes exports through community participations.

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An Empirical Analysis of Food Poverty in Urban Ethiopia

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Abstract

The purpose of this study was to assess food poverty, consumption inequality, and the determinants of food poverty in urban Ethiopia. The fourth wave survey of Ethiopia's Living Standards Measurement Study (LSMS) 2018/2019 was used for this study. Food poverty was assessed using the FGT index, the Lorenz curve, and the Gini coefficient, which were estimated to capture consumption inequality, and a quantile regression model was used to identify the determinants of food poverty in urban Ethiopia. This study comprised 3,596 urban Ethiopian households. An inflation-corrected national food poverty line was used as a cut point to identify food-poor and food-non-poor households, which was found to be 5129.92 ETB per year PAE. The results of the FGT indexes indicate that about 17.7% of urban households were food-poor. Food poverty was prevalent in the SNNP at 36.7% compared to the rest of the region's urban households, but it was lower in Harer (7.5%). It was also confirmed that food poverty was high among female-headed households. In addition, the Gini coefficient is 0.367 which confirms adequate equality of food consumption in urban Ethiopia. Finally, it is suggested to encourage family planning, develop infrastructural facilities that promote access to electricity, water, and waste disposal, enhance access to and make use of formal banks and mobile phones, make it simple to obtain land for building homes, and arrange loans for doing so, and expand access to education while preserving its quality to reduce food poverty in urban Ethiopia.

Keywords: Food Poverty, Consumption Inequality, FGT, Quantile Regression, Ethiopia

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1. Introduction

Getting food is a fundamental human right. Despite this, 795 million people around the world go hungry every day, and improving access to food is a global priority. The world's poor were significantly impacted by the global food price crisis of 2007–2008 and the price spikes that followed in 2010–2011, aggravating poverty and jeopardizing people's right to food (Oxfam, 2019; WFP, 2009). Consumption of food decreased in both quality and quantity more recently due to the COVID-19 pandemic (FAO, UNICEF et al., 2021). Various interventions and tools have been put in place by the international community in this response. However, financial support is insufficient and has not kept up with the pace of the issues. In addition, policies have not succeeded in addressing the systemic shortages and inequalities in the global food system (Botreau and Cohen, 2020).

In a world dealing with numerous crises, the 2021 Global Hunger Index (GHI) indicates a severe hunger situation. Furthermore, there are indications that the trajectory toward eradicating hunger by 2030 is stagnating or even reversing (von Grebmer et al., 2021). Hunger rates are significantly higher in nations that are most vulnerable to the extremes in rainfall and temperature brought on by climate change, especially in economies that depend heavily on agriculture like Ethiopia (FAO, IFAD et al., 2021). According to a recent study, the pandemic made food poverty worse in many parts of the world, in part because lower incomes made food less affordable, which in turn reduced the variety and choice of foods available to consumers (Béné et al., 2021).

Similarly, Sub-Saharan Africa, particularly Ethiopia, has high rates of food poverty, particularly undernourishment and sever food insecurity, with rates of 24.9% and 19.6% respectively, in 2021 (FAO, 2022). In addition, in 2019, there were about 8 million people in Ethiopia that needed food aid or assistance. Of that, approximately 4.2 million were children. Food poverty is a major concern for anyone who relies on purchasing rather than producing food. This includes a sizable proportion of rural residents, as well as most urban dwellers (FAO, 2011). However, most policy prescriptions focus on rural food production while ignoring the factors that contribute to urban food poverty. Rapid urbanization has resulted in an increase in the number of people with low

and unstable incomes who live in settlements with inadequate infrastructure and limited, if not non-existent, basic services in many low and middle-income countries (Cecilia and Susannah, 2013).

In Ethiopia, an urban center includes all capitals of regions, zones, and weredas (districts), as well as localities with urban dwellers' associations (kabeles) whose inhabitants are primarily engaged in non-agricultural activities, regardless of population size (Tegenu, 2010). The existence of urban poverty results in significant barriers to adequate food access and nutrition outcomes for the urban poor, which puts urban households at risk for long-term consequences from nutritional risks (Vilar-Compte et al., 2021). Likewise, in 2015/2016, around 15.2% of the Ethiopian urban population is food poor, with a 3.6% food poverty gap and a 1.4 food poverty severity index. Even if the food consumption inequality was not computed alone, the general consumption inequality was found to be even much worse in urban areas with a 0.38 Gini coefficient in 2015/2016, which was higher than the national level of 0.33 (NPC, 2017). Since many nations around the world, including Ethiopia, are struggling with issues of hunger and extreme poverty, understanding food poverty and knowing its determinants attracts the attention of economists and policymakers. Food is taking center stage on urban agendas, and local stakeholders from the public, private, and civil society sectors are reclaiming control over local food policy (Moragues et al., 2013).

Since the majority of Ethiopia's population suffers from food shortages and malnutrition, it is important to investigate the state of food poverty in Ethiopia as the majority of poverty studies use consumption expenditure as an indicator of overall poverty (Goshu, 2020; Tadesse et al., 2020 and Mohamed, 2017). This disaggregated analysis provides more useful insights into the profiles of household poverty as well as in developing more practical policy solutions. In addition, even though Ethiopia's urbanization rate (22.17% in 2021) is lower than the averages for African and Sub-Saharan African countries, which are 44.6% and 41.79%, respectively (UNDESA, 2021), it is crucial to address food poverty in urban areas because urban populations are net buyers of food items.

Actually, there are lots of studies that identify the state of poverty and its determinants in urban Ethiopia (Mohammed, 2017; Tadesse et al., 2020; Gabusho, 2020; and Tantasa and Sivakumar, 2020), but all did not examine

food poverty alone, which is very crucial for urban population as they are net buyers of food items. In addition, when analyzing poverty in Ethiopia, it is most appropriate to focus on food expenditure because the food share of household total expenditure has been significantly higher than the non-food share over the years. Even more, as Ozughalu (2016) indicates, households in poorer nations spend a much higher proportion of their income on food than on non-food items. Consequently, poverty is frequently equated with hunger, so it is more appropriate to examine the food poverty of households rather than poverty as a whole. Given how dependent urban dwellers are on food purchases, food poverty will become a bigger problem in cities (Cecilia and Susannah, 2013). As a result, this study provides important information on consumption inequality and the extent of food poverty in urban Ethiopia by using poverty headcount, poverty gap, and severity index. Accordingly, this study uses more recent data from the Living Standards Measurement Study (LSMS here after) 2018/2019, which was compiled by the Central Statistical Agency of Ethiopia in partnership with the World Bank, to assess the state of food poverty, consumption inequality and identify the key factors that contribute to food poverty in urban Ethiopia.

2. Methodology

2.1. Source of Data

This study was based on the fourth-wave survey of Ethiopia's LSMS. The LSMS is the country's representative, multi-topic dataset, collected by the Central Statistical Agency of Ethiopia in collaboration with the World Bank at various levels (individuals, households, farm plots, etc.). It includes all nine regional states as well as the two administrative cities of Addis Ababa and Dire Dewa. The data collection began on September 1, 2018, and ended on August 31, 2019. A total of 6,770 households from 535 Enumeration Areas (EAs here after) were interviewed.

For this study, only urban households were considered for further analysis by discarding households from rural areas. The sample respondents were chosen using a two-stage stratified probability sample. The first stage of

sampling for urban areas involves selecting EAs directly from the urban frame of EAs within each region. This is designed in such a way that it automatically results in a proportional allocation of the urban sample by zone within each region. The second stage of sampling for this survey was the selection of households to be surveyed in each sampled EA using systematic random sampling. Accordingly, 3655 urban households were interviewed. Finally, a total of 3,596 households were utilized for further analysis that satisfied the statistical requirements from 219 EAs.

The sample respondents were drawn from nine regions and two administrative cities, as shown in Table 1 below, 21.19% of respondents were from Addis Ababa, while 11.57% of them were from Dire Dawa. It is also indicated that 7.7% from Tigray, 6.17% from Afar, 7.48% from Amhara, 8.2% from Oromia, 7.01% from Somali, 5.34% from Benishangul-Gumuz, and the remaining 7.2%, 8.26%, and 9.87 were from SNNPR, Gambela, and Harar respectively.

Table 7: Distribution of Sample Respondents by Region

Characteristics	**Frequency**	**Percentage**
Living in Urban	3,596	100%
Region		
Tigray	277	7.7
Afar	222	6.17
Amhara	269	7.48
Oromia	295	8.2
Somali	252	7.01
Benishangul Gumuz	192	5.34
SNNPR	259	7.2
Gambela	297	8.26
Harar	355	9.87
Addis Ababa	762	21.19
Dire Dawa	416	11.57
Total	3,596	100

Source: Own Summary from LSMS 2018/2019 data, 2022

2.2. Method of Data Analysis

In this study, simple descriptive statistics were employed to summarize the characteristics of respondents. Food poverty was assessed using the Foster-Greer-Thorbecke index (FGT here after), Lorenz curve and Gini coefficient; and quantile regression was estimated in order to identify factors influencing food poverty in urban Ethiopia. STATA Statistical Package version 14 and DASP (Distributive Analysis for Stata Package) were used to estimate the analysis.

2.2.1. Estimates of Food Poverty and Consumption Inequality

The FGT is a family of poverty metrics, which were used in this study to assess the incidence, depth, and severity of food poverty. The FGT measure was developed by Foster et al. in 1984. This measure is used to quantify the three well-known elements of poverty: the level, depth, and severity (also known, respectively, as incidence, inequality, and intensity) of poverty. The mathematical expression of the FGT index is specified as follows:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{n}\left[\frac{Z-Y_i}{Z}\right]^\alpha \quad \textbf{(1)}$$

where Pα is a measure of poverty, z denotes the food poverty line (in this case 5129.92 ETB), N is the total population, n is a total number of food-poor households normally those below the food poverty line, Yi is the real annual expenditure per adult equivalent (PAE hereafter) and α is a nonnegative parameter indicating the degree of sensitivity of the poverty measure to inequality among the food poor. It is usually referred to as the poverty aversion parameter. Higher values of the parameter indicate greater sensitivity of the poverty measure to inequality among the food poor.

The relevant values of α are 0, 1, and 2. At α =0 equation (1) measures poverty incidence or poverty headcount ratio. This is the share of the population whose real annual food expenditure is below the poverty line, that is, the share of the population that cannot afford to buy a basic basket of foods.

At $\alpha = 1$ in equation 1 measures the depth of poverty (poverty gap). This information indicates how far households are from the food poverty line. This measure captures the overall population's mean aggregate annual consumption expenditure shortfall relative to the food poverty line. It is calculated by adding all of the food poor's shortfalls (assuming that the food non-poor has a zero shortfall) and dividing the total by the population. In other words, it estimates the total resources required to bring all food-insecure people up to the food poverty line (divided by the number of individuals in the population). Also, the poverty gap can be used to calculate the minimum amount of money required to eradicate food poverty; that is, the amount that would have to be transferred to the food poor under perfect targeting (that is, each food-poor person receiving exactly the amount needed to be lifted out of food poverty) to lift them all out of food poverty (Coudouel et al., 2002).

In equation 1, at $\alpha = 2$ represents the severity of poverty or the squared poverty gap. This takes into account not only the distance separating the food poor from the poverty line (the food poverty gap), but also the inequality among the food poor. That is, a higher weight is placed on those households further away from the food poverty line.

In addition, to capture food consumption inequalities, Lorenz curve and Gini coefficient was estimated. The Gini coefficient of inequality is calculated in the study to assess consumption inequality among urban households. The Gini coefficient is the most widely used measure of inequality. The coefficient ranges from 0 to 1, indicating complete equality and complete inequality, respectively (one person has all the income while all others have none).

The Gini coefficient is a well-known index for estimating the degree of deviation of a group's distribution (here, annual food expenditure per adult equivalent) from the perfectly equal distribution. As a result, the Gini coefficient and the Lorenz curve were calculated to represent consumption inequality in urban Ethiopia. The following index is used to calculate inequality (Namara et al., 2008).

$$Gini=(2Cov(X,F))/M \quad \textbf{(2)}$$

Here, X is the total food expenditure, F is the cumulative distribution of X and M is the mean of X.

2.2.2. Determinants of Food Poverty

The determinants of food poverty in urban Ethiopia were identified using a quantile regression model. Koenker and Bassett (1978) developed a quantile regression model, which is used to estimate poverty determinants at various points along the expenditure distribution. It has the advantage of allowing parameter variation across quantiles of the distribution of consumption expenditures. The quantile regression estimated coefficients are less sensitive to dependent variable outliers than the ordinary least square, and the quantile estimator is more efficient than linear regression when errors are not normally distributed, i.e., it is a robust method (Buchinsky, 1998; Cameron and Trivedi, 2005). To obtain more efficient and consistent estimates, the standard errors were computed using bootstrapped techniques (Koenker and Hallock, 2001). It also allows researchers to pre-define any positions in the distribution based on their specific inquiries (Hao and Naiman, 2007).

In this study, to examine the determinants of food poverty at different food expenditure quantile of urban households using quantile regression model is presented below.

$$y_i = X_i'\beta_\rho + \mu_i, i = 1, 2, \ldots, n \quad \textbf{(3)}$$

Where yi is the natural logarithm of real annual consumption expenditure PAE on food items of ith household and, Xi indicates Z X 1a vector of characteristics of the ith household. β are unknown parameters for quantile ρ and μi represents the disturbance term and for a random response variable Y with probability distribution function $F(y) = Pr(Y \leq y)$, the ρth quantile of Y is defined as the inverse function $Q(\rho)=\inf\{y: F(y)\geq \rho\}$, where $0 < \rho < 1$, the quantile regression for a given quantile θ is obtained from the minimization of the objective function F over βρ.

$$F = \sum \theta |y_i - X_i' \beta_\rho| + \sum (1-\rho)|y_i - X_i' \beta_\rho| \quad \textbf{(4)}$$

This study used a simultaneous quantile regression model with quantile levels of ρ =25, 50 and 75, with standard errors estimated using bootstrapping with 100 replications. To investigate the conditional distribution of real annual food consumption expenditure PAE as a function of explanatory variables in urban Ethiopian households at different levels of real annual food expenditure PAE. Finally, the goodness-of-fit is tested, as suggested by Koenker and Machado (1999) for quantile regression analysis.

2.3. Definition of Working Variable and Hypothesis

The Dependent Variable

Food Poverty: Food poverty is defined as the inability or uncertainty of acquiring or consuming an adequate or sufficient quantity of food in socially acceptable ways, or the inability to do so (Riches, 1997, 2002, and Dowler et al., 2001a). In this study, it is captured by real annual food expenditure PAE which is a continuous variable. As real annual food expenditure PAE increases, food poverty is expected to decrease, and as the real annual food expenditure PAE food poverty is expected to increase.

The Independent Variables

Household size: It is the count variable that indicates the total number of household members, which indicates the number of individuals living in the same house. It is expected to increase food poverty by decreasing annual consumption expenditure on food items (Eyasu, 2020 and Teka et al., 2019).

Employment Status: It is a dummy variable that takes the value of 1 if the household head is employed and receives 0 if the household head is not employed. It is expected to decrease food poverty by increasing consumption expenditure on food items as employment is one source of income (Tantasa and Sivakumar, 2020 and Tadesse et al., 2020).

Having a Mobile phone: This variable is a dummy in its nature and takes a value of 1 if the household owns a mobile phone and 0 otherwise.

Having a mobile phone is expected to decrease food poverty as it offers information that is vital for the work they do, and that information can include current market prices, weather reports, and new opportunities for earning income.

Expenditure on Utilities: It is a continuous variable that indicates the amount of money that the household spends on electricity, water, waste disposal, and sewage. This variable is expected to reduce food poverty as electric access serves as a cooking method; safe water, easy waste disposal and sewage increase the health of households and the quality of households' lives (Tantasa and Sivakumar, 2020 and Goshu, 2020).

Saving: It is also a dummy variable that takes the value of 1 if the household saves money and 0 if not. Saving money is expected to reduce food poverty by increasing consumption expenditure by smoothing consumption at a time when households face financial limitations and shocks (Tantasa and Sivakumar, 2020; and Mohammed, 2017).

Sex of households head: It is also a dummy variable that indicates the sex of the household head. It is zero if the household head is male and zero if female. Being a male is expected to reduce food poverty by increasing food consumption expenditure since a male has better access to information, job opportunities, and income (Kebede and Sharma, 2014 and Teka et al., 2019).

Age: It is a continuous variable that indicates the age of the household head. Because age correlates with experience, which increases the income of urban households (Kebede and Sharma, 2014), the age of the household head is less correlated with food poverty. However, the age of household heads increases food poverty as getting old is an additional risk of becoming or remaining poor. In later life, people reduce their working hours or stop working because of retirement options or health issues, and when they need or prefer to continue working, many earn lower wages.

No. room in houses: It is a count variable which indicates the number of rooms in the house by excluding the toilet and kitchen. This variable is expected to reduce food poverty, particularly in urban areas, by providing a source of income by renting it out or using that room to work additional hours to generate cash income (Goshu, 2019).

Education Level: It is a continuous variable that indicates the years of schooling that the household attended. Education is expected to reduce food poverty by increasing consumption expenditure on food items. This may be due to education's ability to create more people for work and increase employability as it increases the knowledge and skills of individuals. (Goshu, 2019; Girma and Temesgen, 2018 and Tantasa and Sivakumar, 2020).

Table 8: Summary of Hypothesized Variables with Expected Effect on Food Poverty

Variable	Nature of variable	Expect effect on food poverty
Family size	Count	Increase
Employment Status	Dummy	Increase
Mobile phone	Dummy	Decrease
Expenditure on Utilities	Continuous	Decrease
Saving	Dummy	Decrease
Sex of Household head	Dummy	Decrease
Age of Households head	Continuous	Decrease/Increase
Number of rooms in the house	Count	Decrease
Education Level	Continuous	Decrease

3. Result and Discussion

3.1. Socioeconomic Characteristics of Respondents

This study was based on 3,596 urban households in Ethiopia with an average age of 40.45 years. Of the total respondents, 64.1% of household heads were male, whereas the remaining 35.9% were female, with an average education level of 7.4 years of schooling (Table 3). The average household size is 3.79 individuals, with an average of 1.9 rooms per house, confirming that more than half of the respondents live in houses with fewer than two rooms. It is also indicated that the average real annual expenditure on utilities (fee for electricity, water, and waste disposal) is 1288.89 ETB and the average real annual food expenditure PAE is 14611.92 ETB. It is also stated that 80% of

respondents own mobile phones, and 50% of respondents save money in either public or private banks. It is also stated that 63.5 percent were married, while 13.3%, 11.7%, and 11.4% were single, divorced, and widowed, respectively.

Table 9: Summary of Socioeconomic Characteristics Sample Households

Continuous Variable	**Mean**	**Observation**
Household size	3.79	3,596
Age of household head	40.45	3,596
Education level	7.4	3,596
Real annual Expenditure on utilities	1288.89	3,596
No of room in house	1.923248	3,596
Real annual food expenditure PAE	14611.92	3,596
Categorical Variables	Yes (%)	No (%)
Own mobile phone	80.03	19.97
Save money	50.61	49.39
Being male Household head	64.1	35.9
Employment Status	34.84	65.16
Marital status	**Frequency**	**Percentage (%)**
Single	480	13.35
Married	2,284	63.51
Divorced	422	11.74
Widowed	410	11.4
Total	3,596	100

Source: Own computation from LSMS 2018/2019 data, 2022

3.2. The Incidence, Depth and Severity of Food Poverty in Urban Ethiopia

The first step in analyzing food poverty is to select an indicator. Accordingly, real annual food expenditure PAE was chosen as a proxy to measure food poverty in urban Ethiopia. The real annual food expenditure PAE

was an inflation adjusted annual food expenditure PAE that was corrected by reporting level national average prices using December 2016 constant prices as the base year. The average CPI for food items in 2018/2019 was 134.356 (CSA, 2019). This figure covers the CPI for food items from September 2018 to August 2019, when this survey was undertaken. As a result, the average real annual food expenditure PAE was 14,611.92 ETB, with a minimum of 865.56 ETB and a maximum of 96,199.67 ETB.

The second step in poverty analysis is determining the food poverty line. Accordingly, inflation corrected national food poverty line is used as a cut point to identify food poor and food non-poor households. The food poverty line for this study was determined based on the 2015/2016 food poverty line, which was 3772 ETB per annum PAE, which was estimated to purchase a basket of goods that provides 2200 kilocalories PAE. To get the 2018/2019 food poverty line, the GDP deflator provided by the National Bank of Ethiopia (NBE) for 2018/2019, which was set to be 1.36 by using 2015/2016 as the base year, was employed. Accordingly, the food poverty line is found to be 5129.92 ETB per year PAE, which is adjusted for existing inflation in the country. This procedure is in line with the technique employed by the National Planning Commission of Ethiopia in 2017 to estimate the food poverty line for 2015/2016 (NPC, 2017). After setting a food poverty line, food poverty incidence, depth, and severity were estimated using FGT indexes.

According to the FGT index, the incidence of food poverty in urban Ethiopia was estimated to be 17.7% in 2018/2019, which was 2% higher than the urban food poverty rate of 2015/2016 (NPC, 2017), with a significant difference across each regional state. As shown in Table 4, the depth of food poverty (gap) was 5.5%, implying that the food poor were 282.14 ETB below the food poverty line, with a food poverty severity index of 0.024. The result also confirmed that food poverty was more prevalent in the SNNP region (36.7%), followed by the Somali region (32.1 %) and the Benishangul Gumuz region (31.8 %), while it was less prevalent in Harer (7.5%), Dire Dawa (9.3%) and Tigray (9.7%). The graphical representation in the appendixes (Appendix Figure 1-3) also supports these findings.

Table 10: Distribution of Food Poverty by Region (Poverty line =5129.92 ETB)

Region	Incidence(α=0)	Depth(α=1)	Severity(α=2)
Tigray	0.097	0.017	0.004
Afar	0.107	0.026	0.009
Amhara	0.178	0.040	0.015
Oromia	0.171	0.043	0.018
Somali	0.321	0.132	0.070
Benishangul Gumuz	0.318	0.071	0.023
SNNPR	0.367	0.148	0.077
Gambela	0.268	0.086	0.037
Harar	0.075	0.022	0.009
Addis Ababa	0.101	0.027	0.010
Dire Dawa	0.093	0.018	0.005
Population	0.178	0.055	0.024

Source: Own computation from LSMS 2018/2019 data, 2022

As indicated in Table 5, the prevalence of food poverty among female-headed households was 20.4%, which was 3.8% higher than male-headed households. This confirms the feminity of food poverty in urban Ethiopia. It has also been confirmed that female-headed households experience a greater depth and severity of food poverty than male-headed households. Appendix Figures 4-6 also confirm these findings. The results also indicate that food poverty was most prevalent in divorced urban households (19.3%), while it was least prevalent in single urban households (13.3%). Food poverty is severe and widespread in divorced households (See Appendix Figure 7-9).

Table 11: Distribution of Food Poverty by Sex and Marital Status (Poverty line =5129.92)

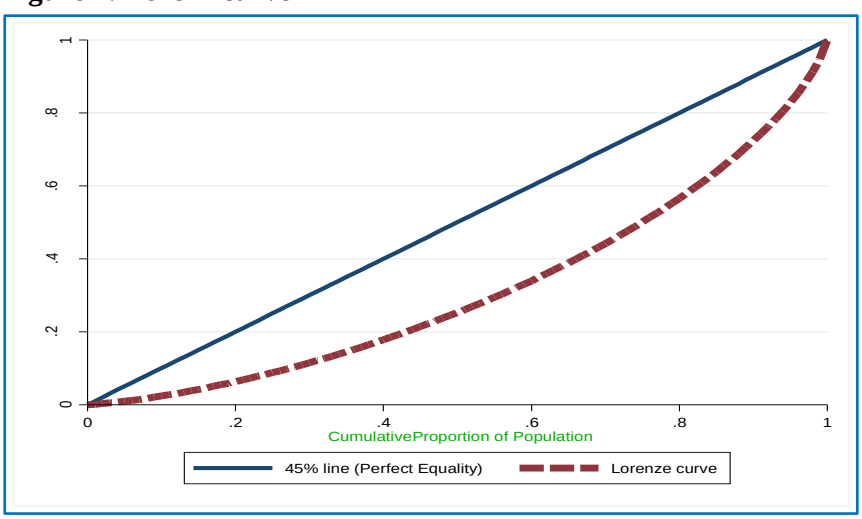
Sex of HH Heads	Incidence	Depth	Severity
Female	0.204	0.066	0.031
Male	0.166	0.050	0.022
Marital Status			
Single	0.133	0.046	0.020
Married	0.178	0.055	0.024
Divorced	0.193	0.058	0.025
Widowed	0.188	0.058	0.027
Population	0.178	0.055	0.024

Source: Own computation from LSMS 2018/2019 data, 2022

3.3. Food Consumption Inequalities in Urban Ethiopia

The lorenz curve, which depicts the distribution of food consumption expenditure among sampled urban Ethiopian households, was used in this study. The Lorenze curve represents the actual distribution of food expenditure in relation to the line of perfect equality (45 degree).

Figure 4: Lorenz curve



The area between the line of perfect equality and the lorenz curve, as shown in Figure 1, represents the gap between food-poor and food-non-poor households. Because lornz curves do not have numerical values, they must be interpreted visually. As the lorenze curve approaches the line of perfect equality, the result confirms the existence of low inequality. The Lorenz curve result is insufficient unless it is supported by numerical values. As a result, in order to capture food consumption inequalities, the Gini coefficient was calculated and then decomposed by region of residence and gender of household head. The overall inequality was calculated to be 0.367, confirming the existence of lower food consumption inequalities in urban Ethiopia because the value is close to zero. This food consumption inequality is nearly equal to the national overall inequality of 0.35, as estimated in 2015. Food consumption inequality was found to be highest in SNNP, at around 0.46 Gini coefficient, followed by Somalia at 0.41 Gini coefficient. The findings also confirm that food consumption inequities persist among female household heads, with a Gini coefficient of 0.387.

Table 12: Gini index distribution

Group	**Gini Coefficient**	**Group**	**Gini Coefficient**
Region		**Region**	
Tigray	0.314	Harar	0.330
Afar	0.345	Addis Ababa	0.339
Amhara	0.335	Dire Dawa	0.320
Oromia	0.342	Gambela	0.408
Somali	0.410	Sex of HH heads	
Benishangul Gumuz	0.380	Female	0.387
SNNP	0.465	Male	0.358
Population	0.367	Population	0.367

3.4. Determinants of Food Poverty

A quantile regression was employed to identify the determinants of food poverty, which is based on the behavior of various food consumer groups. Here, households were divided into different categories based on their real annual food expenditure PAE. As a result, sampled households are divided into three groups (quintiles) at 25%, 50%, and 75% of their real annual food expenditure PAE to identify determinants of food poverty for the lower, medium, and upper classes of food consumers, respectively. A quantile regression analysis was used to explain the level of real annual food expenditure (PAE) as a function of a number of explanatory variables, which estimates how closely each independent variable is related to the various conditional quantiles of real annual food expenditure PAE while all other factors are constant. In this quantile regression result, the interpretation of a statistically significant variable that is positively associated with household real annual food expenditure reduces urban food poverty, whereas the variable that is negatively associated with household real annual food expenditure increases urban household food poverty.

Here, a test for goodness of fit was undertaken for each quantile by using pseudo-R-square as suggested by Koenker and Machado in 1999. The quintile regression results showed that six of the nine hypothesized variables had a significant impact on food poverty, which was captured by the natural logarithm of real annual food expenditure (PAE). As shown in Table 6, food poverty decreased as access to mobile phones, utility expenditure, saving, the number of rooms in the house, and the education level of the household head increased, while it increased as family size and the age of the household head increased.

Quantile regression results show that household family size has a statistically significant and negative effect on real annual food expenditure at all quantiles, which aggravates food poverty in urban Ethiopia. It has been confirmed that as household size increases by one-person, real annual food consumption expenditure PAE decreases by 14.8% to 15.1% across all quantiles that increase household food poverty. This implies that households with a large family size may spend less on food items which increases food poverty in the

study area. This finding is consistent with those of Eyasu in 2020 and Teka et al., 2019. It is also suggested that owning a mobile phone reduces food poverty since it increases real food expenditure in the first quantile by 13.8%. This may be because mobile phones provide information that is important for the work they do, such as current market prices, weather reports, and new income opportunities.

The model result also confirms that spending on utilities such as electricity and water bills reduces food poverty as it correlates positively with real food consumption expenditure. Throughout all consumption expenditure distribution, as real utility expenditure rises by one-unit, real consumption expenditure rises by a minimum of 4.9% to a maximum of 5.8%. This finding is consistent with the findings of Tantasa and Sivakumar, 2020 and Goshu, 2020 which confirm the positive role of electricity and water in reducing poverty. This could be because utilities such as electricity, clean water, and waste disposal techniques improve living conditions, health conditions, and quality of life, which directly or indirectly contribute to lowering the amount of money spent on firewood, charcoal, and health care.

The quantile regression also confirms that saving has a positive and significant effect on real food consumption expenditure, which reduces food poverty across all quantiles of the distribution. The findings confirm that households that save more have higher consumption expenditure on food items, ranging from 7.4% to 9.6% in all quantiles. This may be because saving can smooth consumption during a period when households face financial constraints and shocks (Tantasa and Sivakumar, 2020; and Mohammed, 2017).

The other significant variable that increased real food consumption expenditure was the number of rooms in the house by excluding the kitchen and toilet, which was found to reduce poverty in all quantal distributions. One extra room in the house is expected to raise the real annual food consumption expenditure PAE from 2.2% to 3.9%. This is because rooms in the house, particularly in urban areas, are a source of income by renting them out, or household members may work additional hours to generate cash income in that room. This finding is in line with the finding of Goshu, 2019.

In the second quantile distribution, the age of household heads is negatively correlated with real annual food expenditure by 0.23%, confirming

that being old is an additional risk of becoming or remaining poor. This may be because people reduce or stop working in later life due to retirement options or health issues, and when they need or prefer to continue working, many earn lower wages. Besides that, education level was found to increase real annual food consumption expenditure, which reduced food poverty significantly in all quantiles. As the household head's level of education increases by one level, expenditure on food items increases by 1.9% to 2% for all quantile distributions. This could be due to education's ability to prepare people for the workforce by increasing knowledge and skills that increase their employability (Goshu, 2019; Girma and Temesgen, 2018 and Tantasa and Sivakumar, 2020).

Table 13: Result of Simultaneous Quantile Regression (N = 3,596)

ln Real expenditure on food per year PAE	**Q 25**	**Bootstrap Std. Err.**	**Q 50**	**Bootstrap Std. Err.**	**Q75**	**Bootstrap Std. Err.**
	Coef.		**Coef.**		**Coef.**	
Household size	-0.149***	0.009	-0.151***	0.007	-0.148***	0.007
Employment Status	-0.023	0.029	-0.026	0.032	-0.024	0.034
Mobile	0.138***	0.044	0.040	0.034	0.024	0.039
Utility expenditure (ln)	0.058***	0.009	0.055***	0.006	0.049***	0.006
Saving	0.096***	0.025	0.079***	0.027	0.074**	0.029
Sex of Household head	0.033	0.027	0.022	0.025	0.034	0.029
Age of Household head	-0.0011	0.0010	-0.0023***	0.0009	-0.0008	0.0009
Room number	0.022***	0.009	0.038*	0.022	0.039*	0.015
Education Level	0.020***	0.003	0.019***	0.003	0.020***	0.003
Constant	8.860	0.067	9.375	0.048	9.710	0.053
Pseudo R2	0.2002		0.1879		0.1859	

Source: Own computation from LSMS 2018/2019 data, 2022

***, **, and * represents to significant at 1%, 5%, and 10% level of statistical errors, respectively

In general, as the result of quantile regression indicates, food poverty increased with family size in the first quantile for households with low real annual food expenditure, while it decreased with having a mobile phone, saving money, better expenditure on utilities, more rooms in the house, and the better education level of the household head. Food poverty increased as family size and the age of the household head increased in the second quantile (households with average food expenditure), while it decreased as households saved money, utility expenditure, room number, and education level increased for households with an average (medium) real annual food expenditure. The result also confirms that in the third quantile distribution, households with relatively higher real annual food expenditure have food poverty that increases as family size increases and decreases as household saving, utility expenditure, room number, and education level household head increase.

4. Conclusion and Policy Implication

To sum up, food poverty remains a problem in urban Ethiopia, with a high prevalence in the SNNPR and Somalia regions, as well as among female-headed and divorced households, requiring immediate and long-term policy intervention. Based on the findings of this study, the following recommendations are forwarded. As food poverty is highly prevalent in urban areas of SNNPR, Somali, and Benishangul Gumuz, federal and regional state governments need to offer special support to this region to reduce food poverty. Given that food poverty is high among female-headed and divorced households, the Ministry of Women and Social Affairs should develop policies that support and empower female and divorced households. Because family size has a negative correlation with food consumption expenditure, which increases food poverty, it is important to limit family size based on the income level of the household. As a result, the ministry of health and other non-governmental organizations that work on family planning should work to broaden access to contraception and family planning. It is also confirmed that expenditure on utilities reduces food poverty. Therefore, Ethiopian Electric Power Corporation and Water and Sewerage Authority should work to develop infrastructural

facilities that promote access to electricity, water, and waste disposal to enhance the quality of life and reduce expenditure on health care and firewood (charcoal). It has been revealed that having a mobile phone and saving money help to reduce food poverty. As a result, it is good to increase access to and ease of use of mobile phones and formal banks. In urban areas, the number of rooms in a house reduces food poverty. As a result, it is important to have easy access to land for building houses and to arrange loans for building houses. It has also been found that education level reduces food poverty. As a result, the Ministry of Education should work to increase the provision of education while maintaining its quality. Finally, it is suggested to undertake further studies using the latest dataset and take repeated measures to capture the temporal dynamics of food poverty since this study does not look at it.

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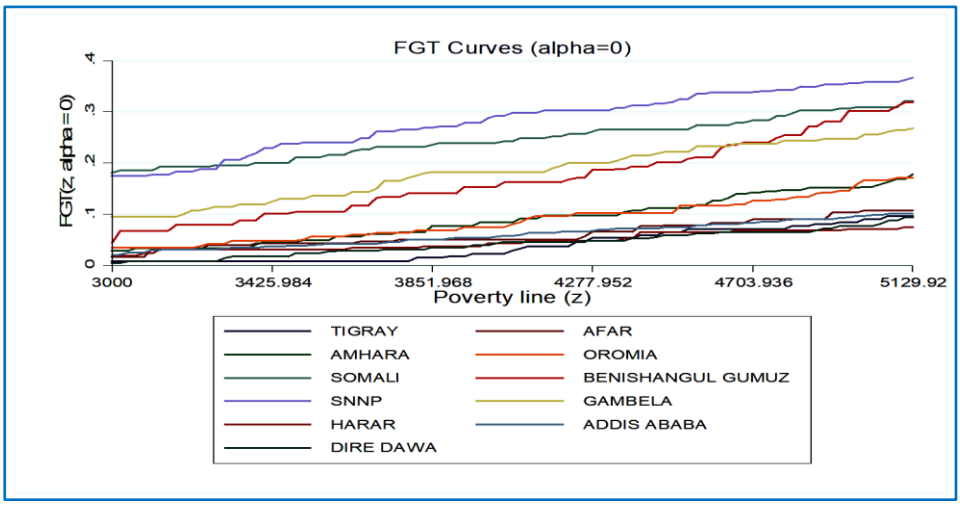
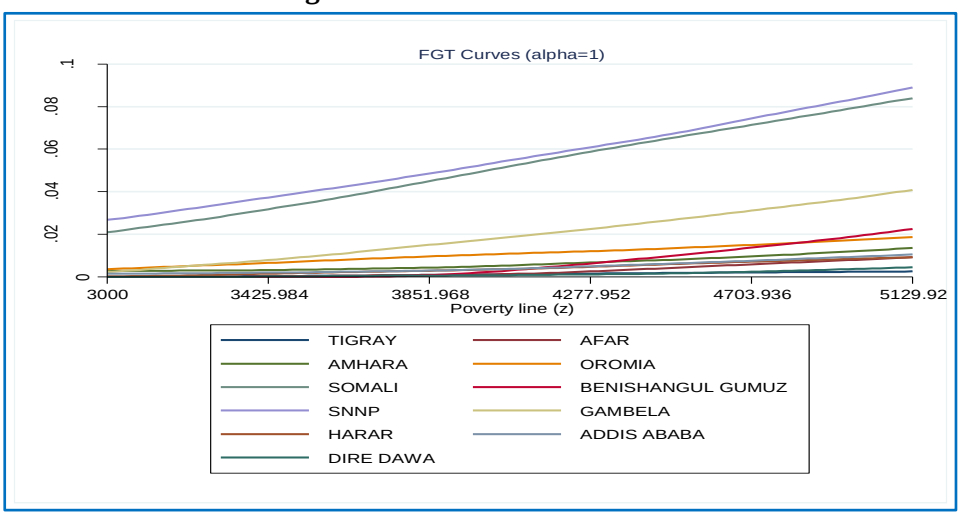
Appendixes

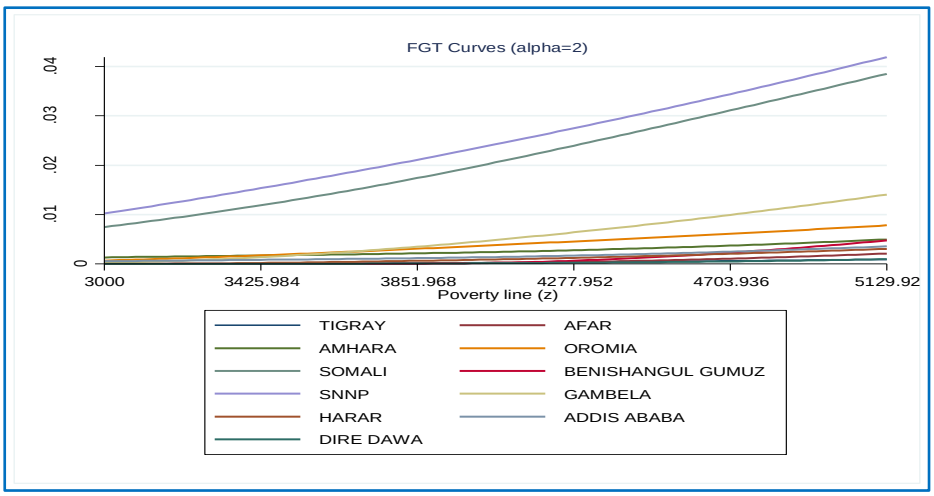
Appendix Figure 1: Graphical Representation of Food Poverty Incidence by Region



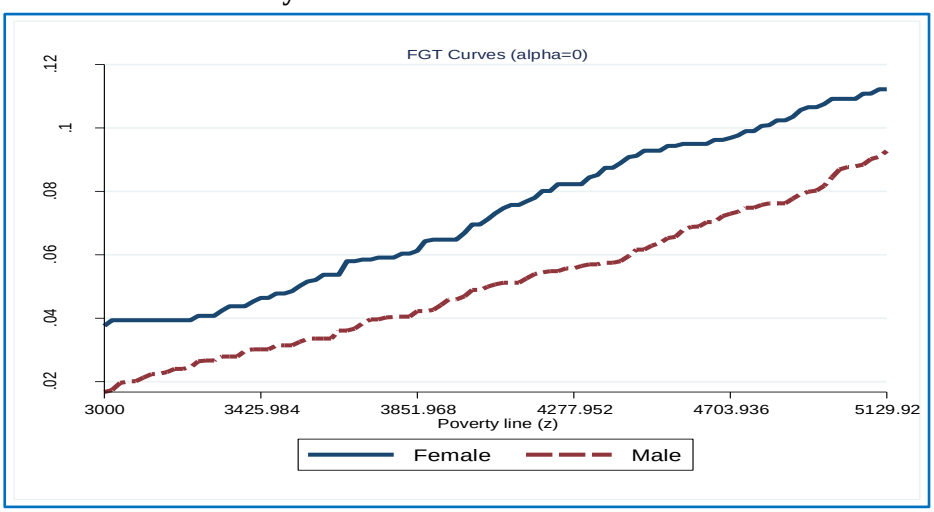
Appendix Figure 2: Graphical Representation of Food Poverty Depth by Region



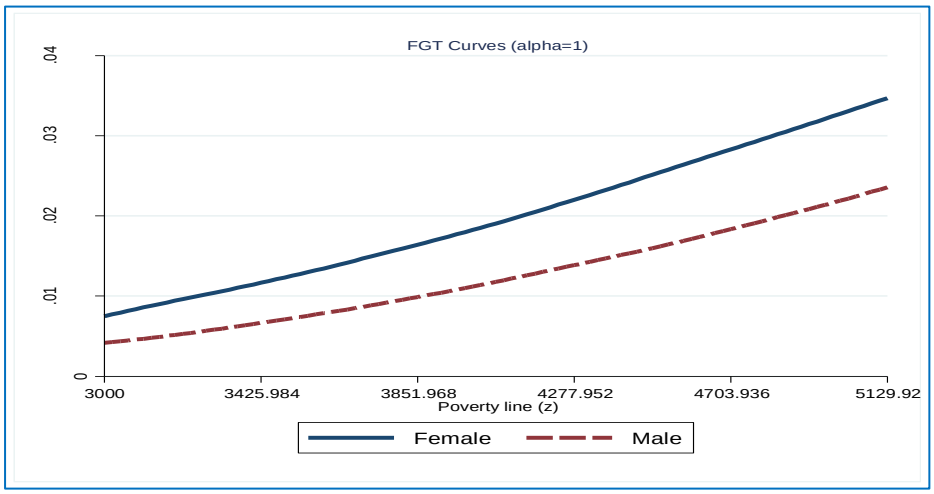
Appendix Figure 3: Graphical Representation of Food Poverty Severity by Region



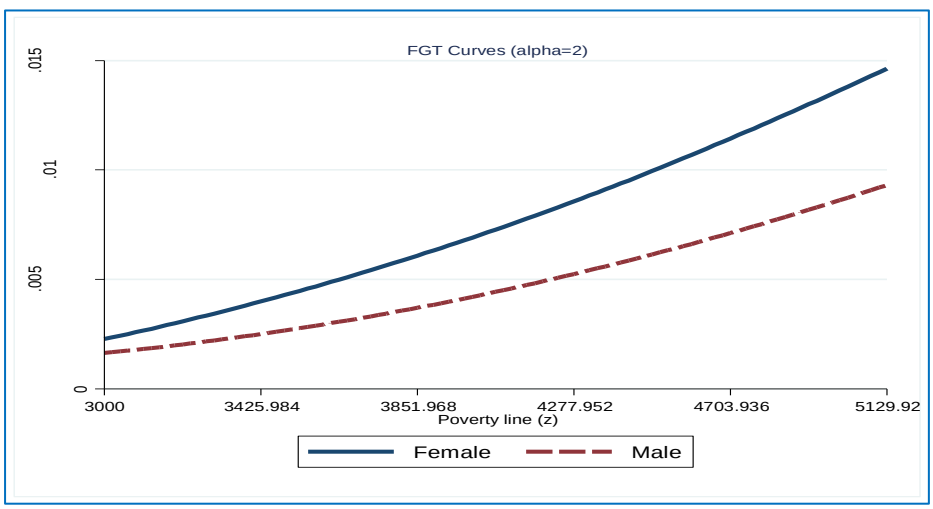
Appendix Figure 4: Graphical Representation of Food Poverty Incidence by Sex



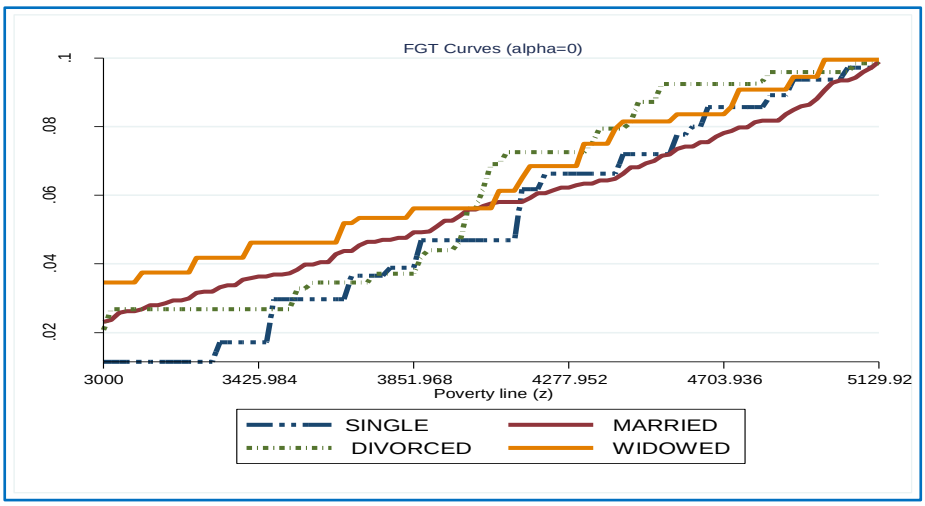
Appendix Figure 5: Graphical Representation of Food Poverty Depth by Sex



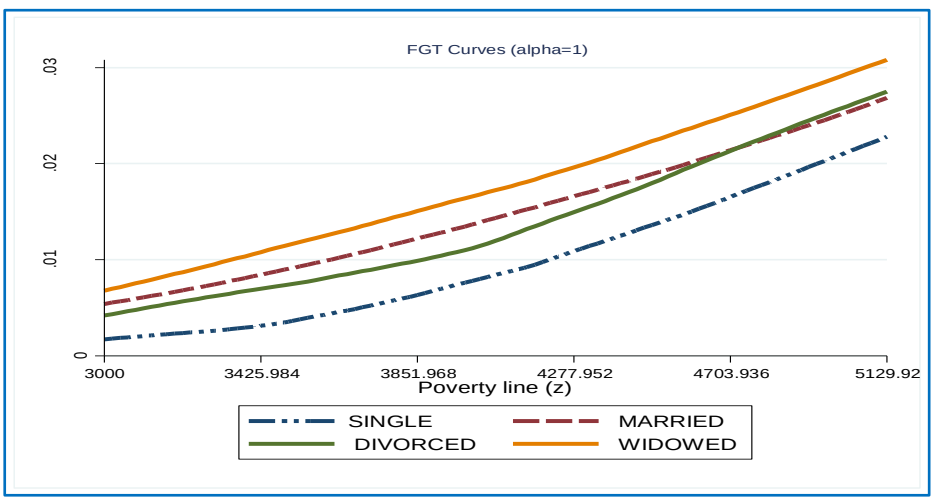
Appendix Figure 6: Graphical Representation of Food Poverty Severity by Sex



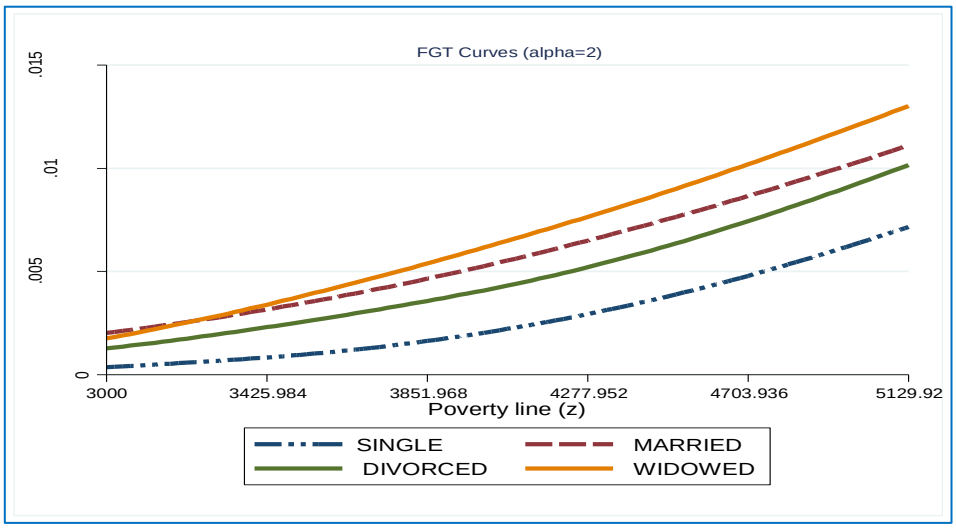
Appendix Figure 7: Graphical Representation of Food Poverty Incidence by Marital Status



Appendix Figure 8: Graphical Representation of Food Poverty Depth by Marital Status



Appendix Figure 9: Graphical Representation of Food Poverty Severity by Marital Status



Growth Potential of Ethiopian Economy: Cointegration Symmetric and Asymmetric Analysis

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Abstract

This paper examined growth potential of the Ethiopian economy using linear symmetric autoregressive distributed lags (ARDL) and non-linear asymmetric autoregressive distributed lags (NARDL) models considering timer series data for the period of 1981-2022. The asymmetric non-linear ARDL model results reveal that there is a unidirectional causality running from a negative downward movement of the agriculture sector to real GDP. The empirical evidences obtained through asymmetric models seems to be superior to symmetric models. Thus, to ensure more efficient policy-making for the economy to be potentially capable in achieving all-inclusive and resilient sustainable growth; agriculture must be the lead sector.

Key-words: Economic growth, ARDL and NARDL analysis
JEL Classification: C10, C32, O40, E52, E62, F62

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The views expressed and arguments employed in this research are exclusively responsible to the author and do not necessarily reflect the institution to which he is affiliated or published this work.

1. Introduction

Ethiopia is an ancient civilized and non-colonized country in African continent. It is one of the developing countries in Sub-Saharan Africa, with a population of about 120 million in 2022, the second populous country in Africa next to Nigeria (UN, 2022). UNDP (2022) projected economic growth of Ethiopia in 2023 to be 4.8% mainly on account of services sector rebound, while slower growth will be observed in the agriculture and manufacturing. However, the two fiscal years (2021 and 2022) have been challenging years for the Ethiopian economy due to the domestic uncertainty, Russia-Ukraine conflict, drought, global supply shocks, a difficult global and regional environment and the multiple shocks render challenging macroeconomic management (UNDP, 2022). In addition, inflation has reached 37.2% in May 2022, largely driven by food inflation. This could result in increment cost-of-living in the country, strongly impacting on the purchasing power of households and exacerbating poverty trends.

The Ethiopian economy is in a mixed transition with a large public sector. However, it is in the process of privatizing many of the state-owned businesses moving towards a market economy and this process has been underway since the late 1990s (Sanchez, 2017). It has embarked on a transformational journey to become a low middle-income and carbon-neutral economy by 2025. However, this target can be achieved by shifting economic activities from the low to high level of productivity, especially the manufacturing sector (UNDP, 2017).

Ethiopia has sustained high economic growth over the last decade with substantial progress on reducing poverty, improving social indicators and one of the fastest-growing economies (IFC, 2012). The Ethiopian real GDP in 2018/19 was estimated to have grown by 9%, driven by manufacturing and services (IMF, 2020a) and registered a remarkable economic performance with annual growth averaging 10.9% over the past ten years (UNDP,2014). This came from the very strong growth in the industry sector in the past three years, the highest performance was in 2012/13 which has been sustained by the construction boom and expansion in mining and manufacturing subsectors. Industry, mainly construction and service sectors have accounted for most of the growth in recent

years. There has been a large potential resource for growth of the manufacturing industry in Ethiopia, for instance, several industrial parks have been built with a focus on textiles (UNDP, 2014).

In Ethiopia, the service sector registered 9.9% annual growth in 2012/13, which took the lion's share in contributing to the overall output growth of the country. This doubled Sub-Saharan Africa and tripled the world average growth over this period and has led to Ethiopia being rated as one of the fastest growing economies in the world (UNDP, 2014). The service sector, which includes banking, telecommunication and transportation is dominated by government-owned companies and considered as strategic sectors expected to remain under state control (Maasho, 2012a, Maasho, 2015b and Gérand, 2019). Tourism is one element of the service sector developed in the 1960s but declined continuously in the late 1970s and 80s under the military government. Its recovery began in the 1990s, but growth has been constrained by the lack of suitable and appropriate infrastructural facilities, despite a boom in construction of small and medium-sized hotels and restaurants and by the impact of drought and the 1998–2000 war with Eritrea (IMF, 2018).

Very large segment of Ethiopian population depends on the subsistence agricultural sector while the performance of infant industries and the low level of services delivery by the service sector; except, the Ethiopian Airlines retard its growth and development. Ethiopia has huge agricultural potential because of its vast areas of fertile land, diverse climate, adequate rainfall, and large young labour-force. Many economic activities in Ethiopia such as marketing, processing and export depend on the agricultural sector and a large part of commodity exports are provided by the small agricultural cash-crop producers (Samuel, 2014). However, the contribution of agriculture has declined accounting about 32% of the GDP, and source for 81% of export earnings, and employed 85% of the labour force (MoF, 2019) and has grown by 7.1%, recovering from 4.9% growth in the previous year mainly attributed to increases in productivity and expansion of area under cultivation (UNDP, 2014).

The existing structural change of the economy is the most viable option for ensuring the pursuit for industrialization that the current Ethiopian government has opt to develop a 10-years comprehensive agricultural and economic development plan in 2020. However, the largest and dominant

agricultural sector, where 80% of the Ethiopian population engages for livelihood recently has been overtaken its position by the services sector and has lagged behind. Here what we actually realize is that there is a structural problem in Ethiopian economy that must be addressed by making agriculture back on the right track as a leading sector of the economy. In this regard, the effect analysis of the linkage between the economy and its three sectors is an important long-term view, but not an accidental phenomenon. In this sense, the study tries to examine whether the 10-year development plan of 2020-2030, needs to be aligned with the home-grown economic reform agenda, the sustainable development goals and the African Union's continental digital strategy to address the macroeconomic imbalances and structural impediments (FDRD, 2020).

Ethiopia for the last two decades has been among the fastest growing countries in the world, with GDP expanding at modest comparing to others. However, despite the fact that its economic growth has been driven by large-scale public investment in infrastructure, the evidences from the World Bank and UN reports show that rural dwellers and the poorest have not equally benefited from growth in recent years. In Ethiopia, tremendous efforts have been put in place and accelerated over the past couple of years through an unprecedented economic reforms process such as privatized government owned development enterprises, constructions of hydroelectric power stations, which includes the Grand Ethiopian Renaissance Dam on the Blue Nile River and allowing operating foreign banking service in the country. These seek to build on resilient and all-inclusive growth and enhance the market share of private businesses in the Ethiopian economy. Since "Ethiopia faces massive developmental opportunities and challenges. It has a very young and dynamic segment of its population; untapped potential to double, triple, even quadruple production and productivity of the agricultural and manufacturing sectors"(EEA, 2021:2). However, continuing macroeconomic challenges such as high inflation rate, low rate of labour productivity and unskilled labour force, brain-drain, high transport costs for imported and exported items as a landlocked country and limited financial resources remain.

Therefore, as far as the author of this research knows, there has been no published research work prior to this study, which compares and contrasts the

application of ARDL and NARDL models to examine the potential capacity and capability of Ethiopian economy to grow despite many challenges in recent times. In this regard, the asymmetric positive upward and negative downward movements of the partial impacts of each explanatory variable are independently analysed. Later on, the study conducted the linear symmetric analysis of the economic sectors in relation to real GDP overtime for the same variables and eventually we reveal the differences in applications of the two models. The objective of this study is to investigate the symmetric and asymmetric effects of the economic sectors on entire Ethiopian economy using ARDL and NARDL.

2. Empirical Literature of the Study

The Ethiopian macroeconomic trend showed that the Gross Domestic Product (GDP) per-capita at market prices increased from 190 USD in 1980 to 846 USD in 2017(IMF, 2018). The economy has registered a continuous real GDP growth of at least 5% since 2004. It has experienced strong, broad-based growth averaging 9.4% a year from 2011 to 2019. However, the real GDP growth slowed down to 6.1% in 2020 due to the coronavirus pandemic disease; yet agriculture has not been affected by the pandemic. Its contribution to growth slightly improved compared to the previous year (World Bank, 2020). On top of this, the IMF (2020b) report revealed that Ethiopia has faced a pronounced economic slowdown and an urgent balance of payments needed owing to the COVID-19 pandemic. Having very consolidated and briefly reviewed the following related empirical literature are presented.

ARDL has been used as a method of cointegration relationships between variables in time series data, first developed by Pesaran and Shin (2001) and followed by many research works which include, Narayan and Smyth(2006); Afonso and Alegre (2008); Ilyas et al., (2010) and Dube, Ozkan and Govindasamy (2018). Narayan and Smyth (2006) examined the long-run and short-run determinants of migration from Fiji to the United States between the years 1972 and 2001, in the framework of human capital. Ilyas, et al. (2010) employed the bounds test cointegration technique for the annual time series data

from 1965 to 2007 in Pakistan as TFP turned out to be the most significant determinant of manufacturing value added both in the short and long run. Dube, Ozkan and Govindasamy (2018) used ARDL bound test Cointegration for the analysing of the export performance in Ethiopia showing, real effective exchange rate, the real GDP, foreign direct investment and prices were significantly influenced by the horticultural export performance both in the short-run and the long-run.

In fact, as a contribution to the asymmetric research literature; Shin, Yu and Greenwood-Nimmo (2011) developed a cointegrating nonlinear ARDL model in which short- and long-run nonlinearities were introduced via positive and negative partial sum decompositions of the explanatory variables. In the analysis they derived the asymmetric dynamic multipliers that graphically depict the traverse between the short- and the long-run. Since then, some researchers have used the NADRL model for economic analyses. Fousekis, Katrakilidis and Trachanas (2016) investigated the vertical price transmission in the US beef sector by employing the Nonlinear ARDL model which can allow prices to be tied by asymmetric relationships both in the long- as well as in the short-run. In their empirical analysis, they showed the long-run elasticities of price transmission were more important from the wholesale to retail level than from the farm to the wholesale level.

The recent research work by Habibi (2019) employing a NARDL model, built upon the Solow model showed there was the short-run non-linear effect of exchange rate on production into the long-run whereas exchange rate changes had short-run linear effects on production of electricity of the economy in the United States. Using NARDL, Katrakilidis and Trachanas (2012) provided the evidence suggesting that ignoring the intrinsic nonlinearities may lead to misleading inference and revealed that there were significant differences in the response of house prices in Greece to positive or negative changes of the explanatory variables in both the long- and short-run time horizons.

The analysis made by Jareño, Escribano and Koczar (2020) utilizing NARDL showed the Polish and Spanish stock market returns were similarly react to positive and negative changes in market returns of German, British, American and the Chinese stock markets, evidencing strong short-run asymmetry. Bahmani-Oskooee and Baek (2016) used the linear ARDL and

nonlinear ARDL to investigate the phenomenon between Korea and its 14 trading partners to check whether the exchange rate changes have short-run and long-run asymmetric effects on the bilateral trade balances. They concluded that separating depreciation from appreciation was the main feature of the nonlinear model that relies upon nonlinear adjustment of the exchange rate.

The study in Hussaina, et al., (2019) proved the symmetric effect of exchange rate fluctuations on GDP of the Pakistan economy which had little effect and it would likely have poor and cointegration relationships lost. On the contrary, the non-linear ARDL technique had more rich information related to the issue at hand; the confirmation of cointegration relationship between the variables and of the asymmetric impact of exchange rate on GDP growth in Pakistan were proved from the evidence of short-run, long-run and adjustment asymmetry. In addition, NARDL asymmetric effects of cyclical output on South Africa's unemployment rate for quarterly data spanning the period 1994Q1–2017Q4 was applied in study by Mazorodze and Siddiq (2018) to see the difference in economic contraction and expansion that concluded the response of the labour market was asymmetric in the long-run in that it loses more workers during contraction than it employs during recoveries.

Amin, Anwar and Liu (2020) studied based on the NARDL model to investigate the long-run and short-run impacts of FDI on the economic growth in Romania covering the period 1990–2019. Their results indicated that both an increase and a decrease in FDI had a positive and significant impact on Romania's economic growth. Khan, Sisi and Siqun (2018) study revealed there was a significant negative linear relationship between environmental regulations and carbon emissions from ARDL both in short and long-run in China for the period of 1991–2015 but NARDL does not exist. The study of Karamelikli (2016) in applying NARDL showed that the dynamic housing sector has an important size in economic activities of Turkey in the sense that a decreasing rent would cause an increase in household savings because of lightening their basic expenditures in the long-run.

On top of the above related empirical literature, we have realized so far, the study by Ibrahim (2015) employing NARDL concluded that the absence of significant influence of oil price reduction on the food price both in the long-run and in the short-run, the role of market power in shaping the behaviour of

Malaysia's food price would likely to be significant. When we look at the study by Ali et al., (2018), it explicitly explored the dynamics between economic growth and overseas investment in China, using asymmetric ARDL technique. Their study suggested that ignoring the intrinsic asymmetries may conceal the true information about the equilibrium relationship among the variables and thus lead to misleading results. Moreover, their findings revealed that economic growth in China responds positively but differently to an increase and decrease in its overseas investment and concluded that the empirical evidence obtained through asymmetric models seems to be superior to that of symmetric models and thus leads to more efficient policy-making to achieve sustainable economic development.

From the above related empirical literature, we observe most of the empirical available evidence clearly suggest that the asymmetric effects analysis is more magnified than symmetric linearity even though the debate remains on-going which necessitates for further studies on the matter. Hence, this paper contributes to the discussion by ascertaining and comparing symmetrical and asymmetrical effects of the change and growth rate of the value-added sectors on economic growth for Ethiopia. It also applies a dataset that stretches up to the very recent years which makes it likely to capture recent output dynamics.

3. Methodology of the Study

The investigation we conduct in this research is based on the conventional linear autoregressive distributed lag (ARDL) of Pesaran, Shin & Smith (2001) and its continuation of the nonlinear ARDL by Shin, Yu, and Greenwood-Nimmo (2014). The NARDL model depicts the positive and negative partial sum decompositions of the variables of interest. More importantly, the model is used for the detection of asymmetric effects both in the long-run and short-run. For this reason, NARDL has been used in some research works by Fousekis, Katrakilidis and Trachanas (2016) to investigate vertical price transmission; Karamelikli (2016) to examine the importance of housing sector size in economic activities; Greenwood-Nimmo and Shin (2013) to analyse the exchange rate pass through and Katrakilidis and Trachanas (2012) to investigate housing price dynamics, are among others. ARDL and NARDL

models are relatively easy to implement and show the dynamic nature of the economy.

After carefully examining the related empirical studies, the study look for an appropriate model; Autoregressive Distributed Lags (ARDL) and its extension nonlinear ARDL or NARDL bounds tests cointegration framework for this study. In recent years, the ARDL and NARDL models cointegration have become popular in time series data analysis. Note that we have to clearly understand the difference between the two in the sense that the first is symmetric and the second one is asymmetric. Here under methodology of the study, we present the variable descriptions, source of data and statistical concepts.

One of the components of the methodology of this study is to make a classification on the variables undertaken. These are real GDP as a dependent variable while agricultural, industrial and services sectors value added are considered as explanatory variables. The descriptions and definitions of the three sectors value added are determined by the International Standard Industrial Classification revision 3 or 4. The United Nations system of National Accounts calls for value added to be valued at either basic prices, excluding net taxes on products or producer prices, including net taxes on products paid by producers but excluding sales or value added taxes. Both valuations exclude transport charges that are invoiced separately by producers. The study employs data measured at constant 2015 U.S Dollars and obtained from the World Bank Development Indicators which cover over the period 1981 −2022. According to the World Bank national accounts, the variables are defined as follows:

Real GDP: is a macroeconomic statistic that measures the final value of the goods and services produced by an economy in a specific period, adjusted for price changes.

Agricultural Value Added: The net output of the agricultural sector after adding up all outputs and subtracting intermediate inputs.

Industrial Value Added: The net output of **the industrial sector** after adding up all outputs and subtracting intermediate inputs.

Services Sector Value Added: denotes the net output of the services sector after adding up all outputs and subtracting intermediate inputs.

For the model specification we assume that the Ethiopian GDP is a function of agricultural, industrial and service sectors in terms of value added at constant 2015 US$. Notice that labour and capital inputs are already involved in the production of these values added and no need to take them here in the model specification. Now we can model using the Cobb-Douglas production function considering constant returns to scale as:

$$Y_t = f(x) = A\prod_{i=1}^{n} X_i^{\theta_i} e^{U_t}, \quad X = (X_1, \dots X_i), \theta_1 + .. + \theta_i \qquad (\mathbf{1})$$

where A is an efficiency parameter or total factor productivity (TFP), n is the total number of non-negative quantities of factor of production, X_1, ..., X_n and $\theta_i$is an elasticity parameter for input factors i. After the log transformation of equation (1), we can estimate as a linear relationship using the following expression:

$$lnY_t = lnf(x) = \alpha_0 + \sum_{i=1}^{n} \alpha_i ln(X_i) + U_t \qquad (\mathbf{2})$$

In the linear regression representation model, we can rewrite equation (2) as:

$$y_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \beta_3 x_{3,t} + e_t \qquad (\mathbf{3})$$

Where ln is the natural logarithm, the lower-case letters represent the real GDP, value added of the agricultural, industrial and service sectors in natural logarithm, respectively and e_t stands for the error term over time and the prior expectation sign of β_1 through β_3 are positive as well.

A well-known cointegration approach, known as the Autoregressive-Distributed Lag (ARDL) model of Pesaran and Shin (1995) and Pesaran, Shin and Smith (2001) bounds test, has certain econometric advantages over the Johnson cointegration approach. Firstly, the long–run and short-run parameters of the model in question are estimated simultaneously. Secondly, the econometric methodology is relieved from the burden of establishing order of integration among the variables and of pre-testing for unit roots. This means the

ARDL model is applicable to test for the existence of a long -run relationship between the variables irrespective of whether the underlying of I (0), I (1), fractionally integrated or mixed of integrated orders, but not higher than (2). Thirdly, while the Johansen cointegration techniques require large data samples for validity, the ARDL procedure provides statistically significant results with small samples and hence, it avoids the problem of biases that arise from small sample size. Fourthly, when one cointegrating vector exists, unlike Johansen cointegration, ARDL procedure can do further, in using a dummy variable inclusiveness in the cointegration test process (for detained see, Nkoro and Uko, 2016; Udoh, 2012 and Narayan, 2005).

Therefore, equation (3) can be set in the form of the standard ARDL bounds test which representing the short-run component in the form of error correction model (ECM) and long-run components in the form of ARDL, respectively as follows:

$$ARDL: \Delta y_t = \alpha_0 + \sum_{i=1}^{m} A_i \Delta y_{t-i} + \sum_{j=0}^{n} B_i \Delta x_{1,t-j} + \sum_{j=0}^{p} C_i \Delta x_{2,t-j} + \sum_{j=0}^{q} D_i \Delta x_{3,t-j} + \beta_0\, y_{t-1} + \beta_1\, x_{1,t-1} + \beta_2\, x_{2,t-1} + \beta_3 x_{3,t-1} + \varepsilon_t$$

$$\&$$

$$ECM: \Delta y_t = \sum_{i=1}^{m} A_i \Delta y_{t-i} + \sum_{j=0}^{n} B_i \Delta x_{1,t-j} + \sum_{j=0}^{p} C_i \Delta x_{2,t-j} + \sum_{j=0}^{q} D_i \Delta x_{3,t-j} + \lambda ect_{t-1} + \varepsilon_t \quad (\mathbf{4})$$

where y_t represents dependent variable; $x_{1,t}$,$x_{2,t}$ and $x_{3,t}$ denote exogenous explanatory variables; m, n, p & q lags that the values of the variables and λ refers speed of adjustment parameter attached to the error correction term ($\mathrm{ect_{t-i}}$). The error correction term is known as the residuals that are obtained from the estimated the log-run component of ARDL model and ε_t is the residual errors.

Noteworthy, the error correction term replaces the long-run components of ARDL but doesn't include the intercept that forms the Error Correction Model (ECM). The non-linear autoregressive distributed lag (NARDL) cointegration model was developed by Shin, Yu and Greenwood-Nimmo (2014)

as an extension of the standard ARDL model. After decomposition of each explanatory variable into a partial sum of positive and negative changes, the NARDL is modelled to capture the effect of asymmetry. Hence, equations (4) can be established in the form of asymmetries and the parameters to be estimated in the framework of NARDL model:

$$\text{NARDL: } \Delta y_t = \alpha_0 + \sum_{i=1}^{m} A_i \Delta y_{t-i} + \sum_{i=0}^{n} B_i^{+} \Delta x_{1,t-i}^{+} + \sum_{i=0}^{n'} B_i^{-} \Delta x_{1,t-i}^{-} + \sum_{i=0}^{p} C_i^{+} \Delta x_{2,t-i}^{+} + \sum_{i=0}^{p'} C_i^{-} \Delta x_{2,t-i}^{-} + \sum_{i=0}^{q} D_i^{+} \Delta x_{3,t-i}^{+} + \sum_{i=0}^{q'} D_i^{-} \Delta x_{3,t-i}^{-} + \beta_0 y_{t-1} + \beta_1^{+} x_{1,t-1}^{+} + \beta_1^{-} x_{1,t-1}^{-} + \beta_2^{+} x_{2,t-1}^{+} + \beta_2^{-} x_{2,t-1}^{-} + \beta_3^{+} x_{3,t-1}^{+} + \beta_3^{-} x_{3,t-1}^{-} + \varepsilon_t$$

$$\&$$

$$\text{ECM: } \Delta y_t = \alpha_0 + \sum_{i=1}^{m} A_i \Delta y_{t-i} + \sum_{i=0}^{n} B_i^{+} \Delta x_{1,t-i}^{+} + \sum_{i=0}^{n'} B_i^{-} \Delta x_{1,t-i}^{-} + \sum_{i=0}^{p} C_i^{+} \Delta x_{2,t-i}^{+} + \sum_{i=0}^{p'} C_i^{-} \Delta x_{2,t-i}^{-} + \sum_{i=0}^{q} D_i^{+} \Delta x_{3,t-i}^{+} + \sum_{i=0}^{q'} D_i^{-} \Delta x_{3,t-i}^{-} + \beta_0 y_{t-1} + \lambda ECT_{t-1} + \varepsilon_t \quad (\mathbf{5})$$

where $x_0 + x_t^{+} + x_t^{-}$ are the decomposition of the variable x_t.

The actual long-run impact of explanatory variables through their coefficients of $B^{+}, B^{-}, C^{+}, C^{-}, D^{+} \& D^{-}$ on the dependent variable via *A* must be done by considering the size and orders associated with dependent variable that leads to the weight cumulative impact of($B^{+}, B^{-}, C^{+}, C^{-}, D^{+} \& D^{-}$). This indicates an approximation to the long-run multiplier effects would involve a non-linear transformation.

The symmetric degree of the impact relationship of a positive change in explanatory variable is the same as a negative change in an explanatory variable on the dependent variable. However, this assumption may not hold up in reality all the time. If the magnitude of the impact is not the same on both sides of the change, we conclude that the impact of the explanatory variables on the dependent variable is asymmetric. This provokes research in the field of asymmetry. The short-run cumulative dynamic multiplier effects (m_h^{+} & m_h^{-})of

the decomposed positive (x_t^+) increases and negative (x_t^-) regressor decreases the dependent variable that can be evaluated, respectively as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} max\left(\Delta x_j^+, 0\right) \;\&\; x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} min\left(\Delta x_j^-, 0\right)$$

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial \Delta y_{t-j}}{\partial \Delta x_t^+} \;\&\; m_h^- = \sum_{j=0}^{h} \frac{\partial \Delta y_{t-j}}{\partial \Delta x_t^-}, h = 0,1,2, \dots n, \qquad \textbf{(6)}$$

where $\beta^+ \; and \; \beta^-$ are the long-run parameters associated to the decomposed regressors into partial sum of the processes of positive and negative changes in x_t and as $h \to \infty, m_h^+ \to -\frac{\beta^+}{\beta_0}$ & $h \to \infty, m_h^- \to -\frac{\beta^-}{\beta_0}$.

The present forms of ARDL model in equation(5) and (6) are not actually long-run functional form explicitly and hence the parameters cannot be directly estimated. However, when we make the analysis of the long-run behaviour and the short-run dynamics with time series data and macroeconomic panel data using ARDL model, we have to calculate the long-run coefficients of the model (Blackburne and Frank, 2007). Thus, the long-run NARDL asymmetric coefficients can be obtained by dividing the negative coefficient of each positive explanatory variable by the coefficient of one period lag of dependent variable and the negative coefficient of each negative explanatory variable by the coefficient of one period lag of dependent variable separately as specified in equation (6) above.

4. Results and Discussions

Table 1 in the appendix shows that the median and minimum values of all the four variables are not far away from the mean values. A standard deviation close to zero indicates that data points are close to the mean and clustered around the mean. Here in this descriptive, standard deviations are considerably insignificant in each variable, indicating error distribution is quite low. Furthermore, the fundamental task in statistical analyses is to characterize the location and variability of a data set including skewness and kurtosis. Skewness is a measure of symmetry in a data set. It is symmetric if it looks the

same to the left and right of the centre point. The skewness value for each variable is positive and less than a unit, which indicates the skewed distribution, is relatively low peaks. Kurtosis is a measure of whether the data are heavy-tailed or light-tailed relative to a normal distribution. Here is where a data set with low kurtosis tends to have absence of outliers. Finally, the number of observations for each variable is 40 which is substantially considered for the time series analysis.

Order selection criteria for optimal lag length is another issue to be considered in time-series analysis. One of the most important considerations with times series data is making an appropriate set of dynamics equations with the most appropriate lag structure. A possible source of a problem in the functional form of the model is lack of lagged structure, which results in autocorrelation. In this case, one way of overcoming an autocorrelation is to add a lagged variable in the system.

As ARDL and its extension, a non-linear symmetric ARDL commonly known as NARDL model can be estimated via the least squares regression, the standard Akaike information criteria (AIC), Bayesian Schwarz information criteria (BSIC) and Hannan–Quinn (HQIC) information criteria are used for the model selection. AIC and BSIC are two different things. AIC generally performs well when the objective is prediction based on asymptotically equivalent to the cross-validation in which it doesn't assume the true model lies in the model space (Pesaran, 2007). On the other hand, BSIC is something that would be preferred to obtain the most parsimonious representation among a group of models. In other words, BSIC selects the simplest possible model to explain the data that assumes that the true model lies in the model space. The optimal lag length in ARDL model can be determined by the Akaike information criterion (AIC) among many others, with the lowest error value indicating the most appropriate model to be used in the analysis. So, as can be seen from the results from Table 2, in (Appendix I) by allowing up to 4 numbers of lag, the optimal lag length this study chooses for the model is 2, since the AIC criterion assumes that the lowest the error value, the better the model is.

Unit root test in the presence of structural breaks using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test statistics is also another key point that the research focuses on it. In this regard, the study includes the

intercept and trend in the test equations and take a maximum lag length of 2 made by automatic selection of the AIC for the former test procedures and spectral estimation method of the Bartlett Kernel by automatic selection of the Bandwidth for the later test. The results reported in the Appendix Table 3 indicates that (see Appendix I), all the four series of data have unit roots or they are non-stationarity in the level. Since the absolute values of both the ADF and adjusted PP test t-statistics values are less than t-test critical values at 1% and 5% levels of significance, the null hypothesis of the unit root would not be rejected. However, after differencing they become stationary and are an integrated order of one so that the study confirms that ARDL and NARDL models are applicable for the analysis.

Before estimation the coefficients of the variables, Tests for structural breaks and endogeneity problems have to be conducted. The study detects presence of structural breaks either weakly by looking at the graph of the dependent variable exogenously or strongly by examining stability diagnostics tests such as CUSUM and CUSUM squares endogenously. With this framework, the first graph on the upper right side of Figure 1 (in Appendix II) shows that after the year 2013 there is a deviation of a trend away from the two lines 5% of significance in CUSUM and unstable while in CUSUM square, in which very slightly diverges away from the two lines in the years between 2000 and 2003.

In order to identify the exact year(s) when the break occurs, the Bai-Perron multiple breakpoint tests are applied which sequentially determine the breaks. However, the tests indicate that just the year 2004 has a break and the Chow breakpoint test with identified the year 2004 with results are shown in Table 4 (in Appendix I). The results indicate that there is a rejection of the null hypothesis of no break at specified point at any conventional level of significance since the probability value of F-statistic is statistically significant. Therefore, the incorporated dummy variable in the series of dataset with base category zero for the year 1981 to 2004 and one for year 2005 to 2020, the problem of structural breaks in the series of data are now overcome and the model becomes stable as can be seen Figure 3 (in Appendix II).

Another potential problem is endogeneity. Endogeneity exists when one or more regressors are correlated with the residual error term which can be the

observed and unobserved variables. An observed heterogeneity usually consists of the covariates whereas unobserved heterogeneity consists of any unobserved difference most likely ability or effort. The best way to deal with endogeneity concerns is through instrumental variables (IV) techniques. The most common IV estimators are two stages least squares (2SLS), three stage least squares (3SLS), limited information maximum likelihood and K-Class estimation (LIML) and generalized method of moments (GMM). Equivalently, ARDL method procedures to remove endogeneity from the series data. The estimation coefficients are biased and inconsistent in the presence of endogeneity, unless otherwise, it has to be removed it from the series of data. The results reported in Table 5 (in Appendix I), therefore, confirms that there is no breaks at specified breakpoints and hence, no endogeneity problem in the data.

The final conducting tests are linear symmetric ADRL and non-linear asymmetric ARDL bounds tests. The ARDL bounds testing for cointegration procedure is based on the F or Wald-statistics tests. The F-test used in procedure has a non-standard distribution. Thus, Pesaran, Shin and Smith (2001) compute the two sets of critical values for a given significance level by assuming some variables are set of I(0) and some others are set of I(1) or combination of the two. Even though the NARDL model separates the reaction of the dependent variable into the negative and positive change in the independent variables, the bounds test procedures for asymmetric long-run cointegration is similar to the ARDL bounds test. The computed F-statistic value exceeds the upper critical bounds values in both ARDL and NARDL models that a rejection of the null-hypothesis of no cointegration at 5%, 2.5% and 1% levels of significance is possible as can be seen in Table 1 below. Thus, the study concludes there is a level relationship among the variables in the linear symmetric ARDL and non-linear asymmetric ARDL models. Note that if the F-statistic falls between the upper and lower bounds, then the test becomes inconclusive and if it is below the lower critical bound values, implies no cointegration.

Table 1: Symmetric linear ARDL and NARDL models F-Bounds test

F-Bounds test	**Symmetric test for level and growth**		**Asymmetric test for level and growth**	
Selected Model	***ARDL(4, 1, 1, 1, 0)***		***NARDL(4, 0, 3, 3, 0, 3, 3, 0)***	
F-Value	6.54		75.32	
Test Signi.	I(0)	I(1)	I(0)	I(1)
5.00%	2.56	3.49	2.17	3.21
2.50%	2.88	3.87	2.43	3.51
1.00%	3.29	4.37	2.73	3.90

Null Hypothesis: No levels relationship and * & ** denotes 1% and 2.5% levels of significance, respectively. Dependent Variable:$Dlny_t$ for the level. With regard to the Wald-statistics test for a joint significance of Pesaran, Shin and Smith (2001), there should perform the null hypothesis as $H_0: \beta_0 = \beta_1 = \beta_2 = \cdots = \beta_k = 0$ for ARDL and $H_0: \beta_0 = \beta_1^+ = \beta_1^- = \beta_2^+ = \beta_2^- = \cdots \beta_k^+ = \beta_k^- = 0$ in which the coefficients attached to the upward movement (x_t^+) and the downward movement levels of (x_t^-) for NARDL.

The upward (x_t^+) and downward (x_t^-) movements in the level of NARDL which implies no cointegration for each model and an alternative confirms, cointegration exists among the given variables. For the later model, since the bounds exist, we proceed to test whether the differences are an asymmetric coefficient statistically significant. This means the magnitude of the change in y_t when x_t increases is not the same as when x_t decreases and thus we conclude the variables are cointegrated in the presence of asymmetry.

We conduct the long-run coefficients test using Wald test reported in Table 2 below, by taking the variables from the conditional error correction regression of ARDL and NARDL long-run form and Bounds test independently one after another. Eventually, we run the two models using the stepwise least square which separates the long-run estimation from the short-run components of the models. The conditional error correction regression of ARDL and NARDL long-run form and Bounds tests presented in Table 6 in the Appendix (which has been depicted in Appendix I) clearly shows that the computed F-statistic is statistically significant which imply that there is a long- run relationship among the variables.

Table 2: Test for ARDL and NARDL long-run coefficient using Wald test

ARDL(4, 1, 1, 1, 0)		NARDL(4, 0, 3, 3, 0, 3, 3, 0)	
F-Statistic Value	**Probability**	**F-Statistic Value**	**Probability**
7.2474	0.0013*	93.055	0.0000*

Note: Besides, the F and Wald tests, there is another option called the t-test of Banerjee, Dolado and Mestre (1998) for the null hypothesis $H_0: \beta = 0; H_A: \beta < 0$. * Denotes statistically significance level, long-run coefficients test for ARDL(4, 1, 1, 1, 0):$H_0: \hat{\beta}_2 = \hat{\beta}_3 = \hat{\beta}_4 = \hat{\beta}_5 = 0 \Rightarrow$Null Hypothesis: C(2)= C(3)=C(4)=C(5)=0 and NARDL(4, 0, 3, 3, 0, 3, 3, 0)⇒Null Hypothesis: C(2)= C(4)=C(5) = C(7)=C(8) = 0.

After all the necessary conducting pre-estimation tests, we attempt to estimate the short-and long-run symmetric and asymmetric coefficients by applying the appropriate models. Thus, selecting ARDL (4,1,1,1,0) & NARDL(4,0,3,3,0,3,3,0) models using the optimal lag length of 2, we run each model via least squares method specifically for NARDL (via labelled by entering "asyvars" on EViews and explanatory variables then go to "add in" to make a platform for estimation) and diagnostics for post-estimation.

The short-run coefficients estimation of the model ARDL and NARDL are as follows:

The ARDL symmetric estimation coefficients on the upper part of Table 3 depict that all the three value added sectors have statistically significant impact on real GDP in the short-run. Specifically in the short-run, a 1% increase in agricultural sector value added causes to increase the real GDP by about 0.57% while others are constant. Likewise, in the short-run a 1% increase in industrial sector value added to the real GDP by about 0.12%, all others kept constant. Similarly, a 1% increase in the service sector value added in the short-run brings an increase in the real GDP by about 0.31%, other things being constant.

The NARDL estimation coefficients presented on the lower part of Table 3 indicate that the first three period lags of real GDP, the upward movement in the current and the first two previous periods of agriculture, the downward movement in the current and the first two previous periods of industry and service sectors as well as the upward movement in the current and the two period lags in service; each of them has statistically significant impact

on the real GDP in the short-run. Specifically, other things remain constant; a 1% upward movement or increase in the current period and the first two previous periods of agriculture, leads to an increase in real GDP by about 0.67%, 0.36% and 0.17%, respectively. Likewise, a 1% downward movement or decrease in the current and the first two previous periods of industry each has led to increase by about 1.48%, 6.74% and 4.91% in real GDP. Lastly, a 1% downward movement in the current and the two period lags in service in each leads to a decrease of real GDP by about 1.48%, 8.61% and 5.58%, but it's an upward movement causes to increase the real GDP by 0.52% and 0.09%, respectively.

Coefficients of the error terms measure the speed of adjustment. As can be seen under ARDL and NARDL short-run estimation in Table 3, the coefficients are statistically significant and an expected negative sign, indicating the economy converges toward the long-run equilibrium after facing disequilibrium within a year. For the economy to return to normal condition, it takes about 2.15 (1/0.4641) years.

Finally, as the Durbin-Watson statistic values under the same tables exceed the adjusted coefficients of determination in both models, which ensure the estimations are non- spurious regressions. In addition, the Ramsey RESET model specification for each model is statistically insignificant at any conventional level of significance, indicating the model specifications are correct and well fit to the data. Also, data used in this analysis are free from serial-correlation and heteroskedasticity in both symmetric ARDL and asymmetric ARDL models (as the results can be seen under Appendix I) in Table 5.

Table 3: Short-Run Symmetric and Asymmetric Coefficients Estimation

Variable	Symmetric Estimation Coefficients: ARDL (4,1,1,1,0)			
	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
*D(**ln**Y(-1))*	-0.0334	0.0188	-1.7726	0.0890
*D(**ln**Y(-2))*	-0.0357	0.0155	-2.3049	0.0301*
D(lnY(-3))	-0.0465	0.0177	-2.6325	0.0146**
*D(**ln**X1)*	0.5701	0.0116	49.165	0.0000***
*D(**ln**X2)*	0.1193	0.0168	7.0948	0.0000***
*D(**ln**X3)*	0.3084	0.0209	14.764	0.0000***
*ARDL ECT (-1)**	-0.4641	0.0674	-6.8859	0.0000***
Asymmetric Estimation Coefficients: NARDL				
*D(**ln** (-1))*	-0.3122	0.0291	-10.738	0.0000***
*D(**ln**Y(-2))*	-0.12065	0.0317	-3.8042	0.0025***
*D(**ln**Y(-3))*	-0.0403	0.0127	-3.1855	0.0078***
*D(**ln**X1_POS)*	0.6725	0.0162	41.502	0.0000***
*D(**ln**X1_POS(-1))*	0.3594	0.0285	12.618	0.0000***
*D(**ln**X1_POS(-2))*	0.1689	0.0377	4.4854	0.0007***
*D(**ln**X2_NEG)*	-1.4799	0.1391	-10.639	0.0000***
*D(**ln**X2_NEG(-1))*	-6.7384	0.2293	-29.389	0.0000***
*D(**ln**X2_NEG(-2))*	-4.9105	0.2934	-16.735	0.0000***
*D(**ln**X3_NEG)*	1.4787	0.1537	9.6184	0.0000***
*D(**ln**X3_NEG(-1))*	8.6109	0.2943	29.263	0.0000***
*D(**ln**X3_NEG(-2))*	5.5755	0.3386	16.467	0.0000***
*D(**ln**X3_POS)*	0.5162	0.0225	22.929	0.0000***
*D(**ln**X3_POS(-1))*	-0.0132	0.0222	-0.5926	0.5645
*D(**ln**X3_POS(-2))*	0.0897	0.0245	3.6618	0.0033***
*NARDL ECT(-1)**	-0.7274	0.0216	-33.612	0.0000***

*** and ** denotes the level of significance at 1% and 5%. The dummy variable is appeared on the list of the short-run estimation because the difference (D) eliminates it.
Source: Own computation from the data

The results shown in Table 4 are short–run the cumulative dynamic multiplier effects of the positive/ upward and negative/downward movements of those explanatory variables on real GDP. However, the negative cumulative dynamic multiplier effects are more magnificent and pronounced than the effects of the counterpart.

Table 4: Short-run cumulative dynamic multiplier effects of NARDL model

The dynamic multiplier effects calculation is based on Equation using (6)							Total
Positive cumulative (m_h^+)	0.6725	0.3594	0.1689	0.5162	-0.0132	0.0897	1.7935
Negative cumulative (m_h^-)	-1.4799	-6.7384	-4.9105	1.4787	8.6109	5.5755	2.5364

Source: Own computation from the data

Furthermore, the asymmetric cumulative dynamic multiplier graphs presented in Figure 2 under Appendix II) show the pattern of adjustment of the real GDP to its new long-run equilibrium following a positive or negative occurred shock from monetary policy to the sectors. From graphs, we can clearly see how the real GDP responds positively to the positive shock and negatively to a negative shock in agriculture, industry and service sectors value added. In response, the real GDP to either negative or positive shock is more pronounced in the long-run than in the short-run where virtually operating on the same level over the horizon for each sector.

The upper continuous and the lower dash black lines show how the real GDP adjusts itself all over the horizon due positive and negative changes in the value added of agricultural, industrial and service sectors, respectively. The red dash line is an asymmetric plot which reflects the difference between the dynamic multipliers of the positive and negative change in the agricultural sector, but not in either of two value added sectors. Since the zero line falls out of the upper- and lower-lines interval that is statistically significant, there is an asymmetry effect of the agricultural sector on real GDP in the long-run with more negative response of real GDP when the negative shocks happen to the economy. In this regard, the first three graphs in Figure 2 confirm these occurrences.

ARDL and NARD models long-run estimation are the last conducting procedures of this study. To check robustness of the models, we rely on fully modified ordinary least squares(FMOLS) since its long-run regression results are similar to the long-run component coefficients estimation of ARDL in which they are presented under conditional error correction regression in Table 5 in the appendix whereas for NARDL model we prefer DOLS to FMOLS cointegrating regression. The dummy variable indicates that the real GDP on average is less

0.62 after the structural break of 2004 than it before in the long-run, while others remain unchanged.

The long-run symmetric and asymmetric coefficients estimation reported on the upper part of Table 5 can be interpreted as follows. Each of the three sectors has symmetrically and statistically positive significant impact on the real GDP in the long-run, while all others kept unchanged. Regarding asymmetric coefficients estimation of dynamic ordinary least squares (DOLS), a unit decrease in agricultural sector value added leads a 0.59 unit decrease in the real GDP, but a one-unit increase will increase real GDP by about 0.61unit in the long-run, all other things being constant. Similarly, one-unit upward movements in the industrial and services sectors in each cause to increase the real GDP by about 0.17 and 0.27 units in the long-run, others are unchanged.

Table 5: Long-Run Symmetric and Asymmetric Coefficients Estimation

Symmetric Estimation Coefficients using FMOLS				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
lnX1	0.6055	0.0127	47.687	0.0000***
lnX2	0.1781	0.0071	25.129	0.0000***
lnX3	0.2888	0.0115	25.044	0.0000***
Dummy Variable	-0.0165	0.0054	-3.0672	0.0042***
Constant	-0.6221	0.1533	-4.0589	0.0003***
Asymmetric Coefficients Estimation DOLS				
lnX1_NEG	0.5881	0.0496	11.854	0.0000***
lnX1_POS	0.6111	0.1164	5.2502	0.0012***
lnX2_NEG	4.7685	2.1539	2.2138	0.0624
lnX2_POS	0.1777	0.0148	12.007	0.0000***
lnX3_NEG	-6.1446	3.0080	-2.0427	0.0804
lnX3_POS	0.2680	0.0665	4.0274	0.0050**
Dummy Variable	0.0224	0.0288	0.7778	0.4622
Constant	23.103	0.0178	1295.4	0.0000***

*** and ** refers 1 and 5% level of significance, respectively

Source: Own computation from the data

Dependent Variable: LNY, Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000), FMOLS, R-squared: 0.9998 and DOLS, R-squared: 0.9998.The existence of cointegration does not necessarily imply that the estimated coefficients are stable as argued in Bahmani-Oskooee and Brooks (1999). Therefore, the cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests of Brown et al. (1975) for stability conditions, based on the recursive regression residuals, may be employed to this end. The test statistics are updated recursively and plotted against the break points of the model, assuming statistics values fall inside the critical bounds of 5% significance, for the coefficients of a given regression to be stable.

The tests are usually implemented by means of graphical representation shown in Figure 2 (under Appendix II) and they confirm that the regression has no stability problem. Noteworthy, we also conduct the diagnostics test of pre-estimation such as structural breaks (the output reported in Table 4 presented in the appendix and post-estimation includes serial-correlation, heteroskedasticity and model specification in Table 5 (as you can see from Appendix I). Hence, the results in both ARDL and NARDL models couldn't give any evidence for the existence of these problems.

As the results from the symmetric linear ADRL model in Table 6 below show that there are bi-directional Granger Causality between real GDP and agriculture as well as the real GDP and industrial sector whereas a unidirectional causality running from GDP to the service sector value added. However, the asymmetric non-linear ARDL model results reveal that there is a unidirectional causality running from a negative or downward movement of the agriculture sector value added to real GDP and an upward movement of industrial sector value added to real GDP.

Table 6: VAR Granger Causality Wald tests for ARDL and NARDL model

Granger Causality in ADRL model			
Dependent variable	**Excluded**	**Chi-square**	**Probability**
$\boldsymbol{lnY}$	$lnX1$	20.411	0.0000***
$\boldsymbol{lnY}$	$lnX2$	24.744	0.0000***
$\boldsymbol{lnY}$	$lnX3$	13.348	0.0013***
$\boldsymbol{lnY}$	DV1	7.2933	0.0261**
$\boldsymbol{lnX1}$	lnY	15.749	0.0004***
$\boldsymbol{lnX2}$	lnY	12.349	0.0021***
$\boldsymbol{lnX3}$	lnY	4.0351	0.1330
Dummy Variable	lnY	6.0134	0.0495**
Granger Causality in NADRL model			
Dependent variable	**Excluded**	**Chi-square**	**Probability**
$\boldsymbol{lnY}$	$lnX1\_NEG$	7.1899	0.0275**
$\boldsymbol{lnY}$	$lnX1\_POS$	5.9045	0.0522*
$\boldsymbol{lnY}$	$lnX2\_NEG$	1.0232	0.5996
$\boldsymbol{lnY}$	$lnX2\_POS$	3.6569	0.1607
$\boldsymbol{lnY}$	$lnX3\_NEG$	4.1439	0.1259
$\boldsymbol{lnY}$	$lnX3\_POS$	1.5424	0.4625
$\boldsymbol{lnY}$	DV1	9.2169	0.0100**
$\boldsymbol{lnX1\_NEG}$	lnY	3.2703	0.1949
LNX1_POS	lnY	2.2598	0.3231
$\boldsymbol{lnX2\_NEG}$	lnY	4.0756	0.1303
$\boldsymbol{lnX2\_POS}$	lnY	8.0887	0.0175**
$\boldsymbol{lnX3\_NEG}$	lnY	4.5924	0.1006
$\boldsymbol{lnX3\_POS}$	lnY	0.4628	0.7934
Dummy Variable	lnY	4.1821	0.1236

lnY stands for real GDP; $lnX1$ for agricultural sector ; $lnX2$ for industrial sector including construction and $lnX3$ for service sector. ***, ** and * denotes 1, 5 and 10% level of significance, respectively, and the null hypothesis No Granger causality

5. Conclusion and Recommendation

This study investigates the symmetric and asymmetric effects of the Ethiopian economy using ARDL and NARDL cointegration approaches. Robustness of the ARDL and NARDL models are ensured by cointegrating regression of fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares, respectively. The long-run symmetric coefficient estimation indicates each of the three sectors has symmetrically and statistically positive significant impact on the real GDP in the long-run, while all others kept unchanged. Regarding asymmetric coefficients estimation of dynamic ordinary least squares (DOLS), a unit decrease in agricultural sector value added leads a 0.59 unit decrease in the real GDP, but a one-unit increase will increase real GDP by about 0.61unit in the long-run, all other things being constant.

The results from the symmetric linear ADRL model show that there are bi-directional Granger Causality between real GDP and agriculture. There are also bi-directional Granger Causality running from the real GDP to industrial sector and vice versa whereas a unidirectional causality from GDP to the service sector. However, the asymmetric non-linear ARDL model results reveal that there is a unidirectional causality running from a negative downward movement of the agriculture sector value added to real GDP and a positive upward movement of industrial sector value added to real GDP.

The asymmetric cumulative dynamic multiplier shows the pattern of adjustment of the real GDP to its new long- run equilibrium following a positive or negative occurred shock in the sectors. The real GDP responds positively to the positive shock and negatively to a negative shock to the economic sectors. In response, the real GDP to either negative or positive shock is more pronounced in the long-run than in the short-run. There is an asymmetric difference between the dynamic multipliers of the positive and negative change in agricultural sector, but not in either of two sectors or an asymmetry effect of the agricultural sector on real GDP in the long-run with more negative response of real GDP when the negative shocks happen to the economy.

In the end, the study recommends that the asymmetric model seems to be superior to symmetric models, ensuring more efficient policy-making for the economy to be potentially capable in achieving all-inclusive and resilient sustainable economic growth; agriculture must be a leading sector.

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Appendices

Appendix I: Tables

Table 1: Descriptive statistics of the variables

	lnY	***lnX1***	***lnX2***	***lnX3***
Mean	23.864	23.136	22.081	22.682
Median	23.613	22.957	21.680	22.399
Maximum	25.277	24.088	24.029	24.381
Minimum	23.055	22.347	21.024	21.631
Std. Dev.	0.7082	0.5135	0.8607	0.8902
Skewness	0.6847	0.5086	0.9996	0.6018
Kurtosis	2.0491	1.8906	2.7309	1.9178
Observations	40	40	40	40

Source: Own computation from the data

Table 2: Order selection criteria for optimal lag length

Lag	**AIC**	**BSC**	**HQ**
0	-7.271083	-7.051150	-7.194321
1	-16.52093	-15.20133*	-16.06035*
2	-16.76797*	-14.34870	-15.92358
3	-16.47844	-12.95951	-15.25024
4	-16.46646	-11.84786	-14.85445

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level)FPE: Final prediction error AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion, VAR Lag Order Selection Criteria, Endogenous variables: LNY LNX1 LNX2 LNX3, Exogenous variables: C, Sample: 1981 2020 and Included observations: 36.

Source: Own computation from the data

Table 3: Unit root tests in presence of structural breaks

With Const & Trend	Var.	ADF-test statistic	Level of significance of t-test critical values at		Adjusted PP test statistic	Level of significance of t-test critical values at	
			1%	5%		1%	5%
Level	lny_t	-1.6482	-4.2268	-3.5366	-1.1863	-4.2119	-3.5298
	$lnx_{1,t}$	-2.9179	-4.2268	-3.5366	-2.2404	-4.2119	-3.5298
	$lnx_{2,t}$	-0.8131	-4.2191	-3.5332	0.0326	-4.2119	-3.5298
	$lnx_{3,t}$	-1.5832	-4.2191	-3.5331	-1.1783	-4.2119	-3.5298
1st Diff	$Dlny_t$	-6.0064	-4.2268**	-3.5366*	-4.3260	-3.6155**	-2.9411*
	$Dlnx_{1,t}$	-7.4338	-4.2268**	-3.5366*	-6.3540	-3.6155**	-2.9411*
	$Dlnx_{2,t}$	-4.3197	-4.2268**	-3.5366*	-4.0390	-4.2191	-3.5331*
	$Dlnx_{3,t}$	-4.3279	-4.2191**	-3.5331*	-4.3706	-4.2191**	-3.5331*

Null hypothesis: a variable has a unit root and ** and * denotes the rejection of the null-hypothesis at 1% and 5% levels of significance, respectively.

Source: Own computation from the data

Table 4: Test for Structural Breaks and Endogeneity Problems

Chow Breakpoint Test at year 2004			
F-Statistic Value	**Probability**	**Wald Statistic Value**	**Prob. Chi-Square**
10.4476	0.0000*	41.7904	0.0000*
Test for endogeneity			
Variable relation with	**Coefficient**	**t-Statistic**	**Probability**
RESID_LNX1	0.590894	35.88834	0.0000*
RESID_LNX2	0.185125	21.00715	0.0000*
RESID_LNX3	0.282281	19.96678	0.0000*

* Denotes rejection at 1% level of significance, Null Hypothesis: No breaks at specified breakpoints and Endogeneity

Source: Own computation from the data

Table 5: Short-run ARDL and NARDL model validation

	Short-run ARDL model		Short-run NARDL	
Type of Residual Diagnostics	**F-statistic**	**Prob(F)**	**F-statistic**	**Prob(F)**
Breusch-Godfrey LM Test for Serial Correlation	2.1732	0.1376	3.8467	0.7714
Breusch-Pagan-Godfrey for Heteroskedasticity	2.2135	0.0563	0.5069	0.9219
Ramsey RESET Test for model Misspecification	0.4304	0.5183	0.4901	0.4984

Source: Own computation from the data

Table 6: ARDL and NARDL Long Run Form and Bounds Test

Selected Model: ARDL(4, 1, 1, 1, 0): Conditional Error Correction Regression				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	-0.5339	0.1477	-3.6144	0.0014
ln*Y(-1)**	-0.4641	0.1514	-3.0649	0.0053
ln*X1(-1)*	0.2804	0.0914	3.0672	0.0053
ln*X2(-1)*	0.0621	0.0280	2.2198	0.0361
ln*X3(-1)*	0.1659	0.0443	3.7453	0.0010
*Dummy Var **	-0.0128	0.0045	-2.8260	0.0093
*D(**lnY**(-1))*	-0.0333	0.0231	-1.4396	0.1629
*D(**ln**Y(-2))*	-0.0357	0.0188	-1.8931	0.0705
*D(**ln**Y(-3))*	-0.0465	0.0205	-2.2662	0.0327
*D(**ln**X1)*	0.5700	0.0153	37.276	0.0000
*D(**ln**X2)*	0.1192	0.0286	4.1703	0.0003
*D(**ln**X3)*	0.3083	0.0313	9.8449	0.0000
Selected Model: ARDL(4, 0, 3, 3, 0, 3, 3, 0):Conditional Error Correction Regression				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	16.771	2.1482	7.8067	0.0000
ln*Y(-1)**	-0.7273	0.0928	-7.8376	0.0000
ln*X1_NEG**	0.5096	0.0411	12.372	0.0000
ln*X1_POS(-1)*	0.2422	0.0770	3.1422	0.0085
ln*X2_NEG(-1)*	5.2505	1.5312	3.4290	0.0050

ln**X2_POS	0.0858	0.0249	3.4474	0.0048
***ln**X3_NEG(-1)*	-7.0260	2.1574	-3.2566	0.0069
***ln**X3_POS(-1)*	0.4092	0.0730	5.6047	0.0001
*Dummy Var***	-0.0241	0.0085	-2.8078	0.0158
*D(**ln**Y(-1))*	-0.3122	0.0987	-3.1611	0.0082
*D(**ln**Y(-2))*	-0.1205	0.0799	-1.5077	0.1575
*D(**ln**Y(-3))*	-0.0403	0.0294	-1.3684	0.1962
*D(**ln**X1_POS)*	0.6724	0.0471	14.265	0.0000
*D(**ln**X1_POS(-1))*	0.3594	0.1102	3.2598	0.0068
*D(**ln**X1_POS(-2))*	0.1689	0.1009	1.6729	0.1202
*D(**ln**X2_NEG)*	-1.4798	0.4408	-3.3566	0.0057
*D(**ln**X2_NEG(-1))*	-6.7384	1.7282	-3.8989	0.0021
*D(**ln**X2_NEG(-2))*	-4.9105	1.4284	-3.4377	0.0049
*D(**ln**X3_NEG)*	1.4787	0.4178	3.5391	0.0041
*D(**ln**X3_NEG(-1))*	8.6109	2.2433	3.8384	0.0024
*D(**ln**X3_NEG(-2))*	5.5755	1.6295	3.4216	0.0051
*D(**ln**X3_POS)*	0.5161	0.0718	7.1854	0.0000
*D(**ln**X3_POS(-1))*	-0.0131	0.0542	-0.2423	0.8126
*D(**ln**X3_POS(-2))*	0.0896	0.0544	1.6466	0.1256

Dependent Variable: D(LNY), Sample: 1981 2020Included observations: 36.

Source: Own computation from the data

Appendix II: Graphs

Figure 1: CUSUM and CUSUMSQ diagnostics tests before and after structural breaks author's calculation

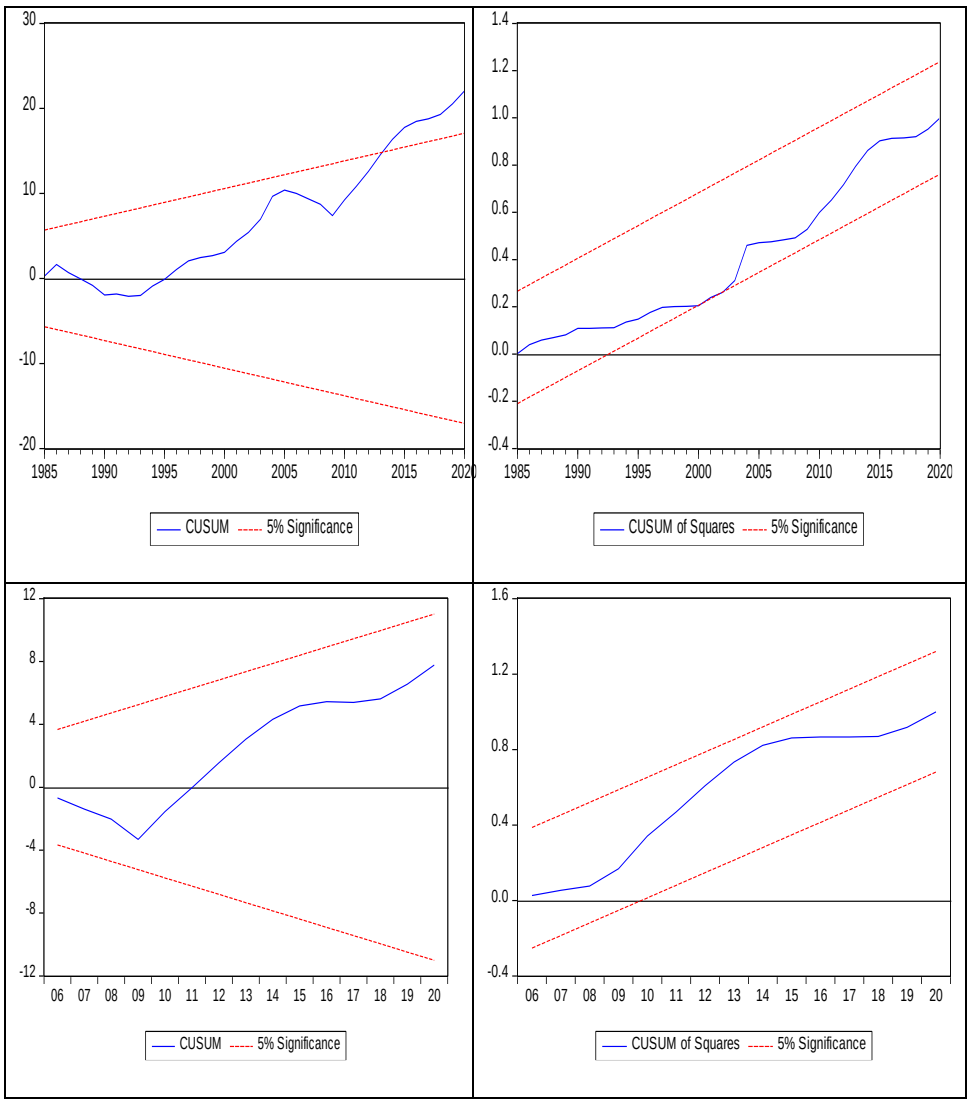
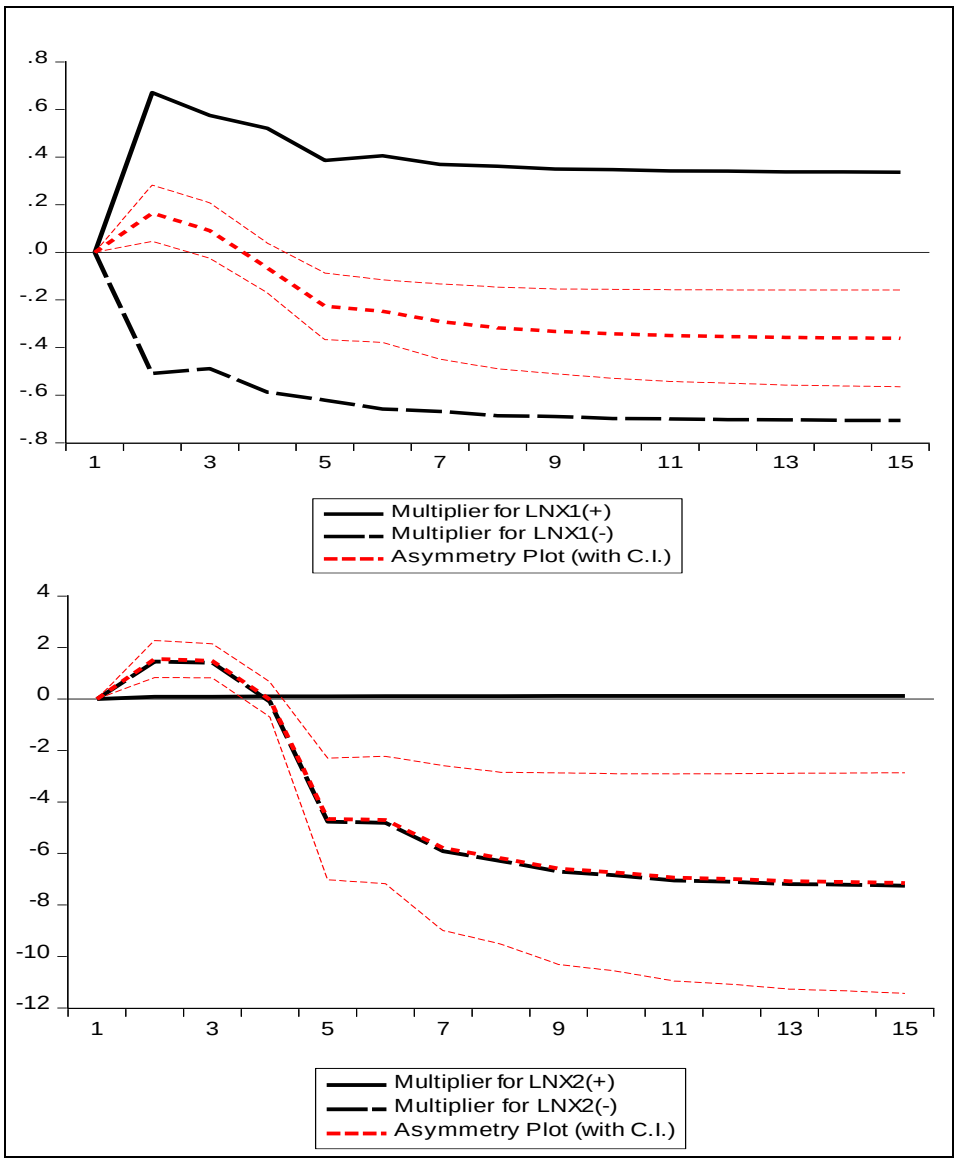


Figure 2: The Dynamic multiplier graphs of Long-run NARDL model



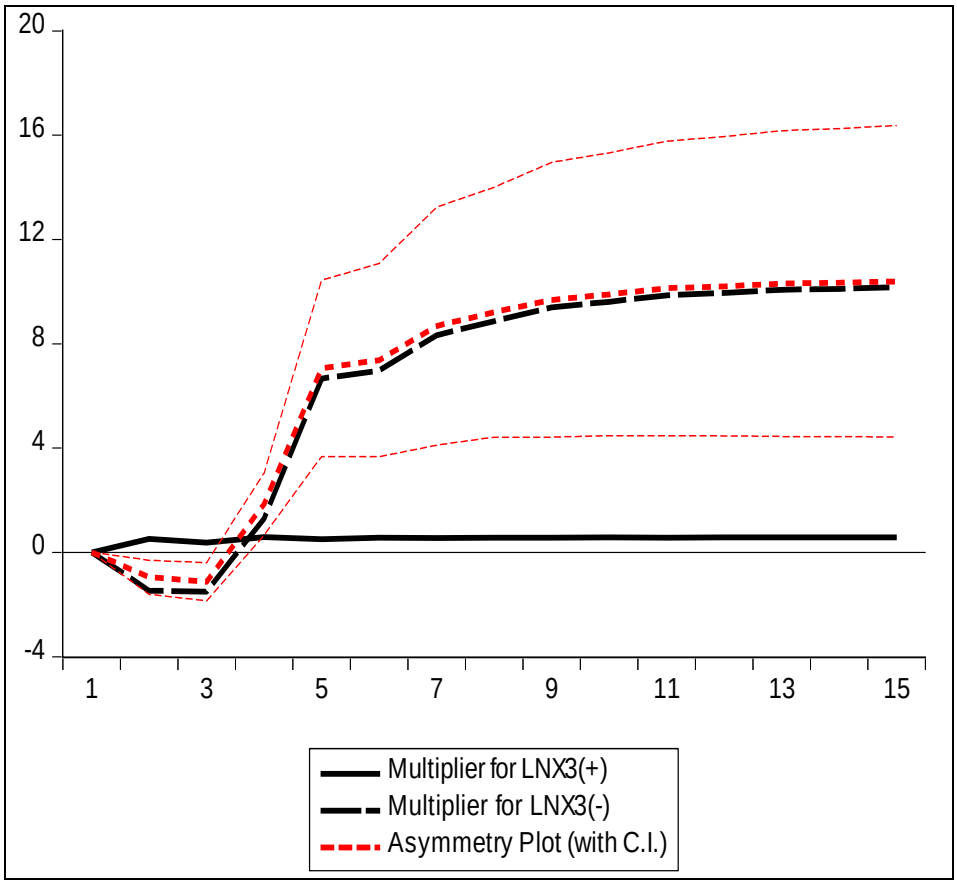

20
16
12
8
4
0
-4
1
3
5
7
9
11
13
15
Multiplier for LNX3(+)
Multiplier for LNX3(-)
Asymmetry Plot (with C.I.)

Figure 3: NARDL CUSUM and CUSUMSQ test for stability condition