Nexus between Economic Growth, Unemployment and Inflation in Ethiopia

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Abstract

Empirical literature reveals that the fast-economic growth in Ethiopia during 2004-2016, averaging 10.6 percent, was affected by inflationary and unemployment pressures. The question of how to maintain low and stable unemployment and price levels and achieve high economic growth were a puzzle for policy makers in Ethiopia. The objective of this study was to investigate the short-run and long run relationships and causalities among inflation, unemployment and economic growth in Ethiopia. The time series data from World Bank: World Development Indicator databases, for the period 1991–2016, were employed. Autoregressive Distributed Lag bounds testing for cointegration and Error Correction Model were used for the analysis. The results indicated the existence of a long run relationship among the variables. In the short-run, a single digit rise in price promotes economic growth in Ethiopia. There is a short run causality running from inflation to real Gross Domestic Product; and in the long run economic growth and inflation move together. The short run, long run and ECM estimates all agree over significance and causation: inflation and unemployment estimates have inverse and significant relationship while inflation and GDP have positive and significant relationship. The speed at which inflation returns to equilibrium after changes in unemployment and real GDP, as measured by ECM, is 112 percent, indicating the strength of the economy's ability to accommodate shocks. Since unemployment and GDP have diverse and opposite effects on inflation, policy choices need to be taken with care and vigilance.

Keywords: Real GDP, Inflation, Unemployment, ARDL, ECM, Ethiopia
JEL Classification: E31, J64, O47

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1. Introduction

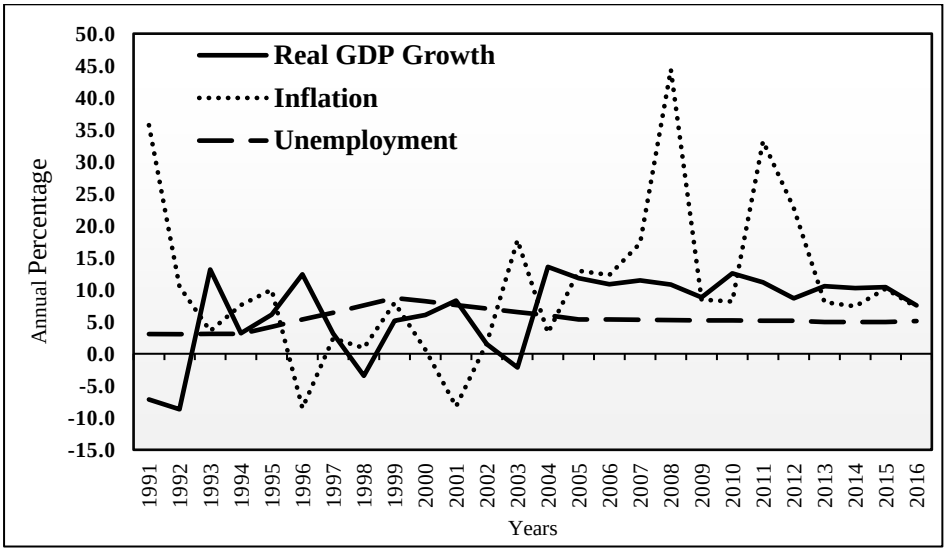
Ethiopia registered 10.6 percent economic growth, one of the fastest in Africa, for the period 2004-2016, but during the same period it was accompanied by an inflation rate of 15 percent and an unemployment rate of more than 17 percent (WB: WDI, 2018).

There are different theories and empirical testimonies on the relation between major macroeconomic variables such as economic growth, inflation and unemployment. In the short run, according to Phillips (1958) and Dornbusch et al (2011), inflation and unemployment have an inverse relationship. Classical economists observe no relationship between inflation and unemployment in the long run, further emphasizing that inflation is caused by alterations in the supply of money. Monetary economists were of the opinion that inflation was a monetary phenomenon (Friedman, 1968); and Keynesians (Keynes, 1936), regarded inflation as an aftermath of increases in money supply.

During 1990s Ethiopia experienced economic stagnation. In 1990/1991 the Ethiopian economy registered a 7.2 percent decline in Gross Domestic Product (GDP), with 12 percent unemployment, 35.7 percent inflation and a budget deficit/GDP ratio of 29 percent (WB: WDI, 2018). Owing to the economy's reliance on nature and external shocks, the Ethiopian economy is characterized by unpredictable growth in output (Alemayehu, 2008). Because agriculture accounted for more than half of GDP for the majority of the recent past, when weather conditions deteriorated, agricultural production fell and GDP fell with it. A systematic price trend resulted from the systematic relationship between GDP and rainfall. Prices followed the inverse trend of output growth. During years of abundant rainfall, as output rises, prices frequently fall precipitously. Even within a single year, prices have been low during harvest seasons (Alemayehu and Kibrom, 2011). Since 2004, Ethiopia has marked double-digit steady economic growth. Unfortunately, that achievement was attended by the challenges of inflation and unemployment (Demissie, 2008; Kassahun, 2002 and NPC, 2016). It is alleged to be deeply rooted in academics and policymaking that a boost in the economy leads to a reduction in unemployment. Although many factors contribute to variation in output, unemployment is singled out as the most important because it has a direct impact on output.

Unemployment and underemployment are features of the informal labour market in Ethiopia. Unemployment has undesirable social, economic and psychological effects. In least developing countries such as Ethiopia in which physical capital is in short supply, labour resources play a significant role in economic growth. However, a sizeable portion of the labour force in Ethiopia is unemployed. Indeed, unemployment caused by political instability, operational problems in industry, volatile investment and a large and growing flow of new graduates into the labour market from an increasing number of higher educational institutions, have been widespread phenomena in Ethiopia for several decades (Gizaw, 2016).

Figure 1: Inflation, unemployment and GDP growth in Ethiopia



Source: WB: WDI, 2018

In Figure 1, the inflation, unemployment and GDP growth trend show how the economy has fluctuated. From WB: WDI (2018) data from 1991-2016 in Figure 1, it is evident that the average growth rate of GDP in Ethiopia was 6.8 percent, lower than the 10.7 percent average growth rate of inflation. The inflation rate, described by average consumer prices in Ethiopia jumped from its 1.7 percent level in 2002 to 17.8 percent in 2003 and a record rate of 44.4 percent during the 2008's world financial crises. After two years of single digit inflation, prices skyrocketed to 33.3 percent in 2011, possibly the result of the exchange

rate devaluation carried out in 2010. The unemployment level in Ethiopia remained high after the downfall of the Derg government in 1991 and increased further in the mid 1990's. It again showed a tendency to rise in 2009-2010 following the global financial crisis. However, as of Figure 1, since 2004, with the country's broad-based and continued achievement of double-digit economic growth, the overall unemployment rate has slightly declined (WB: WDI, 2018).

The economic fluctuations observed in last couple of decades necessitated the importance of taking measures by government to provide efficiencies of allocation, distribution and stabilization. Fiscal and monetary policies in Ethiopia have been unable to realize the combined targets of economic growth, price stability and lower unemployment levels all together. The aim and intention of managing the economic fluctuations has underlined the rationale of increasing government intervention with its fiscal and monetary policy measures; however, the Ethiopian government has not been in a position to treat the troubles of the economy successfully[3].

Even though the economic fluctuations endure and the choice of appropriate policy difficulties related to output, unemployment and inflation relationships persist in Ethiopia, the magnitude of effect, short run and long run causalities, and the statistical significance of those relationships, have not been properly addressed. Yet, policy makers in Ethiopia would be able to use the findings of this study as an input for policy design and intervention. Also, this study on the relationship among output, unemployment and inflation could be expected to add to the literature in the area. To the best of the researchers' knowledge, research encompassing unemployment, inflation and economic growth together have not been carried out in Ethiopia. The studies conducted so far have either covered the relationship between economic growth and inflation, or between unemployment and economic growth. The intention of this study was, therefore, to identify the type and nature of the relationships that exist among those three central macroeconomic indicators. Specifically, the study intended:

- To determine the short-run and long run relationships among inflation, unemployment and economic growth in Ethiopia, and
- To examine the causalities (unidirectional, bi-directional or absence of causality) of inflation, unemployment and economic growth in Ethiopia.

[3] See NPC (2016).

2. Literature Review

The interrelationship among economic growth, unemployment and inflation are governing by the two famous concepts of Okun's law and Phillips's curve.

Okun's law, the empirical relation between unemployment and output, states that if GDP grows rapidly, the unemployment rate declines and if growth is very low or negative, the unemployment rate rises. When the actual growth equals the potential, unemployment rate remains unchanged (Okun, 1962). That law by Okun indicates a short run inverse relation of cyclical unemployment rate and economic growth in the United States of America economy in the period from 1947 to 1960 (Okun, 1962). Since the inception of Okun's law, several studies have been done to validate Okun's coefficient. Some have adopted a single country approach (Caraiani, 2006; Evans, 1989 and Weber, 1995); others consider a pool of countries (Fouquau, 2008) and regional data (Guisinger, et al, 2015 and Freeman, 2000). A remarkable stable result was observed in the United States, but in OECD countries, the estimates have been less stable.

The Phillips curve is a single-equation economic model named after William Phillips that hypothesizes a stable and inverse relationship between rates of unemployment and corresponding rates of wage rises in an economy. According to the theory, economic growth leads to inflation, which leads to more jobs and lower unemployment. Furthermore, the Phillips curve concept states that changes in unemployment within an economy have a predictable effect on price inflation (Phillips, 1958). Studies related to the supposedly inverse relationship between inflation (wage) and unemployment have also been conducted. Stock and Watson (1999) used the conventional Phillips curve to investigate the forecasts of the United States. Inflation at the 12-month horizon and inflation forecasts produced by Phillips's curve have generally been more accurate than forecasts based on other macroeconomic variables. In a related study, Popovic and Popovic (2009) on a comparative analysis of Phillips regularity in the European Union for the period 1998-2007, using a correlation analysis, found an inverse relation of unemployment and inflation.

The work of Fakhri (2011) on the connection between economic growth and inflation in Azerbaijan provides a nonlinear link of those variables with the threshold level of 13 percent. In China, Chang-Shuai and Zi-Juan (2012) researched the link among inflation, unemployment and economic growth by

applying time series models. They found out that unemployment and inflation affected economic growth negatively and positively, respectively. Regarding the short run causality, they observed a two-way causality between economic growth and inflation, a one-way causality between economic growth and unemployment, and no causality between inflation and unemployment.

In Nigeria, a study focused on the links among economic growth, inflation and unemployment (Mohammed et al., 2015). The long run ordinary least squares analysis found that unemployment and inflation had a negative effect on economic growth. Guglielmo and Marinko (2011) employed a panel co-integration method and causality tests by pooling data from 119 countries for the period 1970-2010 to assess the short run and long run linkages among employment, inflation and output. It revealed that employment and output were caused by inflation positively in the short run and negatively in the long run.

Studies in Ethiopia have specifically focused analysis either on the relationship between inflation and economic growth, unemployment and economic growth or one of the variables only, not on the relationship of all three indicators together. In addition, the analytical procedures and datasets adopted in those studies have been diverse. Findings have been contradictory.

Gizaw (2016) assessed the relationship between inflation and economic growth in Ethiopia using co-integration and an Error Correction Model (ECM) for the period from 1991 to 2014. The results indicated the existence of a long run relationship in which the causality runs from economic growth to inflation. The error correction term in the study showed that any disequilibrium in a given period would adjust back to equilibrium by 80.3 percent.

The multiple regression analysis results of Asayehgn (2009) on the relationship between economic growth and inflation concluded that the main determinants of inflation in Ethiopia are imports, depreciation of the Ethiopian Birr (ETB), and a decline in the domestic lending interest rates or an increase in broad money supply. A study by Nandeeswara and Abate (2015) on inflation and economic growth used the framework of VAR, ECM, and causality test and threshold level analysis using annual data covering the period from 1974 to 2012. The results provided a short run and long run connection and bidirectional causality between inflation and economic growth. A recommended level of 9-10 percent threshold inflation level was among the findings.

Even if unemployment has been prevalent in urban centres in Ethiopia, Nzinga and Tsegay (2012) found that national youth unemployment had steadily

fallen since 1999. Women, however, had not benefited from this reduction, and this could possibly explain the severity of poverty prevailing among households headed by females in urban Ethiopia (Jayamohan and Amenu, 2014).

Gizaw (2016), Nandeeswara and Abate (2015) and Asayehgn (2009) focused only on the relationship between inflation and economic growth; unemployment was not included in their work. Nzinga and Tsegay (2012) focused on the youth labour market and their study did not cover the relationship of employment with inflation and economic growth. Contrary to these studies, this study extends the analysis of the association of the variables by bringing in unemployment, one of the significant variables in macroeconomic analysis, and including all the three variables together.

3. Research Method

3.1 Data

This study has employed World Bank (WB) World Development Indicator (WDI) data. It considered the data of three main economic indicators, namely: economic growth, unemployment, and inflation in Ethiopia for the period 1991 to 2016.

3.2 Model Specification

The study adopted the basic Okun's law upon some modifications to offer a sound reflection on the relationship of the main macroeconomic indicators. By assuming a linear relationship among the rate of growth of GDP, unemployment and inflation, the model looks like the following:

$$Rgdp = \beta_0 + \beta_1 Unempl + \beta_2 Infl + u \quad \textbf{(1)}$$

Where: $Rgdp$- The annual percentage growth rate of GDP at market prices based on constant currency is referred to as the real GDP growth rate (Mankiw, 2013).

$Real\ GDP\ Growth\ Rate = \frac{Y_t - Y_{t-1}}{Y_{t-1}} * 100$, Where: Y_t–current year GDP and Y_{t-1} - previous year GDP.

$Unempl$ – unemployment rate, it refers to the share of the labour force that is without work but available for and seeking employment.

$$Unemployment\ Rate = \frac{Unemployed\ People}{Labor\ Force}$$ (Dornbusch et al., 2011).

$Infl$ – inflation rate, the Consumer Price Index (CPI) reflects the annual percentage change in the cost of acquiring a basket of goods and services to the average consumer.

$$Inflation\ Rate = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} * 100,$$

Where: CPI_t- current *CPI*, CPI_{t-1} - preceding year *CPI* (Romer, 2012) and u- error term.

***Testing Stationary*:** The first task in analysing econometric time series data is the testing for the presence of unit roots. The normal stochastic process is fully specified by its two moments, the mean and the variance (Gujarati and Porter, 2008). Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests were used in this study to test the status of unit root in data series (Dickey and Fuller, 1979, 1981 and Phillips and Perron, 1988). The ADF test is presented as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} \sum_{i=1}^{n} \beta_1 \Delta Y_t + \varepsilon_t \qquad \textbf{(2)}$$

Where: Y- linear time series, *n*- optimum number of lags and ε- random error term.

Autoregressive Distributed Lag (ARDL) bounds testing for co-integration: This study used Akaike Information Criterion, Schwarz Information Criterion, and Hannan-Quin Information, which are the widely applied criteria for selecting the lag order. If the unit root tests demonstrate a mixture of various orders of integration such as I(0) (order of integration at level) and I(1) (order integrations at first difference), the ARDL bounds testing technique is an appropriate tool to estimate the status of long run relationship among the variables (Pesaran, 1997; Pesaran and Shin, 1999 and Pesaran et al., 2001). The single reduced form ARDL bounds testing equation that simultaneously estimate long run and short run parameters is specified as follows:

$$\Delta \mathrm{GDP_t} = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta \mathrm{GDP_{t-i}} + \sum_{i=0}^{m} \alpha_{2i} \Delta UNEMPL_{t-i} + \sum_{i=0}^{q} \alpha_{3i} \Delta INFL_{t-i} + \delta_{1i} \mathrm{GDP}_{t-1} + \delta_{2i} \mathrm{UNEMPL}_{t-1} + \delta_{3i} \mathrm{INFL}_{t-1} + \varepsilon_{it} \quad \textbf{(3)}$$

***Granger causality tests*:** These examine whether a variable with its lagged values has any predicting ability on another variable. The F-statistic value determines the parameter under consideration is zero or different from zero (Granger, 1969). It was employed in this study to examine the causal relationship among economic growth, unemployment and inflation.

***Error Correction Model*:** An ECM is intended to estimate a long run co-integration of variables. It explains the achievement of the long run equilibrium of endogenous variables through short run adjustments. The co-integration term, known as error correction term, works to correct the deviation from the long run equilibrium through short-run adjustments. Given the variables are co integrated, the error correction term should be entered into the system to avoid misspecification of constraints. Thus, as of Lütkepohl (2005) ARDL can be reparametrized as ECM and the model is:

$$\Delta \mathrm{GDP_t} = \alpha_0 + \sum_{i=1}^{q} \beta_{1i} \Delta GDP_{t-i} + \sum_{i=0}^{m} \beta_{2i} \Delta UNEPL_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta INFL_{t-i} + \lambda \mathrm{ECT}_{t-1} + \varepsilon_t \quad \textbf{(4)}$$

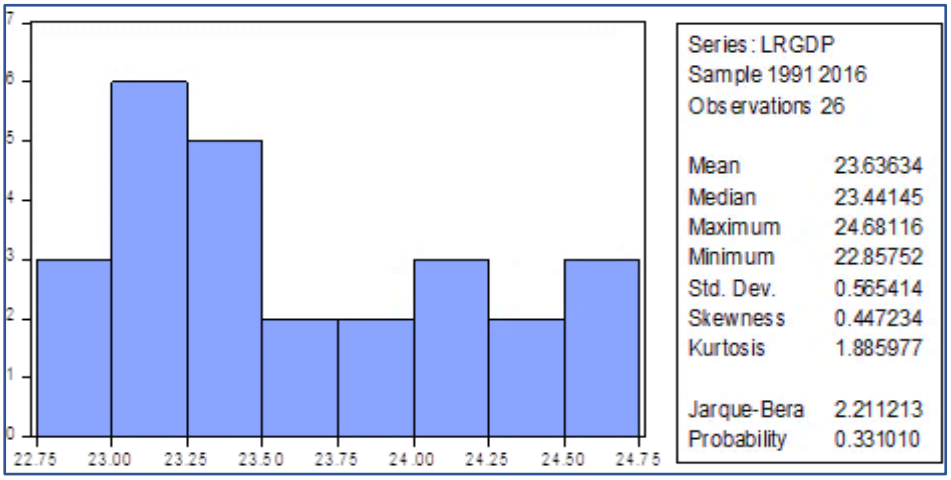
Where: ECT_{t-1}- error correction term, λ–the speed of adjustment parameter is negative and statistically significant as a condition for long run co-integration (Kremers et al., 1992)

***Diagnostics test*:** The pre- and post- estimation tests applied in this study include: a serial correlation test (Breusch, 1978 and Godfrey, 1978) and heteroscedasticity test (Pearson, 1905; Goldberger, 1964 and Johnston, 1972). In addition, Jarque-Bera normality (Jarque and Bera, 1980), and the Cumulative Sum of Recursive (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) (Brown et al., 1975) tests were used to check the data distribution and post-estimation stability, respectively.

4. Results and Discussion

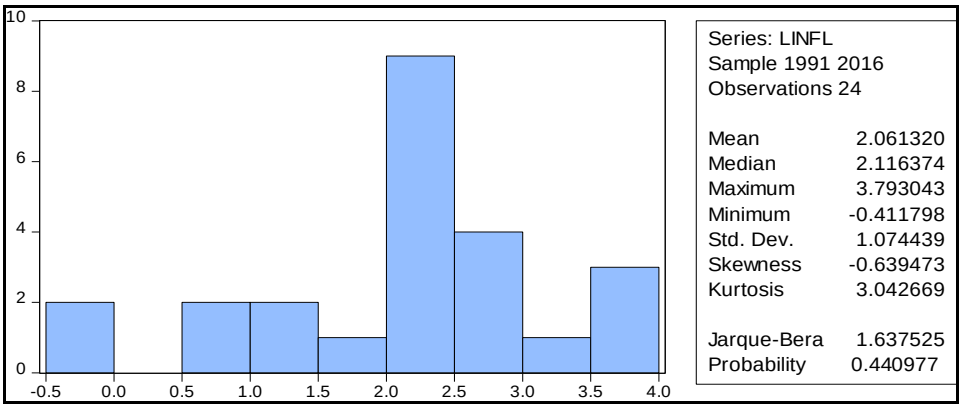
Figure 2 shows the descriptive statistics of Natural logarithm (L) Real Gross Domestic Product (LRGDP), Inflation Rate (LINFL) and Unemployment Rate (LUNEMPL). Of the three, the highest dispersion during the period was for inflation. In this study, the unemployment rate and inflation rate were expressed as percentages, and GDP was expressed in billion US$. To standardize the scales, all variables were converted from level to natural logarithmic form prior to analysis. Furthermore, the Jarque-Bera[4] normality test statistics in Figure 2 showed that compared to the actual data distribution, the data series in the natural logarithm form[5] were normally distributed.

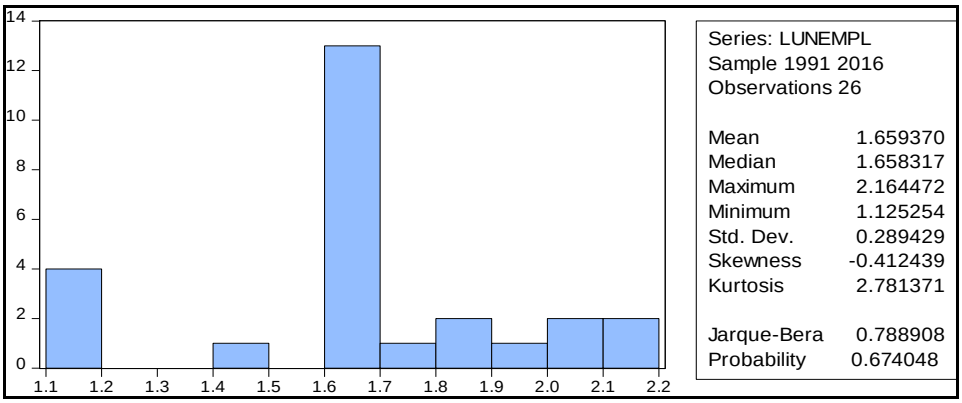
Figure 2: Real GDP, inflation and unemployment during 1991-2016



[4] We reject the null hypothesis of normal distribution when the probability level is less than 5%.

[5] Changing the series to natural logarithmic form is one method for converting the data to a normal distribution.





4.1 Unit Root Test

To examine whether the data series contains a unit root or not, the ADF test was used at level and first difference. The results in Table 1 indicate that LRGDP and LINFL were I(1) order of integration, i.e. stationary at first difference and LUNEMPL was stationary at level, I(0) order of integration.

Table 1: Augmented Dickey-Fuller test

Variables	Level	1st difference
LRGDP	(-1.741484) [0.7021]	(-3.699606) [0.0430]**
LINFL	(0.625797) [0.9969]	(-4.697650) [0.0208]**
LUNEMPL	(-4.910994) [0.0041]*	

Note: * and ** symbolize rejection of the null hypothesis (unit root) at 1% and 5% level of significance, respectively.

: ( ) and [ ] *present* Augmented Dickey-Fuller t-statistic and probability values, respectively.

4.2 Bounds Test for Co-integration

Since the variables in the model of this study are stationary at varied orders of integration, the ARDL bounds test for co-integration method is the appropriate tool to observe the long run relationship. To conduct the test, the maximum lag length for each variable was determined based on the lag order selection criteria. As shown in Appendix 1, the maximum lag length for real GDP, inflation and unemployment, were found to be three, zero, and two respectively. The co-integration test results in Table 2 showed a long run relationship among inflation, unemployment and real GDP. The F-statistic and t-statistic values indicated the existence of the long run relationship when the inflation rate was used as the dependent variable.

Table 2: Bounds test for co-integration

Dependent variable	F-statistic and t –statistic	Co-integration	Estimation procedure
LRGDP	F_{LRGDP} = 1.917001, t_{LRGDP}= 1.919901	NO	ARDL (Short run model)
LINFL	F_{LINFL} = 6.535460, t_{LINFL} = -4.380743	YES	ECM (Long run model)
LUNEMPL	$F_{LUNEMPL}$ = 1.661981, $t_{LUNEMPL}$= -1.747666	NO	ARDL (Short run model)

4.3 Short Run Estimates

Short run estimation results are presented in Table 3 by considering LRGDP as the dependent variable. The variables are denoted by differences and lags of different period such as D(LRGDP(-1))[6], D(LRGDP(-2)) and D(LRGDP(-3)). In the short run, inflation and real GDP exhibit a causal relationship. They are positively related and the coefficients are statistically significant. A Wald test was also used to examine the short run causation and direction of causality. As shown in Table 4, the Wald test's hypothesis that inflation lags do not jointly affect real GDP was rejected at five percent significance level.

The short run estimates and the Wald test results in Table 3 and Table 4 indicate inflation affects economic growth. A moderate rise in price supplements returns to savers, enhances investment and improves productivity. A small

[6] The differenced real GDP lagged by one period.

increase in prices encourages consumers to buy goods and services. It then, rises aggregate demands and the growth rate of the economy. A low inflation rate is also accompanied by low interest rates which increase investment activities and productivity. Therefore, the economic growth and price relationship is justified by a situation where a single digit rise of price promotes short run economic growth[7]. Furthermore, as shown in Table 4, the first and second lags of LRGDP positively and significantly affect LRGDP itself at 5 percent significance level, though after the third lag the effect turns out to be negative.

Table 3: Short run estimates of real GDP

Dependent Variable: D(LRGDP):

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C[8]	-0.062005	0.045539	-1.361594	0.2450
D(LRGDP(-1))	1.107034	0.305906	3.618874	0.0224
D(LRGDP(-2))	0.785757	0.275846	2.848532	0.0465
D(LRGDP(-3))	-0.275950	0.095459	-2.890761	0.0445
D(LINFL(-2))	0.007032	0.002422	2.903351	0.0440
D(LINFL(-3))	0.007470	0.002111	3.538585	0.0240
D(LUNEMPL(-1))	0.425918	0.103927	4.098258	0.0149
R-squared	0.963278	Mean dependent var		0.095117
Adjusted R-squared	0.880653	S.D. dependent var		0.016969
S.E. of regression	0.005862	Akaike info criterion		-7.264745
Sum squared resid.	0.000137	Schwarz criterion		-6.808276
Log likelihood	60.85322	Hannan-Quinn criterion		-7.307000
F-statistic	11.65845	Durbin-Watson stat		2.577853
Prob(F-statistic)	0.015307			
Breusch-Godfrey Serial Correlation LM Test: 12.26640 (0.2062)				

[7] The threshold level of inflation has been reported as 9-10 percent.

[8] Coefficient of constant term.

Table 4: Wad Test (Joint effect of inflation on LRGDP)

Dependent variable (LRGDP)
Null Hypothesis: C(5)=C(6)=C(7)=0

Test Statistic	Value	df	Probability
F-statistic	12.11794	(3, 4)	0.0178
Chi-square	36.35382	3	0.0000

In the short run, real GDP and inflation are negatively related to unemployment and the coefficients are statistically significant (Table 5). Likewise, real GDP and inflation lags that do not jointly affect unemployment were rejected at five percent significance level. As presented in Table 5, the Wald test confirms the joint lags of real GDP and inflation to have a negative effect on unemployment.

Table 5: Wad Test (Joint effect of LRGDP on unemployment and inflation on unemployment)

LRGDP to Unemployment
Null Hypothesis: C(4)=C(5)=0

Test Statistic	Value	df	Probability
F-statistic	11.68537	(2, 10)	0.0024
Chi-square	23.37075	2	0.0000
Inflation to Unemployment Null Hypothesis: C(6)=C(7)=0			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	3.439941	(2, 10)	0.0730
Chi-square	6.879881	2	0.0321

The above results are in line with the inverse relationship between unemployment and output of Okun's law. The Phillips curve, which works along the short run aggregates supply curve, describes the empirical trade-off between unemployment and inflation.

Short run estimation was tested using various pre- and post- diagnostics tests such as Breusch-Godfrey serial correlation, heteroscedasticity and stability. The results in Table 3 and 6 exhibits the absence of serial correlation in the data series. Furthermore, the CUSUM and CUSUMSQ tests were employed to detect the post-stability of the estimation. As shown in Appendix 2, the plots do not cross the five percent critical lines, implying the existence of stability of estimated coefficients over the sample period of investigation.

Table 6: Short run estimate of unemployment

Dependent Variable: D(LUNEMPL)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.313116	0.092633	3.380189	0.0070
D(LUNEMPL(-1))	0.411766	0.215160	1.913773	0.0847
D(LUNEMPL(-2))	-1.076143	0.318747	-3.376169	0.0070
D(LRGDP(-1))	-3.390371	0.851147	-3.983296	0.0026
D(LINFL(-2))	-0.036975	0.014221	-2.599941	0.0265
R-squared	0.806636	Mean dependent var		0.014447
Adjusted R-squared	0.690618	S.D. dependent var		0.102748
S.E. of regression	0.057151	Akaike info criterion		-2.593348
Sum squared resid.	0.032662	Schwarz criterion		-2.250261
Log likelihood	29.04346	Hannan-Quinn criterion		-2.559245
F-statistic	6.952655	Durbin-Watson stat		1.956654
Prob(F-statistic)	0.003999			
Breusch-Godfrey Serial Correlation LM Test: 0.474215 (0.6388)				

4.4 Granger Causality Analysis

The Granger Causality test results in Table 7 show the effect of variables on one another. The test was performed to predict whether the former variable Granger causes the later variable or otherwise. Accordingly, the hypothesis that a real GDP Granger causes unemployment was acceptable at one percent significance level. On the other hand, the hypothesis that an unemployment Granger causes and predicts inflation was significant at 8 percent level. When unemployment is low, more consumers have extra money to spend on goods.

Demand for goods rises, and as demand rises, so do prices. Customers purchase fewer goods during periods of high unemployment, which puts downward pressure on prices and reduces inflation. It also shows unemployment to have weak predicting power for inflation but inflation itself does not predict unemployment. There was also short run causality that runs from inflation to real GDP at five percent significance level. All the causalities found at this point are unidirectional, which in turn pave a way for policy makers to design targets for short run macroeconomic objectives.

Table 7: Granger Causality Tests

Pairwise Granger Causality Tests	**Lags: 3**	
Null Hypothesis:	**F-Statistic**	**Prob.**
D(LRGDP) does not Granger Cause D(LUNEMPL)	12.3933	0.0002*
D(LUNEMPL) does not Granger Cause D(LRGDP)	2.15030	0.1366
D(LINFL) does not Granger Cause D(LUNEMPL)	1.57380	0.3063
D(LUNEMPL) does not Granger Cause D(LINFL)	4.22840	0.0773***
D(LINFL) does not Granger Cause D(LRGDP)	9.72810	0.0158**
D(LRGDP) does not Granger Cause D(LINFL)	0.16199	0.9175

Note: *, ** and *** symbolize statistically significance at 1%, 5% and 10% levels, respectively

4.5 Long Run Estimates

Regression results of long run estimates indicate that unemployment and real GDP coefficients are statistically significant. Real GDP contains positive coefficient, indicating GDP and inflation to grow together. When economic activities rise by one percent, the price level in the economy increases by 0.7 percent. General government total expenditure in Ethiopia rose from 4.9 billion ETB in 1991 to 280.7 billion ETB in 2016, with a sharp increase starting from 2005-2016 (IMF, 2018). The upsurge in government expenditure suggests that the recent Ethiopian government expansion of fiscal policy coupled with the fast growth in the country leading to excess demand for goods and services, could be reasons for the persistent annual increase in inflation. Besides the effect of cost inflation, price power inflation and sectoral inflation would be the contributing factors.

Table 8: Long run estimations

Dependent Variable: LINFL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-11.26715	7.890415	-1.427954	0.1680
LRGDP	0.690416	0.337824	2.043715	0.0537**
LUNEMPL	-1.832380	0.671656	-2.728153	0.0126*
R-squared	0.323726	Mean dependent var		2.061320
Adjusted R-squared	0.259319	S.D. dependent var		1.074439
S.E. of regression	0.924692	Akaike info criterion		2.797757
Sum squared resid.	17.95617	Schwarz criterion		2.945014
Log likelihood	-30.57308	Hannan-Quinn criterion.		2.836824
F-statistic	5.026251	Durbin-Watson stat		2.086447
Prob(F-statistic)	0.016455			
JB –1.509976 (0.470016)				
Heteroskedasticity Test: Breusch-Pagan-Godfrey - 1.897033 (0.1748)				
Breusch-Godfrey Serial Correlation LM: Test - 0.171270 (0.6834)				

Note: * and ** symbolize statistically significance at 5% and 10% levels, respectively.

The F-statistic value of 5.02 represents the two explanatory variables which are jointly accountable for inflation change in the long run. The estimated model is free from serial correlation and heteroscedasticity.

Figure 3 presents the Jarque-Bera statistic of 1.51 with P-value of 0.47, so the data series is normally distributed. Furthermore, the CUSUM and CUSUMS plots as presented in Figure 4 do not cross the five percent critical lines, which implies the existence of stability of variables over the entire sample period of investigation.

Figure 3: Normality test of long run estimates

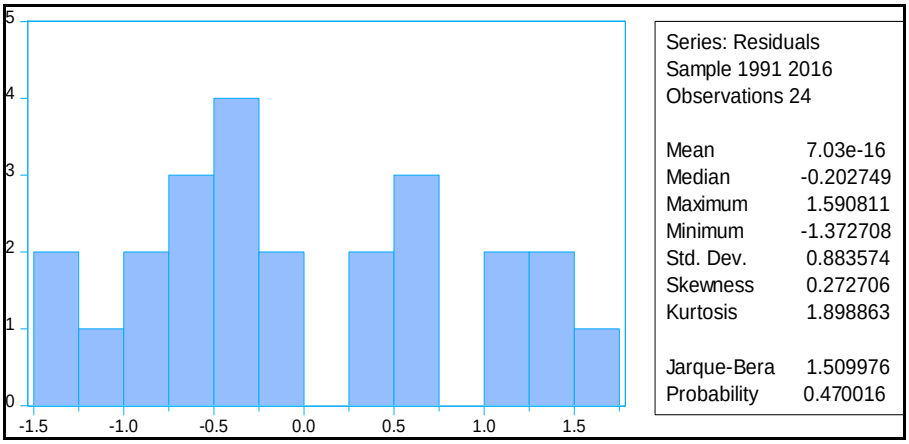
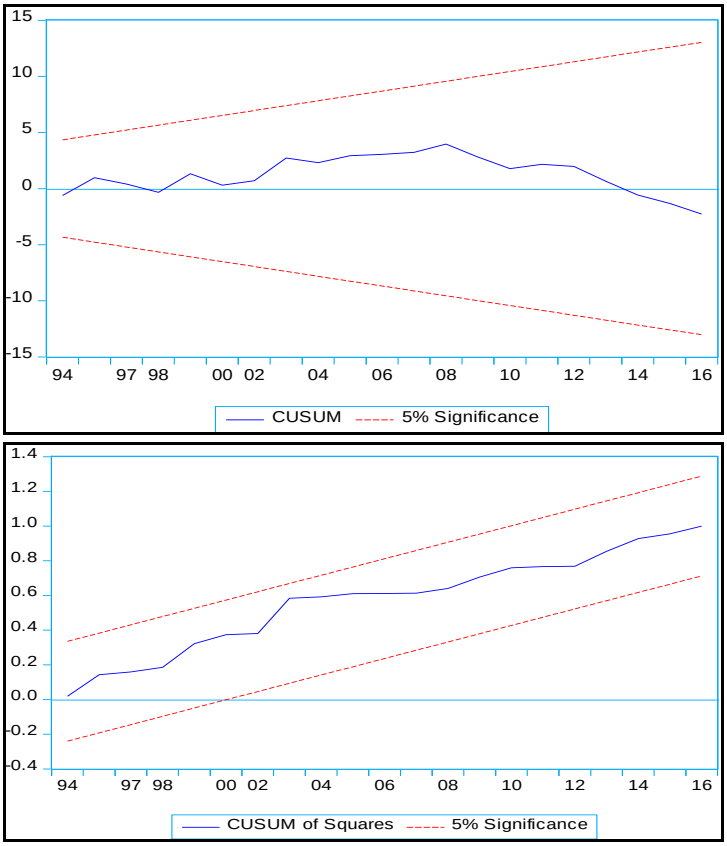


Figure 4: Stability tests of long run estimates of inflation, real GDP and unemployment



4.6 Long Run Equilibrium and Short Run Adjustments

ECM is an amalgamation of short run equation and long run representation. The regression coefficient and probability values in Table 9 exhibit a negative and statistically significant error correction term at one percent level, proving the existence of the long run relationship and short run dynamics. The speed of adjustment of the whole system from short run deviation to long run equilibrium is 1.122. The system is being adjusted towards long run equilibrium at the speed of 112 percent. A study by Gizaw (2016) has indicated 80.3 percent speed of adjustment to long run in Ethiopia. The ECM (-1) explains the previous period's deviation from long run equilibrium influence short-run movement in the dependent variable. In the last two and half decades, the Ethiopian economy has been hit by a series of policy and non-policy shocks; however, as the ECM result demonstrates, the effect of these shocks was not persistent.

Table 9: Error Correction Model results

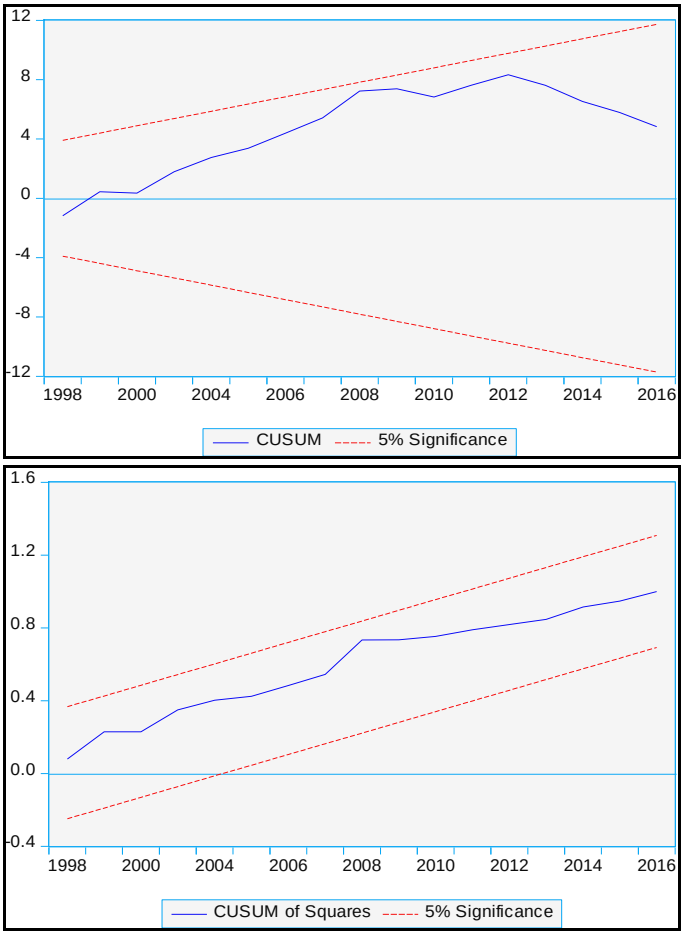
Dependent Variable: D(LINFL)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005157	0.352716	0.014621	0.9885
D(LRGDP)	0.993794	3.884987	0.255804	0.8012
D(LUNEMPL)	-2.315229	2.565732	-0.902366	0.3795
ECM(-1)	-1.121449	0.263570	-4.254837	0.0005*
R-squared	0.519296	Mean dependent var		2.061320
Adjusted R-squared	0.434466	S.D. dependent var		1.074439
S.E. of regression	0.962723	Akaike info criterion		2.797757
Sum squared resid	15.75620	Schwarz criterion		2.945014
Log likelihood	-26.78118	Hannan-Quinn criterion		2.836824
F-statistic	6.121600	Durbin-Watson stat		2.086447
Prob(F-statistic)	0.005118			
JB –1.226526 (0.541581)				
Heteroskedasticity Test: Breusch-Pagan-Godfrey - 0.171861(0.9139)				
Breusch-Godfrey Serial Correlation LM: Test - 0.084609 **(**0.7749**)**				

Note: *symbolizes the error correction model is negative and statistically significant at 1% level.

As observed in Table 9, there are no serial correlation and heteroscedasticity problems in the model estimation. The Jarque-Bera statistic value is 1.23 with P-value of 0.54, implying the data is normally distributed. Figure 5 indicates that the post-estimation procedure is stable; this allows us to rely on the estimated coefficients for policy-making.

Figure 5: Stability tests of ECM estimates (inflation, real GDP and unemployment)



The estimates show that inflation and unemployment have significant inverse relations, and that inflation and GDP have a significant and positive relationship. The speed at which inflation has returned to equilibrium after changes in unemployment and real GDP and after economic shocks, has been

impressively fast. It implies the Ethiopian economy has been experiencing fluctuations in the past two and half decades. However, the main economic activities have quickly been able to return to long run equilibrium. Nevertheless, since unemployment and real GDP have diverse effects on inflation, policy decisions on the matter require proper attention. The government and policy making institutions in Ethiopia should adopt a combination of fiscal, monetary, price and income polices for careful analysis and close observation.

5. Conclusions

Growth in Ethiopia in recent decades has been strongly influenced by unemployment and inflation rates. The objective of this study was to find the nature of the relationship between central macroeconomic indicators. The data set covered the period from 1991 to 2018. ARDL bounds testing for co-integration methods was used for analysis. The short run model and Wald test results indicated a subsequent single digit rise in price promoted short run economic growth in Ethiopia. The short run results were in line with the inverse relationship between unemployment and output and the trade-off between unemployment and inflation of Okun's law and Phillips's curve, respectively. All causalities found were unidirectional, which offers a way for policy makers to design suitable targets for short run macroeconomic objectives. In the long run, output and inflation rise together. This can be explained by the expansionary policies adopted by the government and the fast-economic growth's increasing demand for goods and serves. The Bounds test for co-integration results demonstrated the existence of a long run relationship among the variables. The speed, as measured by ECM terms, at which inflation returns to equilibrium after changes in real GDP and unemployment, is 112 percent. This study, by including unemployment in the model and extending the time to 2016, found out that the economic fluctuations and shocks Ethiopia has experienced can be cured by fast restoration of the economy to long run. However, since unemployment and real GDP have diverse effects on inflation both in the short and the long term, fiscal-monetary policy choices need careful and vigilant decisions.

List of Abbreviations

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag
CPI	Consumer Price Index
CUSUM	Cumulative Sum of Recursive
CUSUMSQ	Cumulative Sum of Squares of Recursive Residuals
ECM	Error Correction Model
ETB	Ethiopian Birr
GDP	Gross Domestic Product
LINFL	Natural logarithm Inflation Rate
LRGDP	Natural logarithm Real Gross Domestic Product
LUNEMPL	Natural logarithm Unemployment Rate
PP	Phillips-Perron
US$	United States Dollar
WB: WDI	World Bank: World Development Indicator

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List of Appendices

Appendix 1: Lag Order Selection Criteria

Endogenous variables: LRGDP

Exogenous variables: C LINFL LUNEMPL

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.442186	NA	0.104105	0.572862	0.721984	0.598099
1	37.54221	63.13326	0.001725	-3.530759	-3.331930	-3.497109
2	37.83153	0.426362	0.001871	-3.455950	-3.207414	-3.413888
3	41.62070	5.185177*	0.001409*	-3.749547*	-3.451303*	-3.699072*
4	42.20343	0.736081	0.001493	-3.705624	-3.357673	-3.646737
5	42.21685	0.015545	0.001689	-3.601774	-3.204116	-3.534474

* 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

Endogenous variables: LINFL

Exogenous variables: C LRGDP LUNEMPL

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-21.67020	NA*	0.910643*	2.741133*	2.889529*	2.761595*
1	-21.56108	0.169746	1.009831	2.840120	3.037980	2.867402
2	-21.38638	0.252344	1.115086	2.931820	3.179145	2.965923

* Indicates lag order selected by the criterion

Endogenous variables: LUNEMPL

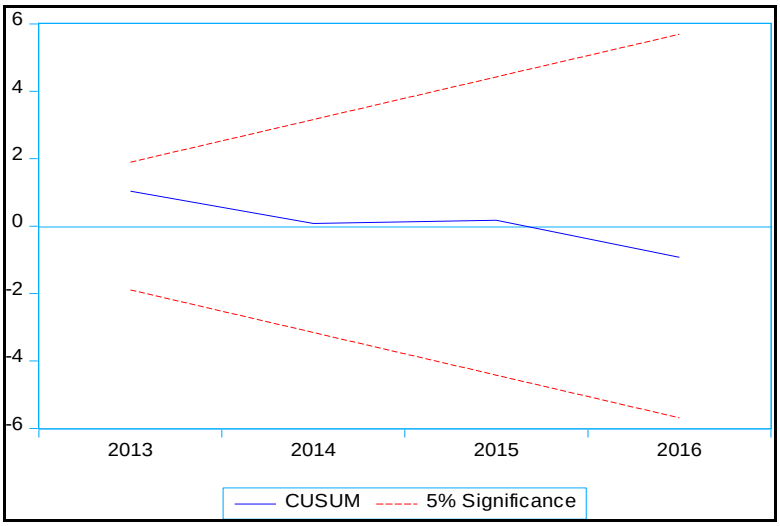
Exogenous variables: C LRGDP LINFL

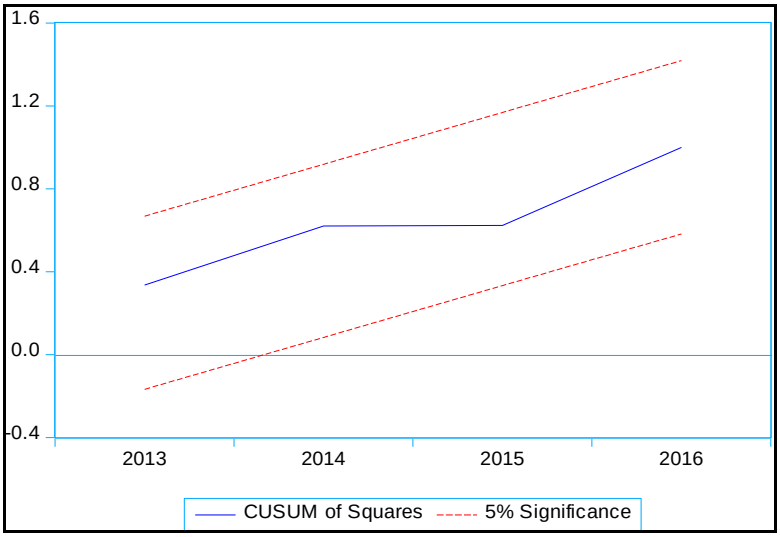
Lag	LogL	LR	FPE	AIC	SC	HQ
0	4.925246	NA	0.048837	-0.183357	-0.034139	-0.150973
1	23.06630	29.37123	0.009571	-1.815838	-1.616881	-1.772659
2	29.59273	9.945031*	0.005680	-2.342164	-2.093469*	-2.288191
3	30.82461	1.759838	0.005596*	-2.364249*	-2.065814	-2.299481*

* Indicates lag order selected by the criterion

Appendix 2: Stability tests

Stability tests of short run estimates of real GDP, inflation and unemployment





Stability tests of short run estimates of unemployment, inflation and real GDP