

Macroeconomic Determinants of Inflation in Ethiopia: A Time Series Analysis

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Abstract: In the last decades, Ethiopia has been one of the fastest growing non-oil producing countries in the world. Along with the economic growth, inflation has been rising. Therefore, the main objective of this study was to identify the major macroeconomic factors affecting inflation in Ethiopia for the year 1981 - 2020. Secondary data were collected from World development indicators database. Both econometrics and descriptive statistics were used for data analysis. The findings of the descriptive result indicated that for forty years the mean official exchange rate was 10.13birr/dollar with standard deviation of 8.6Birr/dollar. The mean inflation rate for Ethiopia was 9.44% with a minimum of -9.81% and a maximum value of 44.39%. Growth of GDP was 5.91% with standard deviation of 6.45%. In order to show long run and short run relationship between variables, vector error correction regression model was applied. Before estimation, stationery test was conducted using dickey fuller test. Inflation rate and growth of GDP were stationary at level while exchange rate and unemployment rate were non-stationary. Therefore, vector error correction model was justifiable. The result of vector error correction model confirmed that there is a significant relationship between devaluation of exchange rate and inflation. Therefore, in order to control inflationary pressure appropriate policies must be designed which compromises unemployment, economic growth and exchange rate regimes.

Keywords: Inflation, Vector Error Correction Model, Ethiopia

1. Introduction

This day's fluctuation of general price level has been serious problem to the economy of Ethiopia. While the economy is growing rapidly, presenting many opportunities, there are also hurdles of inflation in Ethiopia [6]. In 2020/21, annual average headline inflation was 20.2 percent and real GDP growth was 6.3 percent [5].

The current high inflation rate is not only harming consumers, but also firms as they are forced to increase salaries affecting their competitiveness. Inflation also affects the competitiveness of exporting firms by raising the real exchange rate [1]. According Nation Bank of Ethiopia report, Ethiopian Birr was depreciated against all major international currencies, such as Pound Sterling (40.2 percent), Canadian Dollar (37.8 percent), Swedish Kroner (36.1 percent), Euro (31.7 percent), SDR (29.5 percent), Swiss Franc (28.1 percent), USD (24.9 percent), Djibouti Franc (24.9 percent), Saudi Riyal (24.9 percent), UAE Dirham (24.9 percent), and Japanese Yen (21.1 percent).

In Ethiopia, inflationary process has been high due to rising money supply, huge debt servicing, persistence current account and budget deficits, and currency devaluation [7]. In the past inflation, Ethiopia had typically been associated with agricultural supply shocks due to drought [8]. Historical evidence indicated that Ethiopia has suffered from high inflationary experience owing to weather shocks (drought) and conflict (war) [16]. For instance, high inflations were recorded during severe drought (1984/85) and 2002/03 or political instability (1990/91) when inflation reached double digits [13].

Ethiopia's inflation rate remains persistently high, reaching 33.6 percent in February 2022. The headline inflation in February 2022 is lower than the 34.5 percent recorded in January 2022. Food inflation stood at 41.9 percent in February, up from 39.9 percent. Non-food inflation declined to 22.9 percent from 27.3 percent registered in January 2022 [20]. The major factors driving food inflation are spikes in price of cooking oils and fats, non-alcoholic beverages, bread and cereals, fish and seafood, dairy, and meat products [5].

Given this macroeconomic environment, analysing factors that determines inflationary process is important. Therefore,

this study focused on identifying the effects of growth of GDP, unemployment and exchange rate on inflation.

2. Macroeconomic Theories of Inflation

From a theoretical view, the following were some of the theories of inflation.

Quantity theory of money

According to the quantity theory of money, the quantity of money available in an economy determines the value of money, and growth in the quantity of money is the primary cause of inflation [4]. The faster the growth of money in circulation, the more increase in inflation. This theory postulated that if the central bank keeps the money supply stable, the price level would be stable. If the central bank increases the money supply rapidly, the price level will rise rapidly [4].

Keynesian Theory of Inflation

According to Keynes theory of inflation, an increase in general price levels or inflation due to increase taken together demand which is over the increase in aggregate supply. If a given economy is at its full employment output level, an increase in government expenditure (G), an increase in private consumption (C) and an increase in private investment (I) will create an increase in aggregate demand; leading towards an increase in general price levels. Furthermore, Keynesian economists believe that there is a tradeoff between inflation and unemployment [18]

Structuralist theory of inflation

The structuralists hold the view that inflation is necessary with economic growth. According to this view, as the economy develops, rigidities arises which lead to structural inflation. In the initial phase, there are increases in non-agricultural incomes accompanied by high growth rate of population that tend to increase the demand for goods.

Phillips Theory of inflation

The Phillips curve examines the relationship between the rate of unemployment and the rate of According to the Phillips Curve; there exists a negative, or inverse, relationship between the unemployment rate and the inflation rate in an economy. Whenever unemployment is low, inflation tends to be high. Whenever unemployment is high, inflation tends to be low. This inverse relationship between inflation and unemployment is called the Phillips curve [4].

The Okun's law

Okun's law stated the relationship between a country's unemployment rate and the growth rate of its economy.

Okun's noted when unemployment rate increases; the growth rate of the economy becomes slower [11]. By merging the analysis of Phillips law with the Okun's law, inflation, unemployment and economic growth are interrelated.

3. Review of Empirical Literature

Several cross-country and country specific studies have been conducted to find out the determinants of inflation in developing countries. They have found mixed results.

Geda and Tafere in their analysis of inflation found that the most important forces behind food inflation in the long run are a sharp rise in food demand triggered by an alarming rise in money supply/credit expansion, inflation expectation and international food price hike [19]. The long run determinants of non - food inflation, on the other hand, are money supply, interest rate and inflation expectations.

In Kenya, the study by Kirimi revealed that Money supply (M2) and exchange rate had a positive relationship with the inflation rate while GDP growth rate and the corruption perception had a negative relationship with inflation [14].

Using data from the world development indicators, Ahiakpor found that real output growth, population growth rate, broad money, exchange rate, lending rate and budget deficit were key factors affecting in Ghana's inflation [15].

According to Macharia and Otieno, inflation rate and unemployment rate were inversely related both in the long run as well as in short run [17].

Empirical findings of Teshale et al indicated that broad money supply, real gross domestic product and overall budget deficit are statistically significant determinants of inflation with positive sign [8].

Lim and Sek applied an Error Correction Model based on the Autoregressive Distributed Lag (ARDL) modeling has been used to explain the short run and long run impacts of each variable on inflation. In low inflation countries, GDP growth has negative impact on inflation and imports of goods and services have positive impact on inflation [10].

In his analysis, Girma examined determinants of inflation in Ethiopia by applying vector error correction model and found that Broad Money Supply in the economy and the Banks and Financial institutions average lending rate has a positive long run effect on inflation in Ethiopia [2]. While, the Rainfall, the deficit budget and the Nominal Exchange rate has a negative long run determination of the price level in Ethiopia.

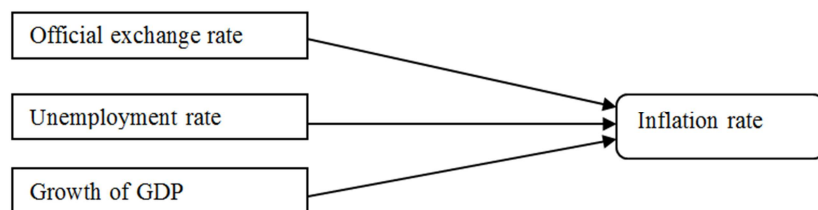


Figure 1. Conceptual framework of the study.

Figure 1, above depicts the relationship between inflation and exogenous variables. The dependent variable for this

study was inflation rate measured in consumer's price index and the independent variables were Official exchange rate, Unemployment rate, and growth of GDP.

4. Sources of Data

The research used secondary data, which was collected for the year 1981 to 2020 from world development indicator (WDI) of World Bank. This implies that the research used 40 years to address the pre-defined objectives. The time series data were yearly type in which one can judge about the macroeconomic determinants of inflation of one nation through having the annual data.

5. Model Specification

The model Vector autoregressive models and Error Correction Model (ECM) are used to investigate the determinants of inflation. In this study, inflation rate was endogenous variable and 4 exogenous variables (broad money supply, growth of GDP, exchange rate, and unemployment). The result is conducted in various steps including the Dickey-Fuller Unit Root test, Co-integration test, Vector Error Correction Model (VECM), Granger Causality Test, stability tests, and Durbin Watson tests.

Accordingly, following Gujarati, the model specification for determinants of inflation rate was shown as [3]

$$INFN = f(UNE, G, EXCH)$$

Where INFN= Inflation rate

UNE= unemployment rate

G= Growth of GDP

EXCH= Exchange rate

Dependent Variable

Inflation (INF) – Inflation is the overall general upward price movement of goods and services in an economy. Inflation is measured by measuring the percentage change in the prices of a given basket goods over time as compared to the price in the base year. We can use the CPI to determine differences in price between two points in time and calculate inflation for that period.

Explanatory variables

Unemployment rate: Unemployment is the situation where a person in the labor force who is currently looking for job to work at the existing wage rate failed to find any. The Phillips theory stated that there is an inverse relationship between wage inflation and unemployment rate. Macharia and Otieno also found that inflation rate had an inverse relationship with an unemployment rate in the long run as well as in short run in Kenya. This due the fact with increase inflation, suppliers

is willing to supply more goods and services to the market [17]. In return, the producers will require more labour and hence this will result to lowering the unemployment rate.

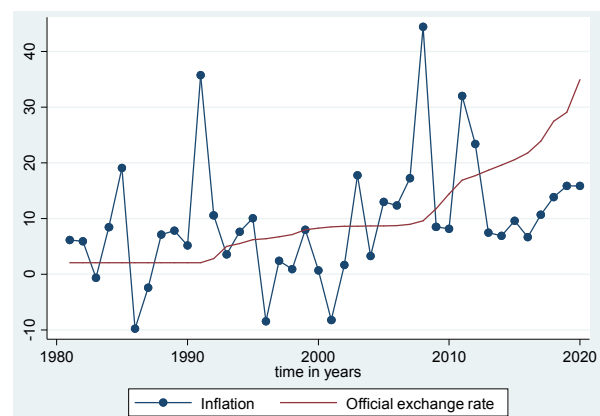
Growth of GDP: It is an indicator for the overall economic status of the country. It is expected to have a positive impact on the level of inflation. GDP growth rate has negative relationship with inflation. Semeneh in his analysis of inflation clearly stated that instead of stimulating economic growth, inflationary pressure in Ethiopia seems to be on the verge of distorting the allocation of resources and is likely to be a deterrent to undertaking productive investments [16].

Official Exchange Rate: It is a rate at which Ethiopian Birr exchange for dollar. The Ethiopian exchange rate is defined as units of Birr per Dollar. It usually believed that depreciation of Ethiopian birr increases demand for output produced in Ethiopia abroad [9]. This increases demand and expected to increase inflation. The trend analysis by [14], [12], and [8] showed that real effective exchange rate varies with inflation. This vary trend of real exchange rate may have resulted in the high impact of its trend on the trend of inflation minimum. With devaluation, imports became more expensive and export becomes cheaper.

6. Results and Discussion

Descriptive analysis

In order to ascertain the distribution of the data being used for this analysis, some descriptive analyses such as mean, standard deviation, minimum and maximum were performed. From table 1, the average Official exchange rate, Unemployment rate, Inflation rate, Broad money supply, and growth of GDP was 10.13 birr/dollar, 2.83%, 9.44% and 5.91%, respectively.



Source: computed from World Bank Data (2022)

Figure 2. Relation between exchange rate and inflation rate.

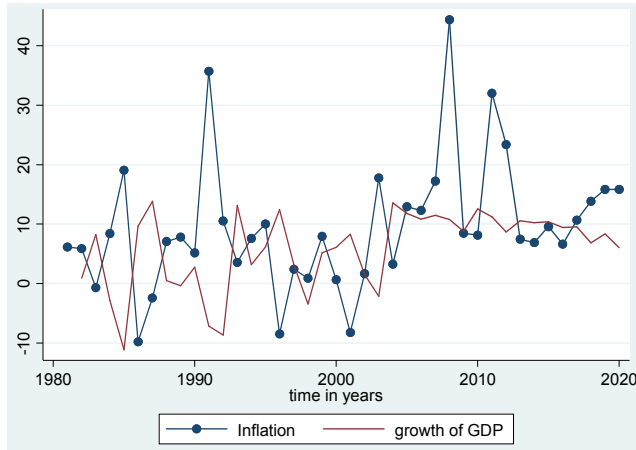
Table 1. Descriptive and summary statistics of variables.

Variables	Observation	Mean	Standard deviation	Minimum	Maximum
Official exchange rate	40	10.13	8.6	2.07	34.9
Unemployment rate	40	2.83	0.43	2.25	3.71
Inflation rate	40	9.44	10.886	-9.81	44.39
growth of GDP	39	5.905	6.445	-11.14	13.86

Source: computed from World Bank data (2022)

Table 1 summarizes the statistics of all variables. As we can see in Table 1 the average Official exchange rate, Unemployment rate, Inflation rate, growth of GDP were 8.6 birr/dollar, 0.43 %, 10.886 % and 6.445%, respectively.

Trends Analysis



Source: computed from World Bank Data (2022)

Figure 3. Relation between growth of GDP and inflation rate.

From Figure 2, we observe that inflation rate and official exchange rate moving together. Ethiopian exchange rate has been increasing overtime. There is ups and down movements for inflation rate over time.

From Figure 3, when inflation rate is rising then growth of GDP is falling. It seems that there is an inverse relationship between economic performance and inflation.

Unit root test

The hypothesis for unit root test is stated as:

H_0 : non-stationary

H_1 : stationary

If time series data is non-stationary, this resulted in spurious regression. Prior to testing Co-integration and implementing further econometric methodology, it is necessary to examine stationarity test for each individual time series variables. Most macroeconomic time series data are non-stationary, i.e. they tend to exhibit a deterministic and/or stochastic trend. It is recommended that a stationarity (unit root) test should be carried out for having logical and meaningful result. In our analysis of inflation, we cannot reject the null hypothesis that unemployment and exchange rate exhibits a unit root. Therefore, unemployment and exchange rate are non-stationary time series.

Table 2. Unit root test (augmented dickey fuller test).

variables	ADF Test static at level					
	without trend	Interpolated Dickey-Fuller 5% critical value	Decision	with trend	Interpolated Dickey-Fuller 5% critical value	Decision
exchange rate	6.1	-2.96	Non-Stationary	3.8	-3.544	Non-Stationary
Unemployment rate	0.71	-2.96	Non-stationary	-061	-3.544	non-stationary
Inflation	-4.8	-2.96	Stationary	-5.23	-3.544	Stationary
growth of GDP	-4.43	-2.964	Stationary	-5.33	-3.548	Stationary

Source: computed from World Bank data (2022)

Table 3. Vector autoregressive regression result of macroeconomic determinates of inflation.

Independent variables	Coef.	Std. Err.
Inflation_L1	0.025	0.144
unemployment rate	-13.789	4.386***
Growth of GDP	-0.794	0.257***
Exchange rate	0.161	0.201
constant	51.307	14.383***

Note: ***, indicates that the variable is significant at 1%

Source: Computed from World Bank Data (2022)

In Table 3 above, Vector autoregressive regression was fitted a Vector Auto-Regressive model of order 1 VAR (1) with three exogenous variables "Unemployment rate, Growth of GDP and Exchange rate. Both unemployment rate and growth rate of GDP has negative relationship with inflation rate.

Table 4. Lag determination of before estimation vector error correction model (VECM).

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-398.284	32650.200	21.745	21.807	21.919			
1	-272.081	252.410	16	0.000	85.054	15.788	16.0951*	16.6589*
2	-253.635	36.892*	16	0.002	77.0317*	15.6559*	16.209	17.223

Sample: 1984 - 2020 Number of obs = 37

Endogenous: inflation, unemymnt rate, grow GDP, Exchange rate

Exogenous: constant

Source: Computed from World Bank Data (2022)

Lag determination of VECM varsoc reports the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the

Hannan and Quinn information criterion (HQIC) lag order selection statistics helps to get maximum lag to be included in vector error-correction model (VECM). To use this

sequence of LR tests to select a lag order, we start by looking at the results of the test for the model with the most lags, which is at the bottom of the table. An ‘*’ appears next to the LR statistic indicating the optimal lag. The results above show that the HQIC and SBIC chose one lags. This means determinants of inflation were explained by one lags. Once we have determined the number of lags, our next task is to

test for cointegration amongst the variables.

Johansen cointegration test

Johansen cointegration test, also known as the eigenvalue test or trace test, is a likelihood ratio test.

The hypothesis for cointegration test is stated as:

H0: no cointegrating equation

H1: H0 is not true

Table 5. Johansen tests for cointegration.

Maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	20	-285.512	.	63.7554	47.21
1	27	-265.813	0.65521	24.3570*	29.68
2	32	-258.65	0.32104	10.0306	15.41
3	35	-253.656	0.23658	0.0424	3.76
4	36	-253.635	0.00115		

In the above table (table 5), the trace statistics at Maximum rank $r=0$ of 63.7554 exceeds its critical value of 47.21, we reject the null hypothesis of no cointegrating equations. The trace statistics at $r=1$ of 24.3570 is less than the critical value of 29.68; we cannot reject the null hypothesis that there is one

cointegration relationship between inflation, unemployment, economic growth rates and exchange rates. Therefore, this confirms the possibility of applying VECM. If series are cointegrated; i.e. they exhibit a long-run relationship, there is a need to estimate longrun models.

Table 6. Vector error-correction model.

Variables	Lags/difference	Coef.	St. Err.	t-value		Sig
D _inflation	Inflation _L	-.875	.18	-4.86	0.063	***
	Inflation _LD	.063	.162	0.39	-0.00074	
	unemployment _LD	-7.654	18.672	-0.41	-0.364	
	Growth of GDP_LD	-.519	.3	-1.73	-0.028	*
	Exchange rate _LD	4.662	2.175	2.14	0.063	**
	Constant	.044	2.291	0.02		
D. unemployment rate	unemployment L	.001	.003	0.46	-7.65	
	Inflation _LD	-.001	.003	-0.28	0.799	
	unemployment _LD	.799	.304	2.63	-6.91	***
	Growth of GDP_LD	.002	.005	0.35	0.74	
	Exchange rate _LD	.02	.035	0.57	-7.65	
	Constant	.002	.037	0.04		
D. Growth of GDP	Growth of GDP_L	.479	.1	4.81	-0.519	***
	Inflation _LD	-.364	.09	-4.05	0.0017	***
	unemployment _LD	-6.913	10.326	-0.67	-0.039	
	Growth of GDP_LD	-.039	.166	-0.24	0.0024	
	Exchange rate _LD	-2.458	1.203	-2.04	-0.52	**
	Constant	.054	1.267	0.04		
D. exchange rate	Exchange rate _L	.039	.016	2.40	4.662	**
	Inflation _LD	-.028	.015	-1.93	0.020	*
	unemployment _LD	.737	1.674	0.44	-2.458	
	Growth of GDP_LD	.002	.027	0.09	0.619	
	Exchange rate _LD	.619	.195	3.17	4.662	***
	Constant	.321	.205	1.56		

Mean dependent var 5.977 SD dependent var 6.558

Note: *** $p < .01$, ** indicates that the variable is significant at $p < .05$, * $p < .1$

Source: computed from World Bank Data (2022)

Table 7. Johansen normalization restriction imposed.

variable	Coef.	Std. Err.	z
Inflation	1	.	.
unemployment	9.02**	4.31	2.09
Growth of GDP	-1.03**	0.3	-3.41
Exchange rate	1.05***	0.29	3.65
Constant	-35.53	.	.

Note: *** $p < .01$, ** indicates that the variable is significant at $P < .01$, $p < .05$, * $p < .1$

Table 7 above reflects the Johansen normalization restriction test where the purpose of the test is to evaluate the long-term effect of unemployment, Growth of GDP, and exchange rate on inflation. All the included variables have significant long term effect on inflation at $p < 5\%$.

Table 8. Cointegration equations.

Equation	Parms	chi2	P>chi2
_cel	3	24.63935***	0.000

Null Hypothesis: There is no cointegration

Alternative Hypothesis: There is cointegration

Table 8 above shows the co-integration equation where the null hypothesis are that there are no co-integrating equations. The p value is computed as 0.000, which indicates that there is no error in the correlation and thus the long-term effects of the variables can be analyzed.

Table 9. Lagrange-multiplier test.

lag	chi2	df	Prob>Chi2
1	19.799	16	0.229

H0: no autocorrelation at lag order vecImar implements a Lagrange multiplier (LM) test for autocorrelation in the residuals of vector Error-correction models (VECMs). At the 5% level, we cannot reject the null hypothesis that there is no autocorrelation in the residuals at first lag. Thus, this test finds no evidence of model misspecification.

Table 10. Eigenvalue stability condition.

Eigenvalue	Modulus
1.0162	1.0162
1	1
1	1
1	1
.08031934 +.666466i	0.671288
.08031934 -.666466i	0.671288
0.6603699	0.66037
0.3918781	0.391878
The VECM specification imposes 3 unit moduli	

Table 11. Partial and semi partial correlations of infln with inflation.

Variable	Partial Corr.	Semi partial Corr.	Partial Corr.^2	Semi partial Corr.^2	Significance Value
unemployment	-0.479	-0.446	0.230	0.199	0.003
Growth of GDP	-0.446	-0.407	0.199	0.166	0.006
Exchange rate	0.129	0.106	0.017	0.011	0.447

Source: computed from World Bank Data (2022)

7. Summary and Conclusions

The main objective of this study was to identify the major macroeconomic factors affecting inflation in Ethiopia for the year 1981 - 2020. Secondary data were collected from World development indicators database. In order to show long run and short run relationship between variables, vector error correction model was applied for data analysis. The VEC model result confirmed that that devaluation of exchange rate increases inflation. Therefore, appropriate policies must be designed which compromises unemployment, economic growth and exchange rate regimes.

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Vecstable checks the eigenvalue stability condition in a vector error-correction model (VECM) fit using vec. This function returns whether the given model satisfies the Eigenvalue stability condition. The Eigenvalue stability condition is satisfied when all Eigen values lie in the unit circle.

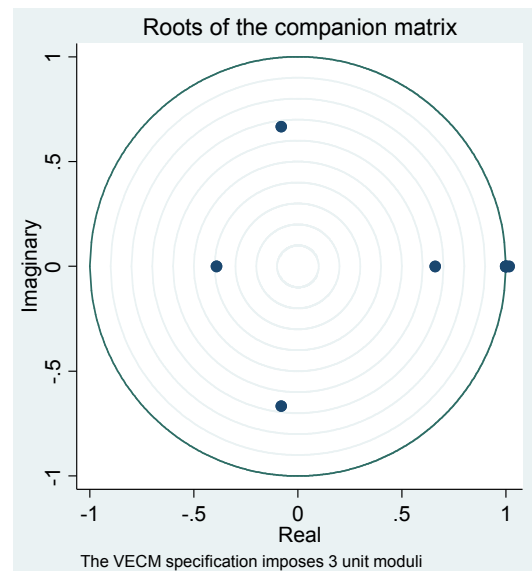


Figure 4. Eigenvalue stability condition.

Our results show that 3 eigenvalues are strictly less than one, thus confirming stability of our ECM model.

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