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THE RELATIONSHIP AMONG INFLATION, INTEREST RATE, AND GDP:

EVIDENCED FROM ETHIOPIA

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Abstract: *The study analyses the relationship among inflation, interest rate, and the gross domestic product of Ethiopia. The time series macroeconomic data was gathered over the periods from 1985-2019. The stationarity for unit root checked using the Augmented Dickey-Fuller unit root test, and Johansen for the co-integration test were conducted. The estimated results indicated that there was unit root at level but stationary after first difference, and not co-integration among variables. Then, unrestricted vector autoregression model, and the Granger causality test was conducted to investigate the relationship and direction of causality. The output of the study indicated that only interest rate lag1 and lag2 jointly could cause the GDP.*

Keywords: *Inflation, Interest rate, GDP, Macroeconomic, Ethiopia*

1. Introduction

This study centers on analyzing the relationship between the interest rate (IR), inflation (INFL), and gross domestic product (GDP) in Ethiopia. Many studies have been conducted on the impacts of INFL, IR, and exchange rates on the GDPs of several countries worldwide. They are basic macroeconomic factors affecting the economy of several countries. They are dynamic for every lively country's economy. A GDP (Anne, 2019) determines how much IR will be. If the GDP of a country appears to be declining, to stimulate the economy IR will be lowed so that the businesses get an opportunity to borrow a lot of money. On the other side when GDP appears to grow, to control inflation, the IR will be raised to decline loan amount as result, the investment will decline.

In the study conducted by (Harswari and Hamza, 2017) entitled "the impact of IR on economic growth" the outcomes of the analysis show that IR has a negative and significant impact on GDP and INFL while having a negative but insignificant impact on foreign direct investment. IR provides information regarding future projections of macroeconomic variables, such as INFL. Based on the theoretical issues and empirical studies, (Bruna, 2007) there is a bidirectional causality relationship between IR and INFL rate. IR has a long-run relationship with INFL and it is also a two-way causality relationship. Regarding (Bhat & Laskar, 2016) the correlation between GDP, INFL, and IR there exists a strong positive correlation. Further GDP has a positive relation with INFL but it has negative relation with IR. The relationship between IR and the INFL rate is one of the prominent points and controversial ideas in macroeconomics works of literature (Şen, Kaya, Kaptan, & Cömert, 2020). The association (Mamo, 2012) between economic growth and INFL is also controversial. INFL may be an indicator for economic growth, however; excess growth leads to hyperinflation while low INFL will lead the economy to stagnant. If the IR changed, INFL also changed.

Based on the above discussion in this study, which variable/s caused the other variable/s was assessed to understand the relationship among them.

2. Review of Literatures

GDP is the common measurement tool to value goods and services produced by a country. The worth of such goods and services is found by deducting the costs and expenses incurred in producing goods and rendering services during a period. GDP (Dynan & Sheiner, 2019) encompasses personal and government consumption expenditure, gross private domestic investment and gross investments, net exports of goods and services. According to (Stutz, 2012: p.16) "*GDP is the single most important indicator to capture these economic activities. However, it is not a good measure of societies' well-being and only a limited measure of people's material living standards"*. There is no all-encompassing model till now in determining the factors that affect the economic growth of a country. However, the key determinants according to (Boldeanu & Constantinescu, 2015) are human resources, natural resource capital information, and technology. Other factors such as according to (Aini, Aziz, & Azmi, 2017), inflation, foreign direct investment, and female labor force are considered in the study. The result showed that inflation is negatively related but insignificant. Only foreign direct investment becomes positively significant to affect GDP.

The inflation rate is according to (Oner, 2010) INFL occurs when the prices of goods and services increased in certain given periods or in other terms increases in the cost of living in a given country at a given period measured against the same baseline purchasing power. Inflation (Tsegay, 2014) may be defined as the overall price rising in the economy of a country. The fact that high and persistent inflation in the economy introduces uncertainty into the economy and may lead to a slowdown of economic growth by discouraging domestic as well as foreign investments. Inflation (Schwarzer, 2018) is may be caused by "demand-pull inflation", which is due to higher aggregate demand than aggregate supply of goods and services. It may also be caused by "cost-push inflation", which is caused by a large increase in the cost of essential goods or services where no appropriate alternatives are available. Anticipated inflation also may be caused and said "built-in inflation". One of the effects of inflation is an impact on economic imbalance by changing the structure of consumption. It (Sattarov, 2011) "…*causes higher costs and makes the economy less efficient, however; creeping and anticipated inflation has positive effects on the economy and stimulates economic growth…"* High inflation and unanticipated inflation are a hazard to any economy. According to (Chaundhary & Xiumin, 2018) inflation is everywhere and is an interestingly touchy issue in macroeconomics. It is mostly discussed issues all over the world among policymakers and academia. It is also the most important apprehension for the government as it has serious implications for the citizen of a country. Moreover, it affects many macroeconomic variables such as investment, real interest rate, real wage, real income, and level of employment. Its effect also affects the value of a domestic currency and in consequence, the imports become expensive which further pushes the domestic price.

Interest rate (Faure, 2014) is the recompense paid by a user of fund (borrower) to a provider for the utilization of fund, and it is articulated in terms of percent per year. It is the price of money. Interest rates both lending as well as deposit rate has a significant effect on saving and investment in Ethiopia as it has been conducted by (Heo & Lee, 2018) inconsequence; saving and investment has an effect on economic growth. According to (Beshir, 2017) if saving increases economy of a country grows in the future, and effect expenditures increases due to increases in consumption. This is supported by the theory of links between future economic development and the current consumption expenditures of a country. Moreover; this theory stressed economic growth becomes realized by increased capital accumulation through saving as a prominent source of finance.

Unit Root Test: The stationarity of the variable is imperative in the case of a time series data set. So, the stationarity test was used to check whether the data was stationary or none. A stationary time series (Davcev, Hourvouliades, & Komic, 2018) is one whose statistical properties such as mean, variance,

autocorrelation, etc. are all constant over time. If there is a unit root then series become non-stationary. For this study Augmented Dickey-Fuller (ADF) test was applied to test stationarity.

Ho: Variables (GDP, INF, and IR) have unit roots

The ADF test is stated below;

Intercept only: $\Delta Y_t = B_1 + ZY_{t-1} + a_i + e_t$
Trend and intercept: $\Delta Y_t = B_1 + b_{2t} + ZY_{t-1} + a_i + e_t$
No trend, no intercept: $\Delta Y_t = ZY_{t-1} + a_i + e_t$

Co-integration Test: A co-integration analysis is done to see if there exists a long-run equilibrium relationship among all variables. This method is used to test the correlation between non-stationary variables. Some series data may be none- stationery in them but stationary in a linear combination and such type of data is said to be co-integrated. The data then at level take for Johansen Juselius (JJ) co-integration test to check the long-run correlation. To be an appropriate estimation, the proper lag length should be selected using statistical methods. According to (Bjørnland, 2000), too large a lag length may lead to inefficient and poor estimation of statistical parameters whereas; too small a lag length may result in spurious insignificance of parameters.

Ho: None (there is no co-integration)

VAR Model: VAR model is a time series statistical method which used popularly in economics and many financial studies. It is used to analyze to find out the relationship among many variables. VAR model is a straightforward and supple model for multivariate time series data. The Autoregressive (AR) is another type of model under VAR which forms a vector among the variables that affect each other, whereas the VAR model is useful to multivariate time series dynamic behavior of data for better forecasting results. It identifies the relationship among its own lags observation of variables and other observations of particular variables of the previous periods. The VAR model is also (Suharsono, Aziza, & Pramesti, 2017) important to differentiate variables which is dependent and which is an independent variable in case of simultaneity between many variables.

Simple AR equation:

$$y_t = B_1 y_{i-t} + e_t$$

A VAR model system contains several p variables expressed as linear functions shown for two variables x and y like according to:

$$y_t = B_{yo} + B_{y1}y_{t-1} + \ldots + B_{yp}y_{t-p} + B_{yx1}x_{t-1} + B_{yxp}x_{t-p} + e^y{}_t$$

$$x_t = B_{xo} + B_{x1}x_{t-1} + \ldots + B_{xp}x_{t-p} + B_{xy1}y_{t-1} + B_{xyp}y_{t-p} + e^x{}_t$$

3. Methodology

The time-series data was collected from world development indicators and the National bank of Ethiopia. It was a secondary data type that covers 34 years periods from 1985 to 2019. To well understand the estimating model as well as to avoid the problem of non-stationary variables and spurious regressions, the ADF unit root test was implemented. The result indicated that there was a unit root for series data under the study. Moreover; to exhibit the existence of a long-run association, the co-integration test was performed using Johansen co-integration test. The appropriate lag length was evaluated using one statistical method such as Akaike Information Criterion (AIC). The Johansen co-integration test resulted that the variables were no more a long-run relationship among them. Then unrestricted VAR model was applied to run the regression equation. The appropriate statistical tests of the OLS assumptions on residuals were necessarily fulfilled before running the regression equation.

4. Data Result and Discussion of findings

The unit root test result: According to AIC at lag2, the p-value was greater than 5% in all three variables with all the three ADF test equations. Except for GDP in equation intercept only, the p-value was less than 5%. Moreover; the value of ADF test statistics for remaining all was less than the value of test critical value in absolute values. As result in both cases, the unit root test confirmed that the variables have got a unit root (non-stationary) at a level. So, unless the stationary is maintained, the time series data with unit root shows a systematic pattern that makes it unable to predict. To make the variables stationary, ADF test estimation was performed using a first difference of the variables. The analysis of unit root using first difference resulted that the absolute value of test statistic is greater than test critical value and p-value became significant at a 5% in all the three variables and all the three ADF test equations. As result, the variables were proved that they were stationary at first difference. To recognize the long-run relationship, the variables should be co-integrated.

Co-integration result: Having lag2 interval and allowing for the linear deterministic trend in data with intercept (no trend) in Co-integration Equation and test Vector Auto Regression (VAR).

Table 1: Johansen Co-integration Test

Series: GDP INF IR
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	**Trace Statistic**	0.05 **Critical Value**	Prob.**
None	0.432230	**29.53117**	**29.79706**	**0.0536**
At most 1	0.253717	11.41791	15.49470	0.1871
At most 2	0.062144	2.053081	3.841465	0.1519

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	**Max-Eigen Statistic**	0.05 **Critical Value**	Prob.**
None	0.432230	**18.11326**	**21.13161**	**0.1257**
At most 1	0.253717	9.364829	14.26461	0.2570
At most 2	0.062144	2.053081	3.841465	0.1519

The hypothesized No. of CE(s) under none was accepted. Therefore, the co-integration test result showed that both Trace statistic and Max-Eigen statistic probability values were greater than 5% indicating that it was unable to reject the null hypothesis. Meaning both tests indicating that there was no co-integration among variables at a 5% significance level. As result, there was no long-run association among GDP, INF, and IR. Since there was no long-run association, then the unrestricted VAR simply VAR model was applied.

VAR Result: To run the unrestricted VAR model the AIC selected and lag selection criterion lag2 was appropriate. As it was aforementioned, all three variables were non-stationary at a level and became stationary at first difference. However; they were not co-integrated using JJ co-integration test at lag 2. As result, unrestricted VAR estimation was conducted. The transformed to first difference variables were used to run VAR.

Table 2: VAR Estimates

Standard errors in ( ) and t-statistics in [ ]

	DGDP	DINFL	DIR
DGDP(-1)	-0.632598	-0.146426	-0.049832
	(0.16507)	(0.33812)	(0.04888)
	[-3.83241]	[-0.43306]	[-1.01945]
DGDP(-2)	-0.498332	-0.107195	-0.042348
	(0.14605)	(0.29918)	(0.04325)
	[-3.41195]	[-0.35830]	[-0.97912]
DINFL(-1)	-0.008186	-0.460988	0.007334
	(0.08648)	(0.17715)	(0.02561)
	[-0.09465]	[-2.60223]	[0.28637]
DINFL(-2)	0.066484	-0.529446	0.008879
	(0.08160)	(0.16714)	(0.02416)
	[0.81479]	[-3.16769]	[0.36747]
DIR(-1)	1.516162	-1.610167	0.217110
	(0.72171)	(1.47834)	(0.21372)
	[2.10079]	[-1.08917]	[1.01586]
DIR(-2)	0.783608	-0.368130	0.089833
	(0.69180)	(1.41706)	(0.20486)
	[1.13272]	[-0.25978]	[0.43850]
C	-0.287722	1.191442	0.203253
	(0.91855)	(1.88154)	(0.27201)
	[-0.31324]	[0.63323]	[0.74722]

The VAR results showed that a significant relationship between the interest rate at lag1 and lag2 and GDP with the coefficients at 1.516 and 0.7836, the Standard errors at (0.7217) and (0.6918), and the t-statistics at [2.1007] and [1.1327]. Further, the relationship was checked by using the Granger Causality test shown in table 4 and system model estimates displayed in table 3.

Table3: System Estimates model

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.632598	0.165065	-3.832406	0.0003
C(2)	-0.498332	0.146055	-3.411948	0.0010
C(3)	-0.008186	0.086483	-0.094649	0.9248
C(4)	0.066484	0.081596	0.814793	0.4178
C(5)	1.516162	0.721710	2.100791	0.0390
C(6)	0.783608	0.691796	1.132717	0.2609
C(7)	-0.287722	0.918548	-0.313235	0.7550
C(8)	-0.146426	0.338117	-0.433064	0.6662
C(9)	-0.107195	0.299176	-0.358301	0.7211
C(10)	-0.460988	0.177151	-2.602233	0.0112
C(11)	-0.529446	0.167139	-3.167691	0.0022
C(12)	-1.610167	1.478339	-1.089173	0.2796
C(13)	-0.368130	1.417062	-0.259784	0.7957
C(14)	1.191442	1.881538	0.633228	0.5285
C(15)	-0.049832	0.048881	-1.019448	0.3113
C(16)	-0.042348	0.043251	-0.979119	0.3307
C(17)	0.007334	0.025610	0.286367	0.7754
C(18)	0.008879	0.024163	0.367466	0.7143
C(19)	0.217110	0.213721	1.015859	0.3130
C(20)	0.089833	0.204862	0.438504	0.6623
C(21)	0.203253	0.272010	0.747225	0.4573

Granger Causality: The Granger causality test is one of the methods of statistics of causality based on an estimate of the occurrence (Foresti, 2007) which employs series of t-tests and F- tests to conclude

whether time series is useful in predicting another time-series data. The output of the study revealed in table 4 suggested that the past values of interest rate jointly contributed to the prediction of the present value of GDP.

Table 4: VAR Granger Causality or Block Exogeneity Wald Tests Granger Causality

Dependent variable: DGDP			
Excluded	Chi-sq	df	Prob.
DINFL	0.806166	2	0.6683
DIR	7.088836	2	0.0289
Dependent variable: DIR			
Excluded	Chi-sq	df	Prob.
DGDP	1.565139	2	0.4572
DINFL	0.166524	2	0.9201

The Granger Causality reported by F-statistics (7.0888) with the p-value (0.0289) is also the Wald statistics for the joint causality hypothesis (Ho: C (5) = C (6) = 0) in other terms the output is the same and shown in table 5. However, it was unidirectional causality running from interest rate to GDP.

Table 5: The Wald Test:

Test Statistic	Value	df	Probability
Chi-square	7.088836	2	0.0289
Ho: C(5)=C(6)=0			

5. Conclusion

In conclusion, all the three variables namely GDP, INFL, and IR had unit roots at a level and become stationary after the first difference. They had no long-run relationship after JJ co-integration test. The unrestricted VAR model (standard VAR) and test for Granger Causality were conducted. The output was that the past values of lag1 and lag2 of interest rate was Granger cause the GDP. In other terms, it was the unidirectional Granger causality running from Interest rate to GDP. The joint Granger Causality among other variables did not cause by other variables. The result implied that those variables had not so strong relationships among them.

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