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The Impact of Oil Price Volatility on Inflation and Economic Growth in Tanzania

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Abstract: The government of Tanzania has persistently experienced uneven growth rate of Gross Domestic Product (GDP) and failed to attain the national target. This research study intended to examine the impact of oil price volatility on inflation and economic growth in Tanzania. Specifically, the analysed the causal relationship between Oil Price Volatility, inflation and economic growth in Tanzania. The study employed secondary data and the modelling of time series data was done by using Auto regressive distributed lag model (ARDL). The analysis showed the following results, after controlling the effect of export and import, the oil price volatility has negative impact on economic growth and after controlling the effect of exchange rate and Interest rate on the inflation rate it showed that the oil price volatility has positive impact on inflation in long run. whenever the oil price volatility increases by one percent the inflation rate increases by the rate of 1.340 percentage. Furthermore, the analysis result showed that there was no causality between the oil price volatility and economic growth (GDP); there was a two-way direction of causality between economic growth (GDP) and inflation rate and also, the result showed there was a one-way direction of the causality from the oil price volatility on inflation that means that oil price volatility enhanced the inflation rate. The study recommendation or advice was the Government through the regulatory authority to manage the oil price volatility, exchange rate, export and import in order to curb effects on inflation and economic growth (GDP).

Keywords: Oil Price Volatility, Inflation, Economic Growth

1. Introduction

The economic growth of the nations including Tanzania depends on a different number of factors, one of them is energy. Energy has been used as the main important factors in the performance of the world economy. Despite of the alternative renewable energy sources still oil continues to play a critical role as an input in the production of goods and services around the world.

Globally, the real oil price has fluctuated since in 1970s, prompting a revival of oil market analysis. Oil price fluctuations were associated with monetary policy shifts, broad labor market changes and energy technology shifts in United states of America (US) that ebbed effects on supply and demand, as the result the correlation between oil price increases and economic downturns in the U.S was not perfect [27] Johansen, S

In Africa, the increase in oil prices over the last few years has made structural reform of the domestic petroleum pricing system as a critical component of their macroeconomic policies. Although in some countries oil price increases may have been partly offset by exchange rate movements (notably the weakening of the U.S. dollar against the euro), it has also had major socioeconomic impacts. Many governments have been reluctant to pass on to consumers a high price because of the potential for social resistance to a policy that could hurt the poor. However, if they do not pass on the higher prices, their countries could experience a significant fiscal burden, which in turn could oblige governments to cut social spending.

The oil price fluctuation or increase in oil price leads to number of policy options to cushion the Country economies from the adverse impact of the high oil price. Despite effort taken by the government to intervened on the retail market for fuel to limit the pass-through of international oil prices still the oil price has been a factor that leads increase in cost of production. Moreover, an increase in oil prices leads to depress the supply of other goods because they increase the costs of producing them whereby cause a shift up the supply curve for the goods and services on which oil is crucial factor and important input that led to some effect on the economic growth as a whole. Therefore, due that consequences the study intends to examine the impact of oil price volatility on economic growth of Tanzania economy.

2. Literature Review

Empirical and Theoretical Research

According to the study conducted by ([6] Álvarez, L. J., Hurtado, S., Sánchez, I., & Thomas, C.; [9] Bhattacharya, K., & Bhattacharyya, I.; [13] Cunado, J., & De Gracia, F. P; [33] Mukhtarov, S. [37] Salisu, A. A., Isah, K. O., Oyewole, O. J., & Akanni, L. O [24] Valcarcel, V. J., & Wohar, M. E. and 2-4 Akinlo, T., & Apanisile, O. T. Akinsola, M. O., & Odhiambo, N. M., Aliyu, S; [8] Berument, M. H., Ceylan, N. B., & Dogan, N; [21] Hanabusa, K.) on the relationship of oil price, inflation and economic growth. The studies result did not state or postulate the degree of inflation and economic growth responsiveness toward the adjusted oil price or the causal relationship between inflation and economic growth. So, through such findings led to conduct research on the impact of oil price volatility on inflation and economic growth looking on the causal relationship among the variables.

3. Research Problem

The oil price Volatility has been a macro-economic problem especially in Tanzania that seems to be intractable over the years [34] Saxena, K. K., & Ndule, M. A.. Many various interventions have taken in order to reduce or curb the effects of the oil price to an acceptable level, but the initiatives seem to have had no effect. The macroeconomic indicator showed that, the annual headline inflation rate for September 2021 has slightly increased to 4.0 percent from the 3.8 percent that was recorded in August 2021, in line with the fact that since 2015, Tanzania has experienced a more negative or declining trend in GDP growth. The increase in the headline rate of growth of GDP as well as the inflation rate indicates that the rate of price change for commodities for the period ended September 2021 has accelerated compared to the rate recorded for the period ended August 2021. The overall index went up from 99.68, as recorded in September 2020, to 103.71 in September 2021, and this might have shown adverse effects on economic growth. Tanzania economy facing uneven trend of economic growth where the growth deviates from the national target. For instance, in 2018, the national target was a 7.2 percent increase in the rate of growth, but the rate of growth was 7 percent [10] Bank of Tanzania (BoT). Monetary policy statement.

The following research questions arose was: to what extent did economic growth and inflation respond to changes in oil prices? Therefore, the importance of studying inflation rates, economic growth, and oil prices in Tanzania is highlighted by the fact that, an increase in industry costs influence the price of goods and services, ultimately resulting in higher consumer costs of living and increasing the cost of production, which in turn have an impact on economic growth and inflation respectively. The study intended to assessing the impact of oil price volatility on inflation and economic growth in Tanzania.

4. General Objective

The overall objective was to analysis the impact of Oil Price Volatility on inflation and economic growth in Tanzania. But the study analysis was based on the causal relationship between Oil Price Volatility, inflation and economic growth in Tanzania.

5. Methodology

The “time series design” employed in the study. The design measures same variables at different points in time so as to analyse social and economic patterns and trends of observations. To determine such pattern over time, the design employed the statistical methods to classify the behaviour of one or more variables in terms of significant patterns in their own previous behaviour. If the pattern behaves the same in future, the estimated pattern is useful for predicting future values. The study further employed the auto-regressive distributed lag model (ARDL) as a way of assessing impact of oil price volatility on inflation and economic growth in Tanzania. The study was relied on secondary data from BOT and NBS. The data base for this study was annual time series data from the Bank of Tanzania. The estimation procedures involved the whole procedure of the data cleaning, data transformation and econometric model estimation by following all steps for analysing the time series data.

5.1. Unit Root Test

To test the unit root or stationarity of the variable was employed simultaneous, Dickey-Fuller test and Phillips–Perron test since even though the Dickey-Fuller test is mostly wide used compared to other unit root test because some are biased so as to avoid that both test of unit root employed for analysis.

In the Dickey-Fuller test and Phillips–Perron test we test the hypothesis:

$$H_0: \emptyset = 1$$

$$H_a: \emptyset \neq 1$$

This implies that, when through the Dickey-Fuller test and Phillips–Perron test the null hypothesis implies presence of unit root or non-stationarity while alternative hypothesis implies presence of stationarity.

5.2. Lag Selection

In order to determine number of lags many test statistics and plot employed to determine number of lag length for example partial autocorrelation function (PACF) and Autocorrelation function (ACF). The test statistics employed to determine the maximum number of the lags. Bayesian Information Creation (BIC) and Akaike Information Criterion employed.

5.3. Co-Integration Test

Each one of the variables must be integrated in the same order (at same difference) or all-time series data must have a deterministic tendency to qualify for co-integration [17] Granger, C. W. J.. The empirical inference of the presence of a long run relationship between variables that are non-stationary at their level form but stationary until difference is co integration [18] Gujarati, D. Consequently, the co-integration test is critical for determining whether the variables have a long-term relationship. Then, using adequate assumptions on trends and lags, the Johansen test for co integration was employed to determine whether the variables under consideration are co integrated or not [26] Johansen, S.. To verify the analyses' robustness, both trace and maximum Eigen-value (max) statistics were used in Johannsen's framework.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{k} log(1-\lambda_i) \quad (1)$$

$$\lambda_{max}(r) = -T\ log(1-\lambda_{r+1}) \quad (2)$$

Where:
λ = Eigen-value
T = Observations
r = 1, 2, 3… n.

5.4. The Autoregressive Distributed Lag (ARDL) Model

The Autoregressive Distributed Lag (ARDL) model is comparatively more robust in small or finite samples [5] Akinsola, M. O., & Odhiambo, N. M.. consisting of 30 to 80 observations. The approach is appropriate where variables have different orders of integration or for mutually integrated data. Modelling the ARDL with the appropriate lags correct for both serial correlation and endogeneity problems [7] Álvarez, L. J., Hurtado, S., Sánchez, I., & Thomas, C.. ARDL co-integration estimates short and long run relationships simultaneously and provide unbiased and reliable estimates. In other words, the Error Correction Model 'ECM' joins together short run adjustments with long run equilibrium without losing long run information [14]. A simplified panel ARDL model [16] Baltagi for variables X, Y and Z can be expressed as:

$$\Delta y_t = \beta_o + \beta_1\Delta y_{t-1} + \gamma_1\Delta x_{t-1} + \delta_1\Delta z_{t-1} + \theta_0 y_{t-1} + \theta_1 x_{t-1} + \theta_2 z_{t-1} + \varepsilon_t \ldots \quad (3)$$

where θ_0; θ_1 and θ_2 are long-run coefficients, whose sum is equivalent to the error correction term of the Vector Error Correction Model.

5.5. Granger Causality Test

Since the regression analysis does not prove the causation or the direction causality among the variable [20] Gujarati, D. N., Porter, D. C, & Gunasekar, S. The granger causality approach was applied in this object to determine the causation among the variables such as oil price volatile, inflation and economic growth in Tanzania. Usually, the following equations employed simultaneous for the purposes of identifying the direction of causality.

$$ln\ X_t = \alpha_0 + \sum_{t=1}^{k+d}\alpha_{11} ln\ X_{t-1} + \sum_{t=1}^{k+d}\alpha_{12} ln\ Y_{t-1} + \varepsilon_{1t} \quad (4)$$

$$ln\ Y_t = \alpha_0 + \sum_{t=1}^{k+d}\alpha_{21} ln\ Y_{t-1} + \sum_{t=1}^{k+d}\alpha_{22} ln\ X_{t-1} + \varepsilon_{2t} \quad (5)$$

If the parameter $\alpha_{12} \neq 0$ and $\alpha_{22} = 0$ granger causality runs from Y to X this is also the same as when the parameter $\alpha_{22} \neq 0$ and $\alpha_{12} = 0$ granger causality runs from X to Y.

6. The Study Analysis

Objective: Was to analyse the causal relationship between Oil Price Volatility, inflation and economic growth in Tanzania. This objective was to analyse the regression for the intention of proving the causation or the direction causality among the variable [20] Gujarati, D. N., Porter, D. C., & Gunasekar, S.. The granger causality approach was applied in the study to determine the causation among the variables such as oil price volatility, inflation and economic growth in Tanzania. Usually, the following equations employed simultaneous for the purposes of identifying the direction of causality.

$$ln\ X_t = \alpha_0 + \sum_{t=1}^{k+d}\alpha_{11} ln\ X_{t-1} + \sum_{t=1}^{k+d}\alpha_{12} ln\ Y_{t-1} + \varepsilon_{1t} \quad (6)$$

$$ln\ Y_t = \alpha_0 + \sum_{t=1}^{k+d}\alpha_{21} ln\ Y_{t-1} + \sum_{t=1}^{k+d}\alpha_{22} ln\ X_{t-1} + \varepsilon_{1t} \quad (7)$$

If the parameter $\alpha_{12} \neq 0$ and $\alpha_{22} = 0$ granger causality runs from Y to X this is also the same as when the parameter $\alpha_{22} \neq 0$ and $\alpha_{12} = 0$ granger causality runs from X to Y.

The Reliability refers to the reproducibility, stability, and accuracy of results. If similar outcomes or findings have been obtained in comparable situations but under different conditions, the results of any study are considered valid [25] Twycross, A., & Shields, L Therefore the reliability guaranteed by the area where the data was obtained. So, in this study the data was collected at Bank of Tanzania and National bureau of statistics. For the case of Validity was assured by the following test statistic which is the CUSUM chart from statistical quality control which was employed to assess the model stability. Since this Durbin Watson (DW) test is biased against accepting nulls, the autocorrelation Lagrange Multiplier (LM) test can be employed instead of Durbin Watson (DW) test [31] Montgomery, D. C., Jennings, C. L., & Kulahci, M. When regressors have included a lagged dependent variable, there is no autocorrelation hypothesis. Miss-specification is frequently the cause of autocorrelation in estimated model residuals. Autocorrelation Lagrariane [22] Hill, R. C., Griffiths, W. E., & Lim, G. C

$$LM = \sum_{t=1}^{K} x\beta_t + \sum_{i=1}^{p} \varepsilon_{t-tp} + np \quad (8)$$

Moreover, the Jarque – Bera test was used to assess the normality of the error test by assess whether the residual values they follow normal distribution so as to conclude whether the residual is pure random or is not pure random.

$$JB = n\left(\frac{S^2}{6} + \frac{(K-3)^2}{24}\right) \quad (9)$$

Where:
n=the sample sizes
S=skewness coefficient
K=kurtosis coefficient

7. Results and Discussion

The general objective of the study was to analyse the impact of Oil Price Volatility on inflation and economic growth in Tanzania from 1970 to 2020. The study's findings were organized and evaluated to help the scholars to determine and evaluate whether the study met its goals or objective. The discussion of findings falls under the causality between oil price volatility, inflation and economic growth in Tanzania.

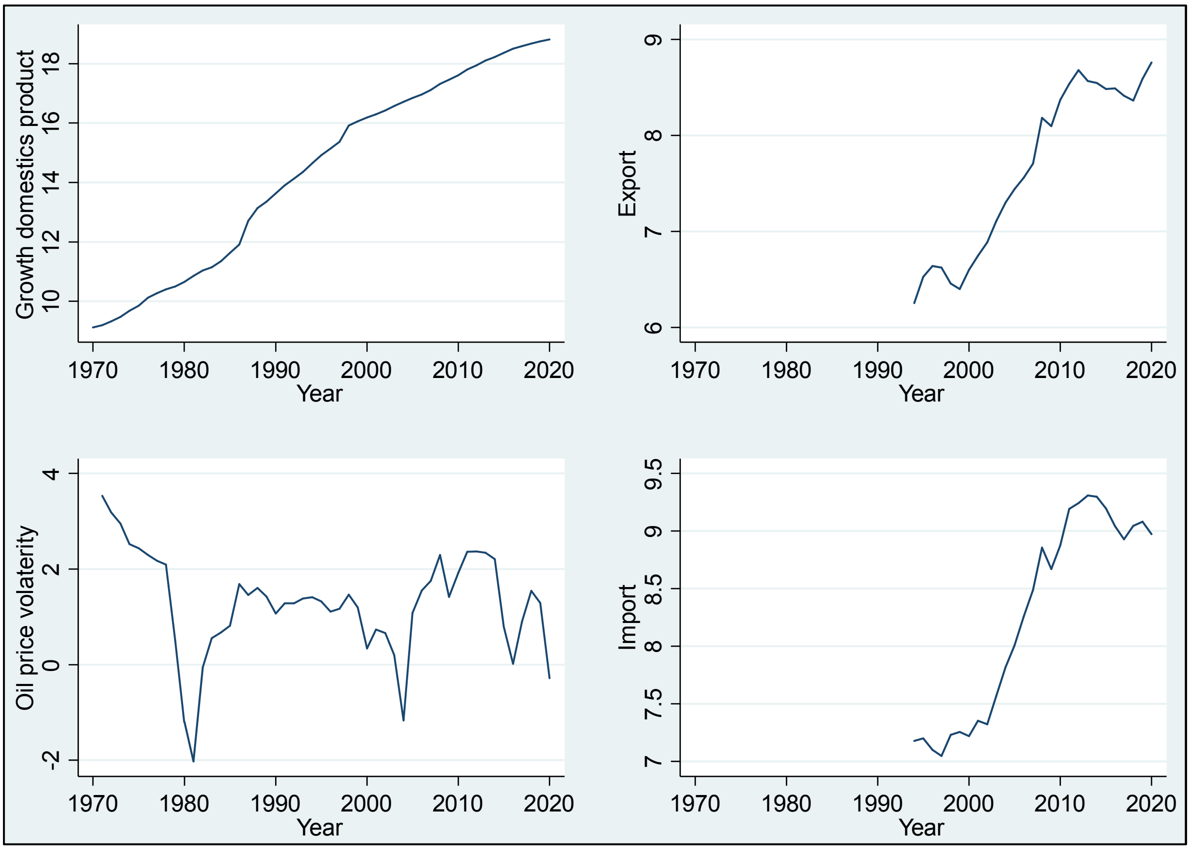

Figure 1. *Trend of Macroeconomic variables.*

Figure 1 show the time series plot for the economic growth, export, oil price volatility and import.

Figure 1. shows the finding for time series data from 1970 to 2020 yearly data that depicts that the gross domestic product has the trend components and since the gross domestic product increases with time this depicts the tendency of non-constant variance and mean i.e is non-stationary. For the Export and import these depicts two components of time series that showing the trend component and small cyclical components similarly these exports and import depicts the presence of non-constant variance and mean i.e is non-stationary. Lastly, oil price volatility depicts two components of time series such as cyclical pattern and irregular pattern. Moreover, all macroeconomic variables they are not having non-constant variance and mean i.e are non-stationary by visual inspection so this depicts the need of transforming these variables to be stationary and also this show there is a need for testing for co-integration test before applying any kind of the linear regression model.

7.1. Summary of Statistics of Macroeconomic Variables

Summary statistics describe the main features of the data in the study. It is also used to present huge amounts of data clearly and understandably. Every statistical description sums up a large amount of information in a concise sample overview, and thus constitutes the basis of any quantitative data analysis. Also in other words, descriptive statistics, are of considerable help in suggesting the nature of the distribution of data through the use of skewness and kurtosis. Lastly, assistance to show whether it helps transform data by applying natural logarithms. Therefore, Table 1 provides the summary statistics for the gross domestic product, oil price, export, import and inflation rate which were taken for the period of 51 years from 1970 up to 2020.

Table 1. *Descriptive Statistics.*

Variable	Obs	Mean	Std. Dev.	Min	Max	Skew	Kurt
GDP	51	25633498	41456936	9173	1.485e+08	1.718	4.731
Export	27	2885.922	2036.52	519.36	6371.716	0.206	1.417
Import	27	5241.292	3658.755	1147.982	11029.119	0.207	1.439
oil price volatility	50	5.774	6.257	.132	34.228	2.608	11.048
Inflation rate	51	15.601	11.055	2.4	36.1	0.504	1.693
Ln (GDP)	51	14.375	3.25	9.124	18.816	-0.22	1.585
Ln (Export)	27	7.642	.885	6.253	8.76	-0.22	1.407
Ln (Import)	27	8.25	.864	7.046	9.308	-0.18	1.313
Ln (oil price volatility)	51	1.273	1.081	-2.024	3.533	-0.69	4.054

Gross domestic product: table 1. shows that the log (Gross domestic product) had a mean of 14.375 and also a maximum value of 18.816 while a minimum of 9.124. In addition, the skewness was negative (i.e skewness is equal to -0.223), which implies that this is negatively skewed and it has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Export: table 1. shows that the log (Export) had a mean of 7.642 and also had maximum value of 8.76 while a minimum of 6.253. In addition, the skewness was negative (i.e skewness is equal to -0.22), which implies that is negatively skewed and has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Oil price Volatility: table 1 shows that the log (oil price volatility) had a mean of 1.273 and also had maximum value of 3.533 while a minimum of -2.024. In addition, the skewness was negative (i.e skewness is equal to -0.69), which implies that is negatively skewed and has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Import: table 1 depicts that the log (import) had a mean of 8.25 and the maximum value of 9.308 with a minimum value of 7.046. Also, the findings show the skewness was negative (i.e skewness is equal to -0.18), which implies that is positively skewed and has the right tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency. Moreover, since the magnitude value of skewness 0.177 is lower than 3 and the value of kurtosis 1.313 this show that this data of interest rate is normally distributed.

7.2. Lag Length Selection

The step in the analysis of the distributed autoregressive lag (ARDL) model or vector error correction model applying a previously established procedure for selecting lags. The numbers of lag can be accomplished in many ways, when making a selection about the amount of lag the random variable can have in these studies. The priority in picking maximum lag length came from the Bayesian Information Criterion (SBIC), which has theoretical advantages over other criteria and is thus used to avoid any kind of bias in estimating results [28] Lütkepohl, H.. [29] Lütkepohl, H., & Xu, F. The VAR model can provide a more comprehensive determination and evaluation of the lag lengths of the variables' relationship, therefore in this part adopted for sake of obtained the maximum number which was being employed in the test of unit root test and the test of the cointegration test. As shown in Table 2, the Estimation of Lag Length Based on Vector Autoregression (VAR) Model. To pick the maximum lags, go with the option with the lowest value on any criterion among the following test criterion as follows; Final predictive error (FPE), Akaike Information Criterion (AIC), Hannan Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC).

Table 2. *Lag length selection.*

Variable	Lag	FPE	AIC	HQIC	SBIC
Ln (GDP)	0	9.222	5.05944	5.07425	5.0988
	1	0.015	-1.34979	-1.32017	-1.27106
	2	.0132*	-1.4889*	-1.44449*	-1.37084*
	3	0.014	-1.44883	-1.38958	-1.29137
	4	0.014	-1.42109	-1.34702	-1.22426
Ln (Export)	0	0.6765	2.44702	2.45944	2.49639
	1	.0200*	-.81318*	-.788351*	-0.714445*
	2	0.0273	-0.76546	-0.72821	-0.61735
	3	0.0289	-0.70633	-0.65667	-0.50885
	4	0.0312	-0.63627	-0.57418	-0.38942
Ln (Import)	0	0.6409	2.39297	2.40539	2.44234

Variable	Lag	FPE	AIC	HQIC	SBIC
	1	.0252*	-.842251*	-.817418*	-0.743512*
	2	0.0266	-0.79099	-0.75374	-0.64288
	3	0.0286	-0.71994	-0.67028	-0.52247
	4	0.0271	-0.77578	-0.7137	-0.52893
Ln (Oil Price Volatility)	0	0.9772	2.81484	2.82973	2.85459
	1	0.5519	2.24351	2.27329	2.32301
	2	.5268*	2.19675*	2.24143*	2.31601*
	3	0.5469	2.23394	2.29351	2.39296
	4	0.5714	2.27735	2.35181	2.47611

Table 2: show that the gross domestic product has two maximum lag because at that number of lag it has the least value of SBIC compared to other values, export has one maximum number of lags, oil price volatility has two maximum number of lags and lastly, the import has maximum one number of lag since at this number of lag all the variable the comprises the least value of final predictive error (FPE), Akaike Information Criterion (AIC), Hannan Quinn Information Criterion (HQIC) and Schwarz Bayesian Information Criterion (SBIC). Therefore, these numbers of lag obtained from each independent and dependent variable were employed in the analysis of the unit root or stationary test for the sake of obtaining or determining whether the variable is stationary or not stationary so as to apply for a number at the specified number of lags which obtained in this section.

7.3. Unit Root Test

For the time-series data, the test of unit root or stationarity was used to assess whether the time series or sequence of the variables are stationary, where a series of tests are run. A time series is stationary when its mean and variance remain unchanged over time. On the other hand, time-series data are said to be non-stationary if either variance or mean (or both) change over time. To see the unit root, the unit root test is required because non-stationary variables yield inconsistent or vague findings due to changing data series. The first step in time series model construction is to test the unit root, according to [15] Dickey, D. A., & Fuller, W. A. a popular way to see if a set of time series data has a root unit is the Dickey-Fuller Augmented (ADF) test. Although the ADF criterion has a low-test power, it is recognized for this, according to [11] Chin, W. W., Peterson, R. A., & Brown, S. P. Phillips' Perron (PP) test procedures supplemented the unit root test, as the ADF test was often criticized for low power. PP is a better metric as it can help determine which time series have no long-term trend, appear to be unit root, or do not meet the tests for stationarity. The unit root or stationary test is always applied before the test of cointegration test. Error correction model applied for the sake of avoiding to have the spurious regression [22] Hill, R. C., Griffiths, W. E., & Lim, G. C.. The outcomes of the Phillips's Perron (PP) and Augmented Dickey-Fuller (ADF) test have been illustrated in Table 3.

Table 3. *Show test for stationarity both augmented Dickey fuller test and Phillips's perron.*

ADF Test					
Variable	**Level**		**First difference**		**order of integration**
	Test statistics	**Critical value**	**Test statistics**	**Critical value**	
Ln (GDP)	-1.539	-3.587	-3.218 ***	-3.014	I (1)
Ln (Ex)	-0.572	-3.750	-3.950 ***	-3.600	I (1)
Ln (PR)	-3.016	-3.600	-4.739 ***	-3.607	I (1)
Ln (Im)	-1.067	-3.750	-3.886***	-3.600	I (1)
The PP Test					
Variable	Level		First difference		order of integration
	Test statistics	Critical value	Test statistics	Critical value	
Ln (GDP)	-0.724	-18.900	-33.804 ***	-18.832	I (1)
Ln (Ex)	-6.915	-18.900	-43.801***	-18.832	I (1)
Ln (PR)	-15.011	-18.832	-39.099***	-18.764	I (1)
Ln (Im)	-0.966	-17.268	-18.421**	-17.200	I (1)

Note: Ln (GDP) stand for Natural logarithms of GDP; Ln (Ex) stand for Natural logarithms of Export; Ln (PR) stand for Natural logarithms of oil price and Ln (Im) stand for Natural logarithms of Import. To assess whether the variables were stationary prior to performing the error correction model (ECM) estimation, their time-series properties were first assessed. Before conducting statistical analysis, all variables were transformed into logarithm form and then they were differenced for the purpose of obtaining the mean and the variance which is stable over time as shown in Table 3 there are two sides the side of variable in level form and the side of the variable after applying the first difference.

The findings in table 3 show that all the variables at level form were not stationary at 1 percent level of significance since by applying absolute function all test statistics were less than the critical value at 1 percent level of significance. Then after differenced all log-transformed Macroeconomic variables they were statistically significant at one percent level of significance due to the fact that by applying absolute function all test statistics were greater than the critical values at one percent level of significance.

7.4. Co-integration Test

Johansen co-integration is one of the analysis tests that describe the long-term relationship between the variables [1] Akaike, H., [26] Johansen, S. The maximum estimation method is widely used in this test. Two main statistics, maximal statistics and Eigenvalue statistics, are covered in the Johansen co-integration test [19] Gujarati, D. N., [23] Hjalmarsson, E., & Österholm, P. If the results of this test are present, the zero ranks imply that the variables have no co-integration relationship.

On the other hand, if the results happen, it indicates that there is a single equation of co-integration. The variables should not be stationary in the Johansen test but should follow the state of stationarity when they have transforming into the first difference. Consequently, the exchange rate, the oil price volatility, inflation rate and the interest rate are non-stationary but are probably stationary when they move into the first difference. The guiding rule is: when the statistics are >5 percent critical, the null hypothesis of no co-integration is rejected. If statistics >5 percent are critical, accept the hypothesis that co-integration occurs. Table 4 show the test of co-integration.

Table 4. *Show the finding for the Johnsen Co-integration test.*

Null Hypotheses	Trace Statistics	Critical Value	Max-Eigen Statistics	Critical Value
r = 0	142.7877	47.21	85.3417	27.07
r ≤ 1	57.446	29.68	35.1153	20.97
r ≤ 2	22.3307	15.41	12.1245	14.07
r ≤ 3	10.2062	3.76	10.4466	3.38
r ≤ 4	1.2476	1.63	1.2278	2.07

Table 4: depicts that $\lambda trace$ tests rejected the null hypothesis of no co-integration (r = 0) against the alternative; as evidenced by test statistics which are greater than critical values at 5 percent significance levels. Addition to that the findings Johansen co-integration approach reveals that an existence co-integrating vectors (relationships) in the regression equation. Moreover, the trace statistics and Max-Eigen Statistics accept the null hypothesis that there is at most four r ≤ 4 integrating vectors (relationships). This is evidenced by the test statistics which are smaller than their corresponding critical values at 5 percent level of significance. Therefore, this implies that there is a long-run relationship between the exchange rate, oil price volatility, term of trade, inflation and interest rate.

7.5. Auto Regressive Distributed Lag Model (ARDL) Result for Impact of Oil Price Volatility on Economic Growth in Tanzania

Table 5. *Show the impact of oil price volatility on economic growth in Tanzania.*

Variables	(1)	(2)	(3)
	ADJ	LR	SR
LD. Ln (GDP)			-0.231**
			(0.0807)
D. Ln (Export)			-0.339***
			(0.0729)
LD. Ln (Export)			-0.105
			(0.0670)
D. Ln (Import)			-0.309**
			(0.0934)
LD. Ln (Import)			-0.400***
			(0.0787)
L2D. Ln (Import)			-0.405***
			(0.0441)
L3D. Ln (Import)			-0.271***
			(0.0432)
D. Ln (OPV)			0.109***
			(0.0185)
LD. Ln (Oil price Volatility)			0.104***
			(0.0159)
L2D. Ln (OPV)			0.0879***
			(0.0114)
L3D. Ln (OPV)			0.0718***
			(0.00887)
Ln (Export)		0.693***	
		(0.174)	
Ln (Import)		0.436*	
		(0.187)	
Ln (Oil Price Volatility)		-0.243***	
		(0.0303)	
L. Ln (GDP)	-0.470***		
	(0.0409)		
Constant			4.325***
			(0.299)
Observations	23	23	23
R-squared	0.986	0.986	0.986

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.18.6. ADJ (Adjustment Coefficient)

Table 5 shows the findings of the parameter of error correction term (ADJ= -0.470) that is negative. The coefficient value is 0.470 percent yearly this imply that the system corrects the previous period disequilibrium at a speed of 47 since the p-value was less than 1 percent level of significance.

7.6. Short Run and Long Run Model

Table 5 show that in the short run all the variables were statistically significant influence the economic growth. This conclude that all the independent variable included in the model they have short run effect on economic growth.

In Table 5 also, show that in the long run the following independent variable export and oil price volatility were statistically significant influence the economic growth while import was not statistically significant influencing the economic growth. The Export is statistically significant (p< 0.001) influence the economic growth with positive regression coefficient of 0.693. This implies that under ceteris paribus for each percent increase in export, on average, the economic growth increases by 0.693 percent. The Oil price volatility is statistically significant ($p< 0.001$) influence the economic growth with negative regression coefficient of -0.243. This implies that under ceteris paribus for each percent increase in oil price volatility on average, the economic growth decreases by 0.243 percent.

7.7. Diagnostics Test

The diagnostics tests were performed to obtain test results for sake of identifying whether the model or the findings are valid. The step in analysing the results of the estimations was to perform an autoregressive distributed lag model, vector autoregressive model or error correction model then to confirm the models were valid and could be used for predictions. In order to ensure that the empirical models were statistically good and that the CLRM assumptions were not violated, the following diagnostic tests were performed: To confirm that the residuals were normally distributed, the Jerque-Berra (J-B) test was used to see if a non-parametric equivalent of Leven's test for homogeneity of variance was rejected, and then Breusch-Godfrey LM test was employed to determine the level of autocorrelation in the data, the heteroscedasticity test, and finally CUSUM tests and CUSUM of squares tests to check for the model's stability. To keep this in mind, it's crucial to recall that it is essential to remember that when a traditional linear regression model's assumptions are no longer valid, estimating statistical models can lead to biased and inconsistent parameter estimates.

7.7.1. Breusch-Godfrey LM Test for Autocorrelation

Autocorrelation, also is known as serial correlation, is a prevalent issue in time series data analysis, although it can also arise in cross-sectional data [12] Creel, M Autocorrelation can be caused by removing essential variables from the model, functional misspecification of the model, lags in shock adjustment and measurement error in the independent variable. The null hypothesis for the serial correlation test is that there is no serial correlation, whereas the alternative hypothesis is that the error terms are autocorrelated. When the p-value is less than the 5 Percent level of significance, the null hypothesis is always rejected in Breusch-Godfrey Serial Correlation tests. As shown in Table 6, the following results were obtained after executing a Breusch-Godfrey LM test for autocorrelation.

Table 6. *Breusch-Godfrey LM test for autocorrelation.*

Lags (p)	chi2	Df	Prob > chi2
1	1.105	1	0.7801

Table 6 show that the test of autocorrelation or serial correlation of the error or disturbances term. The findings in Table 6 show that the p-value (p-value =0.7801) for the test of autocorrelation is greater than 5 percent level of significance. This depict that the alternative hypothesis is rejected and the null hypothesis is accepted. This implies that the model is free of autocorrelation or in other words the model is not suffering with autocorrelation problem.

7.7.2. Test of the Normality Assumption

Table 7: illustrate the findings of the jerque -Berra statistics which employed to test whether the data are normal distributed or not. The null hypothesis of this test is that the data are normally distributed and the alternative hypothesis is that data are not normally distributed so the rule of thumb in this test is to reject the null hypothesis once the p-value is less 5 percent level of significance. The results in Table 7 depict that failure to reject the null hypothesis and the alternative hypothesis is rejected. This implies that the error term from this model they follow normal distribution properties.

Table 7. *Jarque-Berra statistic.*

Model	Chi2	Prob>Chi2
Model one	0.8242	0.4538

7.7.3. Test of Heteroscedasticity Assumption

It recognized that the variance of every ε_t error term or disturbance should be constant this is one of the main and important assumptions of Classical or ordinary linear regression models. This assumption is known as Homoscedasticity, Homo stands for identical or constant and scedastic means not identical or not. This usually involves equal variance or means that the variance of the error term for all observations is constant and the same. However, in cross-sectional data, the heteroscedasticity problem may be more likely to occur than in time series [20] Gujarati, D. N., Porter, D. C., & Gunasekar, S [22] Hill, R. C., Griffiths, W. E., & Lim, G. C.. This could be due to fact that members can be different in size in cross-sectional data, when variables tend to be similar in magnitude, for example, during time series analysis. We can have heteroscedasticity if the classical linear regression is violated or not satisfied. The results on the heteroscedasticity status were obtained by using Breusch- Pagan (see Table 8) below.

Table 8. *Test for Heteroscedasticity.*

Test for Heteroscedasticity			
Source	**chi2**	**df**	**P**
Heteroskedasticity	11.42	9	0.246
Skewness	4.01	3	0.348
Kurtosis	2.15	1	0.285
Total	14.43	13	0.304

Table 8: showed that the Breusch-pagan test for heteroscedasticity which employed to test whether the model is homoscedasticity or is suffering with heteroscedasticity. The null hypothesis of this test is that the model is free from heteroscedasticity (i.e no heteroskedasticity) and alternative hypothesis is model is suffering with heteroscedasticity so the rule of thumb in this test is to reject the null hypothesis once the p-value is less 5 Percent level of significance. The results in table 8: depict that failure to reject the null hypothesis because the p-value is greater than 5 percent level of

significance. This implies that the model did not violate the classical linear regression analysis of no heteroskedasticity.

8. Summary Statistics of Macroeconomic Variables

Summary statistics are of considerable help in suggesting the nature of the distribution of data through the use of skewness and kurtosis. Lastly, assistance to show whether it helps transform data by applying natural logarithms. Therefore, Table 9: provides the summary statistics for the exchange rate, term of trade, oil price volatility, inflation and interest rate which were taken for the period of 51 years from 1970 up to 2020.

Table 9. *Descriptive Statistics.*

Variable	Obs	Mean	Std. Dev.	Min	Max	Skew	Kurt
oil Price	51	35.918	28.807	1.21	105.01	1.11	3.252
EX	51	743.118	768.974	6.9	2294.146	0.712	2.246
If	51	15.601	11.055	2.4	36.1	0.504	1.693
It	51	16.554	7.579	7.5	35.95	0.874	3.15
ToT	27	.55	.086	.397	.808	0.744	4.184
Ln (ToT)	27	-.608	.153	-.925	-.214	0.216	3.245
Ln (Ex)	51	5.249	2.251	1.932	7.738	-0.484	1.523
Ln (P)	51	3.201	1.016	.191	4.654	-1.055	4.425
Ln (Inf)	51	2.461	.797	.875	3.586	-0.073	1.649
Ln (Int)	51	2.707	.452	2.015	3.582	0.051	2.135

Note from Table 9: ToT stands for Terms of trade; Ex stands for Exchange rate; p stands for oil Price; Inf stands for inflation rate; Int stands for Interest rate; Kurt stands for kurtosis: skew stands for skewness.

Term of trade: Finding table 9 shows that the log (Term of trade) had a mean of-0.608 and also a maximum value of-.214 while a minimum of-.925. This implies that we are importing more than exporting. In addition, the skewness was positive (i.e skewness is equal to 0.216), which implies that this is positively skewed and it has the right tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Exchange rate: Table 9 findings shows that the log (Exchange rate) had a mean of 5.249 and also a maximum value of 7.738 while a minimum of 1.932. In addition, the skewness was negative (i.e skewness is equal to -0.484), which implies that this is negatively skewed and has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Oil Price: Table 9 Findings shows that the log (Oil Price) had a mean of 3.201 and also a maximum value of 4.654 while a minimum of 0.191. In addition, the skewness was negative (i.e skewness is equal to -1.055), which implies that this is negatively skewed and has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Inflation rate: table 9: Finding shows that the log (Inflation rate) had a mean of 2.461 and also a maximum value of 3.586 while a minimum of 0.875. In addition, the skewness was negative (i.e skewness is equal to -0.073), which implies that this is negatively skewed and has the left tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency.

Interest rate: Table 9: Finding shows that the log (Interest rate) had a mean of 2.707 and also a maximum value of 3.582 while a minimum of 2.015. In addition, the skewness was positive (i.e skewness is equal to 0.051), which implies that this is positively skewed and has the right tail is mainly extreme. Furthermore, the difference between the maximum and minimum values was not greater, implying that the data was not subjected to any outlier tendency. Moreover, since the magnitude value of skewness 0.051 is lower than 3 and the value of kurtosis 2.135 this show that this data of interest rate is normally distributed.

8.1. Correlation Matrix

A correlation matrix determines the initial pattern of the relationship between the set of independent variables and response variables. This correlation matrix illustrates the random variables' direction. If the correlation is present, the explanatory factors may be associated. It might be zero, or negative or positive, or close to plus or minus. A strong correlation between variables means that multicollinearity is present if values are close plus or minus one. Variables will have limited collinearity when values are close to zero. The data in Table 10: is obtained after the correlation matrix test was conducted.

Table 10. *Pairwise correlations.*

Variables	(1)	(2)	(3)	(4)	(5)
(1) Ln (Terms of trade)	1.000				
(2) Ln (Exchange rate)	0.255	1.000			
	(0.200)				
(3) Ln (Oil Price)	0.015	0.661	1.000		
	(0.939)	(0.000)			
(4) Ln (Inflation rate)	-0.365	-0.384	-0.070	1.000	
	(0.061)	(0.005)	(0.627)		
(5) Ln (Interest rate)	-0.179	0.711	0.297	0.162	1.000
	(0.372)	(0.000)	(0.034)	(0.257)	

Table 10: shows the correlation matrix table which was conducted for the sake of determining the extent of the relationship between the set of independent variables and the response variables. The findings in Table 10 show that the inflation rate has a very weak negative association with the exchange rate. This is due to the fact that the magnitude of the correlation coefficient between inflation and the exchange rate was-0.384, which is lower than 0.5 in absolute value, and also that the p-value for this test of association between inflation and the exchange rate was 0.005, which is less than a 5 percent level of significance. Apart from that, the findings in Table 10 show that the inflation rate has a very weak positive association with the interest rate. This is due to the fact that the magnitude of the correlation coefficient between inflation and the interest rate was 0.297, which is lower than 0.5 in absolute value, and the p-value for this test of association between inflation and the interest rate was 0.034, which is less than 5 percent level of significance.

8.2. Analysis of the Causality Between Oil Price Volatility, Inflation and Economic Growth in Tanzania

Estimation of Lag Length explained basing on the time-series data is lagged observations of variables that have an effect on independent variables (i.e., autocorrelation). The VAR model is a critical specification or test for time series data in identification maximum number. The co-integration, error correction models and Granger Causality Test are all based on the VAR model due to the fact that the application of the VAR model to estimate the lag lengths of the variables is widespread. Because the VAR model can provide a more comprehensive determination and evaluation of the lag lengths of the variables' relationship. The precise selection of the lag length is critical to the co-integration, error correction models and Granger Causality Test that will be used in the final section of this research dissertation. The lags or previous observations may not only come from dependent variables but also independent variables. The VAR model is a very important specification for time series data. The VAR model is used in the following applications: co-integration, error correction models, and the Granger Causality Test. VAR model can give a more comprehensive evaluation of the lag lengths of the relationship between the variables. The accurate selection of the lag length is very important to the co-integration, error correction models and Granger Causality Test which will be adopted in the latter part of this research dissertation. Table 11: shows the estimated lag length based on the VAR model.

Table 11. *Estimation of Lag Length Based on Vector Autoregression (VAR) Model.*

Lag	FPE	AIC	HQIC	SBIC
0	0.780479	8.26577	8.3102	8.38386
1	0.000155	-0.25655	-0.07879	.215826*
2	0.000155	-0.26528	0.045797	0.56138
3	.0001*	-.720159*	-.275761*	0.460787
4	0.000134	-0.45205	0.125668	1.08318

Table 11. show that all the variable inflation rate, Economic growth and price of oil together they have three maximum lags since at this number of lags all the variable the comprises the least value of Schwarz Bayesian Information Criterion (SBIC), final predictive error (FPE), Hannan Quinn Information Criterion (HQIC), Schwarz Bayesian Information Criterion (SBIC) and Akaike Information Criterion (AIC).

After the lag length was obtained the analysis of the granger causality test was adopted for the sake of obtaining the unbiased estimate and also to get the more robust findings. Therefore, by applying the lag length test before granger causality test led to avoidance of committing the type two error may have led to reject the true null hypothesis meaning that to say there is no causality or cause-effect of two variables while the two variable they have the causal effect in between. Therefore, table 12: show the results of the Granger causality between economic growth, inflation and price of oil.

Table 12. *Granger causality Wald tests.*

Equation	Excluded	chi2	df	Prob > chi2
Ln (GDP)	Ln (Oil price)	4.3331	2	0.115
Ln (GDP)	Ln (Inflation)	8.7393	2	0.013
Ln (GDP)	ALL	15.001	4	0.005
Ln (oil Price)	Ln (Gross domestics product)	0.52713	2	0.768
Ln (oil Price)	Ln (Inflation)	1.8699	2	0.393
Ln (oil Price)	ALL	5.1857	4	0.269
Ln (Inflation)	Ln (Gross domestics product)	6.4313	2	0.04
Ln (Inflation)	Ln (oil Price)	8.1257	2	0.017
Ln (Inflation)	ALL	21.943	4	0

The table shows the findings of the granger causality test that employed for sake of identifying the causality between oil price volatility, inflation and economic growth in Tanzania. The findings in Table 12: depict that there is no causality between the oil price and economic growth due to the fact that the p-value for causal effect from oil Price to economic growth was greater than 0.05 and similarly for the causal effect from of economic growth to oil Price. Also, the findings show that there is a two-way direction of causality between economic growth and inflation rate since the p-value in both states of direction was less than 0.05 level of significance which implies that is the economic growth (i.e., gross domestic product) enhanced the inflation rate as well as the inflation rate enhanced the economic growth (i.e., gross domestic product). Last the findings depict that there is a one-way direction of the causality from the oil price to inflation that is the oil price of enhanced the inflation rate.

The analysis results showed that there is a two-way direction of causality between economic growth and inflation rate consequently this implies that, the economic growth (i.e., gross domestic product) enhanced the inflation rate as well as the inflation rate enhanced the economic growth while for the case of oil price, economic growth and inflation the study concluded the presence one-way direction from the oil price to the inflation rate and economic growth.

9. Recommendations

9.1. To Government

Results have shown that most of activities that trigger the economic growth depend much oil. As such, increases in oil price led to increase in price of goods and service and unfortunate persistence increase in the general price of goods that is known as inflation. Hence, the government should put much attention on oil price by introducing interventions to reduce price of oil. Consequently, it will maintain stable inflation rate and economics growth as per national targets.

9.2. For Future Research

This study used only yearly data for gross domestic product, oil price, export, import, term of trade, and inflation rate from 1970 to 2020; However, future studies may use quarterly data in order to obtain a larger number of observations that can be analysed for their impact on Tanzania's gross domestic product.

10. Conclusion

The study intends to examine the impact of oil price volatility on inflation and economic growth, After the preliminary tests for unit roots and co-integration, the Johansen (ML) procedure was used to jointly estimate co-integrating vectors and error correction model. Financial time series analysis is crucial in the worlds of economics and finance. For forecasting and analysis, time series analysis has been frequently employed in finance variables. Stakeholders in business, finance, and investments are clearly interested in forecasting future returns on assets and non-assets. According to the conclusions of the study, it is strongly recommended that the government, particularly stockholders, pay more attention to exchange rates and interest rates, since these variables have a negative impact on their business. Basing on the objective the study concluded that there is a two-way direction of causality between economic growth and inflation rate consequently that implies an economic growth (i.e., gross domestic product) enhanced the inflation rate as well as the inflation rate enhanced the economic growth while for the case of oil price, economic growth and inflation the findings concluded the presence one-way direction from the oil price to the inflation rate and economic growth.

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