International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 6, Issue 6
June, 2023
Pages: 128-137

Multivariate Time Series Model in Forecasting Gross Domestic Product Growth, Inflation, and Foreign Direct Investment in Tanzania

Yohana Maiga[1]; Peter E. Tengaa[2]

[1]Tanzania Institute of Accountancy (TIA), Dar es Salaam, Tanzania

[2] College of Business Education (CBE), Mbeya, Tanzania

E-mail: yohanamaiga2016@gmail.com

http://dx.doi.org/10.47814/ijssrr.v6i6.1184

Abstract

The purpose of this study is to use time-series econometric methods, specifically Vector Autoregression (VAR) models, to predict the growth of Tanzania's Gross Domestic Product (GDP), Inflation, and Foreign Direct Investment (FDI) using annual data from 1991 to 2020. The research finds that there is a Granger causality between GDP and FDI, largely due to increased private investment and consumption. However, there is no Granger causality between inflation and GDP or FDI. The study predicts that inflation will remain stable but may experience occasional spikes due to supply-side shocks. Additionally, the study anticipates that FDI will continue to increase due to ongoing reforms aimed at improving the business climate and attracting more overseas investments. The model diagnostic test shows no autocorrelation and a stable model. Finally, the study forecasts that both GDP and FDI will continue to rise due to major sectoral projects taking place in Tanzania. This information is useful for policymakers and investors who can use it to make informed decisions and manage the risks associated with economic growth and development in Tanzania.

Keywords: *FDI; GDP Growth; Inflation; VAR; Multivariate Time Series; Granger Causality*

1.Introduction

Using statistical models and econometric techniques to anticipate future economic trends, including GDP growth and inflation, is known as economic forecasting. This critical tool is crucial in assisting policymakers and investors in making well-informed decisions. In Tanzania, the government and central bank rely heavily on economic forecasts to develop monetary and fiscal policies to promote economic advancement.

However, various studies have attempted to forecast GDP growth and inflation in Tanzania. For example, Kibonajoro et al. (2020) used a vector autoregression (VAR) model to forecast GDP growth and an autoregressive integrated moving average (ARIMA) model to predict inflation (Nyoni, 2019).

Forecasting GDP growth and inflation is essential for policymakers and investors to make informed decisions. Accurate forecasts can help the government anticipate potential economic shocks and take appropriate measures to mitigate their impact. Furthermore, accurate inflation forecasts can help individuals and businesses make better decisions about spending and investment, which can ultimately affect economic growth. Therefore, there is a need for reliable forecasting models to predict GDP growth and inflation in Tanzania (Nyoni, 2019; Nyoni & Bonga, 2019)(Kimolo, 2009).

Several studies have attempted to forecast GDP growth and inflation using various methods. (Byaro, 2013; U. & U., 2021) used a vector autoregression (VAR) model to forecast GDP growth in Nigeria. Their results showed that monetary policy, external shocks, and domestic investment are the main drivers of GDP growth. They found that inflation influences food prices, monetary policy, and exchange rate fluctuations.

Accurate GDP growth and inflation forecasting are crucial for Tanzania's economic development. Various methods have been used to forecast these variables, and policymakers and investors can use the results to make informed decisions that can further boost the country's economic growth (Flora et al., 2020; Udemba, 2019; Vujanović et al., 2021).

Tanzania is an African country that has experienced steady economic growth in recent years. However, like many other developing countries, it faces challenges related to inflation, foreign direct investment (FDI), and GDP growth. In particular, the country has struggled to maintain consistent economic growth rates while keeping inflation under control and attracting FDI.

Inflation is a significant concern for Tanzania as it erodes its citizens' purchasing power and reduces its exports' competitiveness. Inflation in Tanzania has remained high, averaging 5.2% in 2020, and is projected to increase to 5.6% in 2021. High inflation rates can lead to a decline in real GDP growth and increase uncertainty for businesses and investors, making it difficult to plan and invest in the country (Benefits, n.d.)(Byaro, 2013; Were & Madete, 2022).

Another challenge facing Tanzania is attracting foreign direct investment. FDI is essential for economic growth, as it brings in new capital, technology, and expertise and creates employment opportunities. However, Tanzania has struggled to attract FDI due to its poor infrastructure, lack of access to finance, and bureaucratic hurdles. In 2019, Tanzania received only USD 1.1 billion in FDI, a decrease from USD 1.2 billion in 2018 (Kisswani, 2017).

Finally, GDP growth is a critical factor for economic development, poverty reduction, and improving the standard of living of citizens. Tanzania's GDP growth rate has been volatile, averaging 6.7% between 2010 and 2019 but declining to 4.8% in 2020. Maintaining consistent economic growth rates is essential for the country to achieve its development goals and attract FDI.

Tanzania faces significant inflation, FDI, and GDP growth challenges. The country must address these challenges to maintain economic stability, attract FDI, and achieve sustainable development. Therefore, this study aims to forecast GDP growth, inflation, and FDI in Tanzania using a combination of macroeconomic variables and machine learning techniques.

2.Materials and Methods

2.1 Data Source

Three secondary data sets were used in this study. The GDP (in billion US dollars), inflation (in percentage), and Foreign direct investment (FDI) are computed based on the percentage changes in GDP. All these data were obtained from the world database from the sample period spans from 1991 to 2020.

2.2 Stationarity test

The Vector Autoregressive model (VAR) model is performed with lags 5. Following the obtained results based on Akaike Information Criteria (AIC), Schwartz Bayesian Information Criteria (SBIC), Likelihood Ratio (LR), Hannan Quinn Information Criteria (HQIC), and Forecast Prediction Error (FPE)

2.3 Lagrange-Multiplier Test

The Lagrange Multiplier test was used for detecting autocorrelation of 2nd order autocorrelation, by first deciding on the order of autocorrelation that we wanted to test, which is 2, and secondly, running the usual OLS regression of y against the explanatory variable x.

$$y_t = \alpha + \beta x_t + u_t \qquad (1)$$

and saved the residuals u_t

Again, we run a regression using the residuals from the second step as the dependent variable

against the explanatory variable x_t, (as in step two) and also lagged variables of u (depending on the order of the autocorrelation, in this case, 2 lags)

$$u_t = \delta_0 + \delta_1 x_t + \delta_2 u_{t-1} + \delta_3 u_{t-2} + \varepsilon_t \qquad (2)$$

And calculate TR2 for this regression (total number of observations multiplied by the R^2 value).

3.Results and Discussion

3.1 Descriptive Analysis

The descriptive statistics, including the mean, standard deviation, minimum and maximum values of the GDP growth rate, Inflation rate, and FDI inflows, as shown in Table 1. The results show that the inflation rate had attained the highest mean with a more significant deviation than other variables under study, implying a greater variety of data with the time period. On the other hand, FDI lags behind.

Table 1: Descriptive statistics of selected economic variables from the year 1991 up to 2020

Variable	Obs	Mean	Std. Dev.	Min	Max
Inflation rate annual	30	11.282	8.624	3.290	34.083
GDP growth rate	30	5.144	2.034	0.584	7.672
FDI inflows (Bil.)	30	0.738	0.598	0	2.087

3.2 Trend of the Data

Following the time series sequence in figure1, the pattern and nature of the trend on each variable were expressed, describing the inflation rate as one of the variables used with huge deviation hence altering fluctuation with time compared to other variables, which triggers the non-stationarity of the data by observing the trend of it.

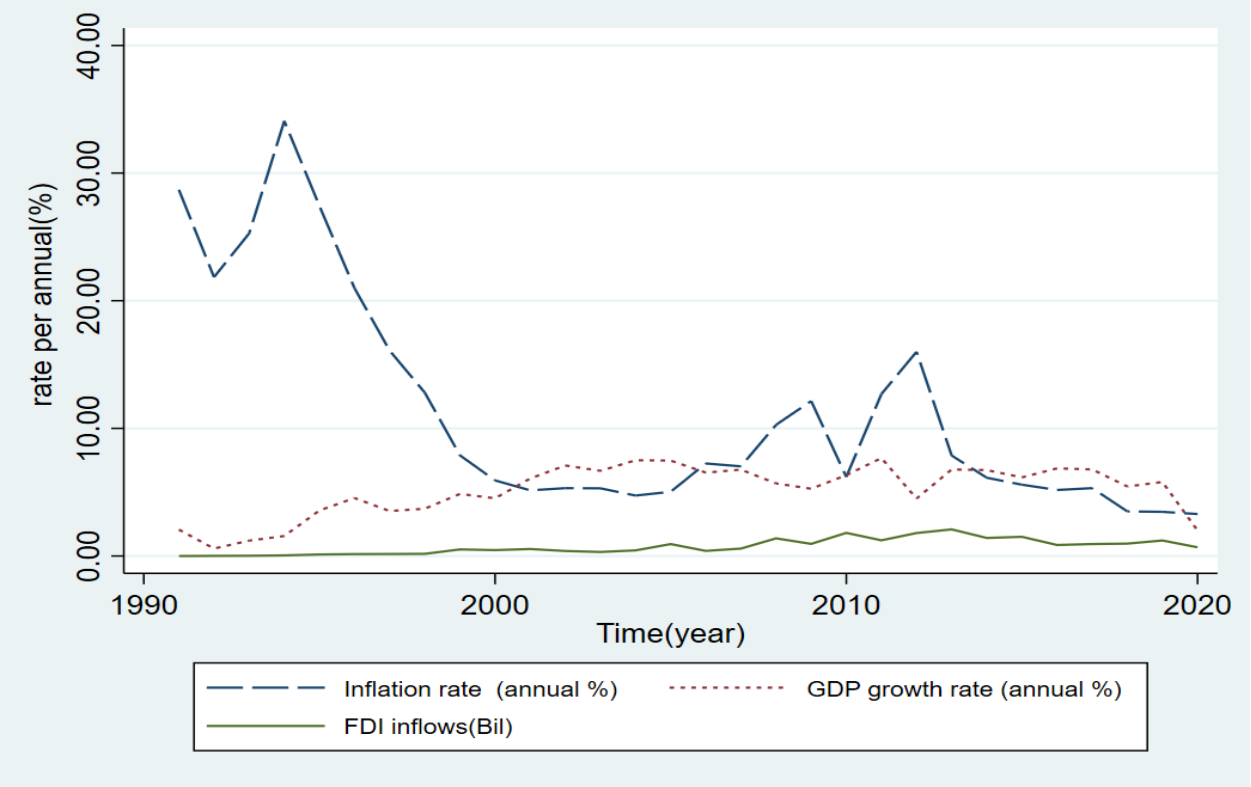

Figure 1: shows the GDP growth rate, Inflation rate, and FDI inflows (B) from 1991 to 2020.

3.3 Optimal Lag Order Stationary Test Analysis

The lag order test for stationarity was conducted under the Vector Autoregressive model (VAR) with lags 5. Following the obtained results based on Akaike Information Criteria (AIC), Schwartz Bayesian Information Criteria (SBIC), Likelihood Ratio (LR), Hannan Quinn Information Criteria (HQIC), and Forecast Prediction Error (FPE), all the criteria admit lag 1 as an optimal lag to be selected (the value with the star) the number of observations will be 28.

Table 2: Lag-order selection criteria for the VAR model using five lags (n=26)

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-145.444				18.27	11.419	11.461	11.564
1	-108.295	**74.299***	9	0.000	**2.11104***	**9.25342***	**9.42063***	**9.83408***
2	-100.556	15.476	9	0.079	2.405	9.351	9.643	10.367
3	-93.933	13.246	9	0.152	3.142	9.533	9.951	10.985
4	-88.416	11.034	9	0.273	4.872	9.801	10.345	11.688

* Optimal lag, Endogenous: LnFDI, Lninfl, lnGDP, Exogenous: _cons

3.4 Vector Autoregressive Model

The model fit results in Table 3 show the goodness of fit, coefficient of determination of approximately 0.8 (80%), and the lowest root mean square error (RMSE) suitable for economic models. This justifies that the model fit is good for parameter estimations.

Table 3: Model fit of LnFDI, Lninfl, and lnGDP at optimal lag

Equation	Parms	RMSE	R-sq	chi2	P>chi2
LnFDI	4	0.510067	0.8637	183.8347	0.000***
Lninfl	4	0.309388	0.8063	120.7046	0.000***
LnGDP	4	0.300838	0.7833	104.8514	0.000***

3.5 Parameter Estimation

The results in Table 4 show a significant influence of FDI on GDP with a $p<0.05$; the corresponding coefficient is 0.973. In contrast, there is no significant influence of FDI on Inflation as $p=0.412$, which is not less than the p-value. On the other hand, inflation has no significant influence on GDP and FDI as the p-value is 0.283 and 0.95, respectively. Moreover, there is a significant positive influence of GDP on FDI with $p<0.05$, while there is no significant influence of GDP on inflation.

Table 4: Parameter estimation on VAR model at lag 1

Variable	Coefficient	St. Err	z	p>z	lower	upper
lnFDI						
lnFDI						
L1.	0.344	0.052	6.55	0.000***	0.241	0.447
ln infl						
L1.	0.166	0.202	0.82	0.412	-0.23	0.562
ln GDP						
L1.	0.973	0.238	4.1	0.000***	0.508	1.439
_cons	-2.239	0.726	-3.08	0.002**	-3.663	-0.816
lnINF						
lnFDI						
L1.	-0.002	0.032	-0.06	0.951	-0.064	0.06
lninfl						
L1.	0.771	0.123	6.29	0.000***	0.53	1.011
lnGDP						
L1.	-0.155	0.144	-1.07	0.283	-0.437	0.128
_cons	0.667	0.441	1.51	0.130	-0.196	1.531
lnGDP						
lnFDI						
L1.	0.162	0.031	5.22	0.000***	0.101	0.222
lninfl						
L1.	0.102	0.119	0.86	0.391	-0.131	0.336
lnGDP						
L1.	0.421	0.14	3.01	0.003**	0.147	0.696
_cons	0.848	0.428	1.98	0.048**	0.008	1.688

3.6 VAR Model Diagnostic

One good thing about time-series Vector Autoregression (VAR) is that we can test causality in some sense. This test is first proposed by Granger (1969), and therefore, we refer to it as Granger causality.

Granger causality test: Examines if a current of one variable's lagged values helps predict a variable in the model.

Granger Test: The formulation of the null hypothesis and alternative hypothesis are as follows

Ho1: Foreign direct investment does not Granger cause Inflation

Ho2: Foreign Direct Investment does not Granger cause GDP

Ho3: Inflation does not Granger cause Foreign direct investment

Ho4: Inflation does not Granger cause GDP

Ho5: GDP does not Granger cause Foreign direct investment

Ho6: GDP does not Granger cause Inflation

The Granger causality test was used in estimating the causal relationship existing between fitted model values at a 0.05 level of significance. The test results in Table 5 show that both GDP percentage change and FDI inflows help predict the model contrary to the inflation rate, which is not helpful to predict both. The result also shows that the inflation rate is unimportant in predicting any of them. Therefore, the VAR model will include only GDP and FDI.

Table 5: Granger causality test results

Equation	Excluded	chi2	df	Prob>Chi2	Hypothesis	inference
LnFDI	lnINF	0.672	1	0.412	HO1	Do not reject
	lnGDP	16.794	1	0.000***	HO2	Reject
	ALL	19.728	2	0.000***		
LnINF	lnFDI	0.004	1	0.951	HO3	Do not reject
	lnGDP	1.151	1	0.283	HO4	Do not reject
	ALL	1.447	2	0.485		
LnGDP	lnFDI	27.289	1	0.000***	HO5	Reject
	lnINF	0.735	1	0.391	HO6	Do not reject
	ALL	27.508	2	0.000***		

Table 5 clearly shows there is a significant influence between GDP and FDI as bidirectional p values are less than 0.05. It should be noted that the removal of the inflation rate from the VAR model does not affect the lag length of the model, as it can be traced from results from Table 6, which shows that the second lag is an optimal lag of the model but based on likelihood ratio test (LR) and SBIC lag 1 is still consistent with being used as it will aid to maintain the highest number of observations rather than opting lag 2.

Table 6: Justification of optimal values (n=28)

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-66.182	0.650			.649912	5.245	5.273	5.342
1	-52.127	28.109*	4	0.000	0.300	4.471	4.555	4.76167*
2	-47.399	9.456	4	0.051	.286298*	4.41533*	4.55467*	4.899
3	-46.520	1.758	4	0.780	0.370	4.655	4.850	5.333
4	-43.834	5.372	4	0.251	0.423	4.756	5.007	5.627

* Optimal lag **Endogenous**: GDP, FDI, **Exogenous**: _cons

3.6.1 Stability Checks of the Model

The VAR (1) Process is stationary if the eigenvalues are inside the unit circle. Therefore, the diagnostic of the model stability by using eigenvalue was done. The results are shown in Table 7. It is observed that the modulus for Eigenvalues of the dynamic matrix lie within the unit circle and hence justify the model stability (VAR satisfies the stability condition).

Table 7: Eigenvalue stability condition

Eigenvalue	Modulus
0.783	0.783
0.630	0.63
-0.434	0.434
-0.054	0.054

3.6.2 Testing for Autocorrelation by Lagrange-Multiplier Test

The Lagrange Multiplier test was used to check for autocorrelation at lag orders. The result is shown in Table 8.

Table 8: Showing autocorrelation test for the VAR model

lag	chi2	df	Prob > chi2
1	3.5299	4	0.47334
2	3.7498	4	0.44092

Ho: No autocorrelation at lag order.

The results in Table 8 show that we fail to reject the null hypothesis and conclude that there is no autocorrelation at lag order, which means that the model is good for prediction.

3.6.3 Forecasting the Model

Table 9 shows the forecast results from 2020 to 2025 with their converted value transformed to actual values. Similarly, the prediction forecast is shown in Figure 2 to express the information in detail with a 95% confidence level bonded by the upper and lower limit.

Table 9: Showing the forecasted values

Year	Natural logarithm of forecasted data						Actual value from (ln)	
	LCL	lnFDI	UCL	LCL	lnGDP	UCL	FDI	GDP
2020	-	-0.3785	-	-	0.6913	-	0.6849	1.9963
2021	-0.3767	0.4013	1.1792	0.7726	1.3407	1.9087	1.4937	3.8216
2022	-0.9186	-0.0261	0.8664	0.7771	1.3847	1.9923	0.9743	3.9937
2023	-0.8636	0.1238	1.1113	0.9159	1.5594	2.2029	1.1318	4.7560
2024	-1.0003	0.0330	1.0662	0.9553	1.6061	2.2568	1.0335	4.9831
2025	-1.0113	0.0547	1.1207	1.0077	1.6628	2.3179	1.0562	5.2740

Further, the graph in Figure 2 was used to clarify the results in Table 9.

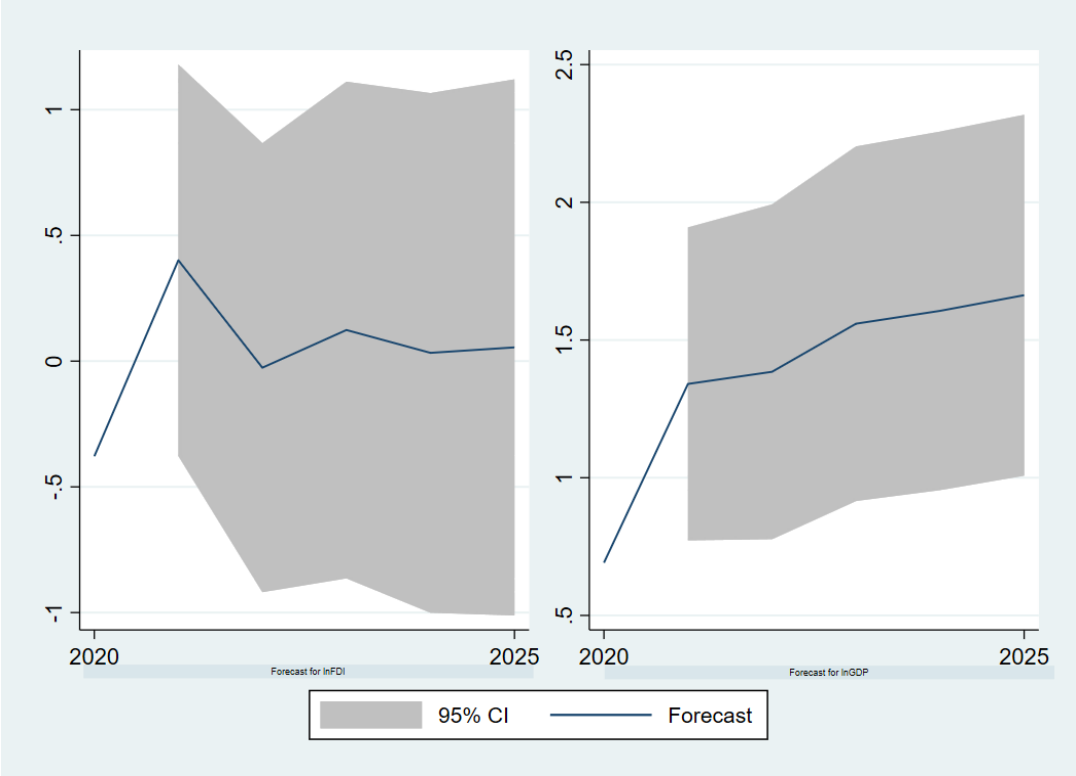

Figure 2: The forecast results from 2020 to 2025

FDI figure depicts a sharp rise up to the end of the year 2020, then a sudden decline, and this trend might have been caused by the impact of Covid 19 and the Russia – Ukraine war resulting in a fall. However, FDI seems to increase from 2023 to 2025 steadily. Moreover, the GDP trend seems to keep increasing, possibly due to mega investment undertaken and private sectoral investment.

3.7 Discussion

One of the main contributions of this study is the development of a multivariate time series model that takes into account the dynamic relationship between GDP growth, inflation, and FDI. The model is based on the vector autoregressive (VAR) framework, which allows for the estimation of the influence and relationships among these variables. The findings of the study suggest that FDI positively affects

GDP growth in Tanzania, while inflation has a negative impact, which is consistent with previous research by Mahembe & Odhiambo Pretoria (2014), Tang et al. (2008), and Wakyereza (2017).

The model's forecasted values can be beneficial for policymakers and investors in making informed decisions. However, the study has some limitations that need to be taken into account. First, the model only considers three economic variables, and other factors such as exchange rate, interest rate, and government spending may also affect economic growth in Tanzania. Therefore, future research should expand the model by including additional variables.

Second, the study assumes that the relationship among the variables remains constant over time, which may not always be accurate. To address this, future research can use a time-varying VAR model that accounts for changes in the relationships among the variables over time. Additionally, the study only considers linear relationships among the variables, and advanced modeling techniques can be used in future research to explore nonlinear relationships among the variables.

Overall, this study provides valuable insights into the dynamic relationships among GDP growth, inflation, and FDI in Tanzania. The findings can assist policymakers and investors in understanding future trends in these variables and making informed decisions. However, the study's limitations highlight the need for further research to expand and refine the model.

Conclusion

To sum up, this research paper has proposed a multivariate time series model that effectively predicts GDP growth, inflation, and foreign direct investment in Tanzania. The outcomes indicate that policymakers, investors, and other stakeholders in Tanzania can rely on the model to generate precise forecasts of these vital economic indicators. The study has also found that GDP growth and foreign direct investment are positively associated, while inflation does not have a significant impact on either of them. Hence, policymakers should adopt policies that foster foreign direct investment and economic growth while keeping inflation under control. Additionally, the model has been utilized to forecast GDP and FDI, demonstrating that both indicators are expected to increase. Overall, these findings have significant practical implications for policymakers and investors in Tanzania, providing a valuable framework for forecasting key economic variables.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this manuscript.

References

Benefits, M. (n.d.). Foreign Direct Investment for Development Foreign Direct Investment for Development Maximising Benefits, Minimising Costs. Organisation for Economic Co-operation and Development. Retrieved from www.oecd.org.

Byaro, M. (2013). Inflation, Saving Deposit Rate and Economic Growth in Tanzania: Evidence from Toda and Yamamoto (1995) Level VAR Causality Test. Journal of the National Board of Accountants and Auditors Tanzania, (Issue 2).

Flora, U., Tian, Z., & Ezezue, J. O. (2020). FDI (Foreign Direct Investments) as a Determinant for the Economic Growth of Nigeria (2009-2018). Open Journal of Business and Management, 8(2), 770–782. https://doi.org/10.4236/ojbm.2020.82047.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. Econometrica, 37(3).

Kimolo. (2009). Munich Personal RePEc Archive Modelling and Forecasting Inflation in Tanzania: A Univariate Time Series Analysis.

Kisswani, K. M. (2017). Evaluating the GDP-energy consumption nexus for the ASEAN-5 countries using nonlinear ARDL model. OPEC Energy Review, 41(4), 318–343. https://doi.org/10.1111/opec.12113.

Mahembe, E., & Odhiambo Pretoria, N. M. (2014). FOREIGN DIRECT INVESTMENT INFLOWS AND ECONOMIC GROWTH IN SADC COUNTRIES-A PANEL DATA APPROACH.

Nyoni, T., & Bonga, W. G. (2019). Modeling and Forecasting GDP per capita in Rwanda. DRJ-JEF, 4(2). www.dynamicresearchjournals.org.

Nyoni. (2019). Munich Personal RePEc Archive Modeling and forecasting inflation in Tanzania using ARIMA models.

Tang, S., Selvanathan, E. A., & Selvanathan, S. (2008). Foreign direct investment, domestic investment and economic growth in China: A time series analysis. World Economy, 31(10), 1292–1309. https://doi.org/10.1111/j.1467-9701.2008.01129.x.

U., A., & U., E. (2021). Multivariate Time Series Modelling of Nigerian Gross Domestic Product (GDP) and Some Macroeconomic Variables. African Journal of Mathematics and Statistics Studies, 4(3), 12–31. https://doi.org/10.52589/ajmss-0bvpbd9k.

Udemba, E. N. (2019). The triangular nexus causality among economic growth, TRADE, FDI and Oil Price: a time series analyses of Nigeria.

Vujanović, N., Casella, B., & Bolwijn, R. (2021). Forecasting global FDI: a panel data approach *. TRANSNATIONAL CORPORATIONS, 28(1).

Wakyereza, R. K. S. (2017). The Impact of Foreign Direct Investment on Economic Growth, Employment and Poverty Reduction in Uganda.

Were, M., & Madete, L. (2022). WIDER Working Paper 2022/155-The link between public debt and public investment in Tanzania. https://doi.org/10.35188/UNU-WIDER/2022/288-1.

Copyrights