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An Efficient Estimation Technique for investigating Economic Growth and its Determinants for Nigeria in the Presence of Multicollinearity

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Abstract

This study aimed to investigate economic growth (RGDP) and its determinants such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN). Quarterly data from 1986-2021 used for this investigation were extracted from Central Bank of Nigeria. Exploratory data analysis (EDA) revealed linear dependence of RGDP and the aforementioned determinants. The EDA and the variance inflation factor revealed the presence of multicollinearity caused by the INDT. As a result of this, the ridge regression method was used and it was found that the multicollinearity problem was addressed with appropriate ridge constant K= 0.29. Hence, ridge regression technique with constant K= 0.29 was a robust method to predict economic growth in Nigeria using the explanatory variables under consideration. Thus, served as a great benefit to the policy makers as the study provided a better understanding of the economic growth and the aforementioned determinants in terms of relationship and in particular the set back caused by EXDT on the economy of Nigeria. Also, the researchers benefited from this study as it engendered the understanding of the appropriate estimation technique to be used when the presence of multicollinearity was established in fitting a linear model.

Keywords: Multicollinearity; Least Square Regression; Variance Inflation Factor; Ridge Regression; Ridge Trace

JEL Classifications: G17; G21

Introduction

Nigerian economy poses several challenges to scholars and various researchers as a result of its structural, distinctiveness and outcomes and the fundamental contradictions therein. In the late 1960s, crude oil became the main driver of growth after a move from agricultural based economy. Since then, all diversification efforts made on the economy to provide better, stable and productive growth have not yeilded the desire result and success. Despite the high-level of revenues generated from oil since its main stay and the economy driver, it has failed to transform into expected prosperity and development of the nation and its citizens. The ranking of the countries based on major development indicators still showed that, the country is one of the poorest in the world. The economic growth is epileptic, face serious unsustainable and inconsistent growth subject to the instability and crashes witnessed in the revenue generated from crude oil in the world market in spite of several plans, policy frameworks and reforms. Various developmental plan, programme, vision and reforms on macroeconomic variables such trade openness, interest and exchange rate, external and domestic debt management proposed at the different time and level stimulates much expectations but in actual fact bring into being minute impact due to negligence and dishonesty and as such the continuous pitiable show that put the growth of the economy under serious problem and threat. Poverty, avoidable disease and misery are the traceable attributes and characteristics to describe Nigerian citizens because those in the helm of affair of the nation has failed to demonstrate stern dedication, control and sacrifice in steering growth and advancement.

Recently, the incident of growth impediment witnessed in 2015 in Nigeria ultimately deteriorate into 2016 and mid 2020 harsh economic recession after a partial relief in 2018. Agbanobi (2017) identified shift in global monetary policy cycles as a major reason for the country's economic wretchedness which has seriously impinge on financial market; particularly, inflation rate which was situated at 14 percent level in 2017Q1 against 12 and 13 percent mark in 2016Q1 and 2015 respectively. Interest rate is one of the main drivers of the economy, although inversely related via its consequence on investment. According to Habib *et al.* (2017) it was posited the critical consequence of interest rate on the growth and development whether it was examined using the cost of capital outlook or as the function of forgone alternative on funds. Therefore, it is important to state that monetary and fiscal policies influence the economy productivity. Thus, Anoka and Takon (2014) and Akonji (2013) asserted the strength and the competitiveness of economy with other nations based on exchange rate as a vital economic measurement. Oguntegbe and Alexander (2019) stressed that both interest rate and exchange rate enhanced the economic competitiveness and the need for viable policy formulation and direction for better improvement. Akinmulegun and Falana (2018); Lyndon and Ikechukwu (2019); Lawali, Machief and Aliyu (2020) stated the need to redesign the monetary policies so as to ensure stable exchange rate and the potentials of enhancing industrial output growth.

Odubuasi, Uzoka and Anichebe (2018) emphasized that spending of government in executing capital project through foreign loans influenced the growth of Nigeria's economy and that foreign debt service cost hindered the growth of the economy. Yusuf and Mohd (2021) submitted that improvement in economy suffered serious setback as a result of external debt such that long term growth was hindered even when it was economic growth enhancing in the short-term. Moreover, the consequence of domestic debt in relation to the growth of the economy was in inverse order for both long and short term growth when compared with the external debt. Also, debt servicing constitutes a major hindrance to economic growth as it confirmed the effect of debt overhang. Lawali, Machief and Aliyu (2020) stated that the economic openness can be made to enhance economic growth via a sustainable diversification effort. Sunday and Ahmed (2019) asserted that in both short and long run, trade openness had a serious constraint on the growth of the economy. Thus, it can be emphasized that the imports were greater than export in Nigeria and as such the need by the government to engage in export led diversification to spur economic growth. However, this research focus on investigating the causal relation of economic growth and its drivers that includes internal and external debt, interest rate and exchange rate as well as trade openness in Nigeria. Also, the study is seeking to obtain the estimated parameters for the aforementioned drivers in the presence of multicollinearity problem in other to enhance the efficiency of the estimate which was majorly lacking in various work carried out when examined the relationship among various macroeconomic variables in literatures. The remaining parts of the study are discussed as follows. Section two was set aside for the review of literature, section three was centre on research method or methodology while section four and five focused on results and discussion as well as the conclusion.

Literature Review

In examining economic growth various studied have been carried out using different macroeconomic variables as a determinant thus, this section deals with the review of various existing literature relevant to this study. Some of the work done includes: Yusuf and Mohd (2021) investigated the effect of government debt on Nigeria's economy for the period (1980-2018). An Autoregressive Distributed Lag technique was empirically adopted in analyzing collected data. From the output, it was discovered that improvement in economy suffered serious setback as a result of external debt such that long term growth of the economy was hindered even when it was growth enhancing in the short-term. On the other hand, the domestic debt impacted economic growth in inverse order for the long-term and short-term growth when compared with the debt incurred externally. Also, debt servicing hindered the economic growth as it confirmed the effect of debt overhang. Obayori, Krokeyi, Kakain (2019) carried out research to examine the contribution of external debt to economic growth in Nigeria (1980-2016). Secondary data gathered from the Statistical Bulletin of CBN were analysed by means of Generalized Method of Moments (GMM). Finding indicated that external debt was positively and significantly contributed to the Nigeria's economy.

Moh'd AL-Tamimi and Jaradat (2019) investigated external debt and economic growth in Jordan 2010-2017. A descriptive statistic adopted for the study during the period under examination indicated that external debt and economic growth were negatively and significantly linked. Odubuasi, Uzoka and Anichebe (2018) analysed external debt and economy of Nigeria (1981-2017). The secondary data collected on the identified economic variables from CBN and NBS were used for the study. The Granger Causality test and Error Correction Mechanism techniques revealed that debt stock from foreign nation and spending on capital projects by government had positive and significant influenced on the economy. It was also revealed that the influence of cost of servicing foreign debt on economy of Nigeria was insignificant. Ademola, Tajudeen and Adewumi (2018) carried out investigation on external debt and Nigeria's economy (1999-2015). An econometric technique such as Johansen Co-integration and VEC Mechanism were employed for examining the collected data. Findings showed that external debt and Nigeria's economy were inversely related during the period investigated.

Al Kharusi and Ada (2018) in their study investigated the relation of external borrowing by the government and growth of the economy spanning (1990-2015). An incessant increase of Oman's external debt in financing budget on yearly basis served as the motivation for the study. In the study, an Autoregressive Distributed Lag cointegration method was adopted in analyzing the data. Thus, it was discovered from the result that external borrowing by the government caused a setback that was significantly negative on growth of the economy in Oman. It was further discovered that gross fixed capital positively and significantly impacted the Oman's economic growth during the period examined. Ndubuisi (2017) carried out analysis on external debt and the growth of economy in Nigeria focusing (1985-2015). The data gathered on the variables under investigation were analyzed using OLS method, unit root test, Johansen cointegration and ECM test. From the results, a negative and insignificant was discovered as the main influence of debt servicing on the growth of economy in Nigeria. Also, it was discovered that the stock of external debt on Nigeria's economy index under consideration was significantly positive. The effects of other control variables examined were also significantly positive in determining economy index for growth. A long-run relationship and unidirectional causality was established as link of external debt to economy index for growth in the period considered.

Ijirshar (2019) carried out study to assess trade openness and economic growth in ECOWAS nations spanning 1975-2017. A dynamic panel models for examining heterogeneity of non-stationary data using Pooled Mean Group (PMG) and Mean Group (MG) estimation method were employed to explore the secondary data gathered for the study. In the findings, it was evidenced that effect of trade openness on economy of ECOWAS countries was positive in the long-run compare to short-run mixed effects observed. Thus, it was emphasized that the cooperation among ECOWAS member countries need to be improved this would help economic actors in the region to access international markets and to be more strategic in term of trade and competitiveness through export consortia. Sunday and Ahmed (2019) studied the dynamic trade openness on the growth of Nigeria's economy (1980-2016). The data extracted in the Statistical Bulletin of CBN were used. The techniques and diagnostic test carried out during the studied include: ADF test, cointegration and ECM. It was discovered from the result that the reflection of trade openness on growth of the economy was negative. Thus, it can be emphasized that the imports were greater than export in Nigeria and as such the need by the government to engage in export led diversification to spur economic growth.

Ezeuchenne and Lawal (2017) conducted a research to examine international trade and the growth of Nigeria's economy (1985-2015). Data were collected on the variables: interest rate, the balance of trade, exports and trade openness. The analytic techniques: ADF test, cointegration and vector of ECM adopted and it was found that the relationship between the variables under investigation were insignificant at long run. Also, it was found that economic growth and trade openness were unidirectionally related. Ude and Agodi (2015) carried out study on sensitivity of trade openness using Nigeria trade policy as yardstick. An ARCH, GARCH and Pairwise Granger causality were employed. Findings showed that trade openness and economic growth were significantly related. Also, it was found that interest and exchange rate significantly served as determinants of economy in Nigeria. Thus, it was emphasized that trade policy makers should put into consideration the policy environment before the formulation of trade policies that may not be implemented.

Ugbor (2014) investigated the causal relation evidence from trade openness and the growth of economy in Nigeria. The focus was to examine pre and post Structural Adjustment Programme (SAP) which were 1970Q1-1985Q4 and 1986- 2011. The data gathered on the following variables: Trade Openness, Government Expenditure and Investment were examined using unit root by Dickey Fuller and Pillips Perron, Granger Causality and Cointegration method. Thus, it was discovered that openness caused more changes in growth of the economy during SAP period when compared with pre SAP period. Ehinomen (2014) studied was focused on examination of economic openness and growth productivity in Nigeria (1970-2010). Secondary data collected on economic variables under consideration were analysed using OLS estimation techniques. Thus, it was found that openness of economy was positive and statistically significant on economic growth in terms of relation. Thus, emphasized the need for appropriate utilization of income from export, diversification of the economy as well as the encouragement of export promotion policies.

Awujola (2013) examined the drivers of external trade in Nigeria with the aimed of identifying main factors that influence external trade growth so as to formulate economic policy. The secondary data were gathered from CBN, IFS and WB on total trade the response variable and explanatory variables ('GDP, inflation rate', 'capacity utilization', 'exchange rate', 'government expenditure', 'interest rate', and 'import and export'). A Least Square regression method employed for the study revealed that all the explanatory variables except government expenditure, interest rate and import were positive and significantly influenced external trade. Thus, revealed that government expenditure, interest rate and import had a negative influenced on external trade. Ajayi et al. (2013) examined empirically trade openness and the growth of economy in Nigeria (1981-2009). Data collected on the variables such as "foreign direct investment, openness, exchange rate, and political stability" were analysed using OLS method. Findings indicated that a negative and insignificant relation existed between the degree of openness and political stability. However, the remaining variables showed positive and statistical significant relationship with the growth economy. Olaifa, et al. (2013) examined on whether long run relationships exists between trade openness and growth of the economy in Nigeria spanning (1970–2010). An OLS was adopted and the obtained results showed that trade openness greatly influenced economy in Nigeria. Thus, emphasized needs of conducive atmosphere such as reformed institutional structures should be put in place to enhance better economic growth.

Lawali, Machief and Aliyu (2020) examined the contributing effect of exchange rate on economy in Nigeria (1980-2019). Data extracted from the CBN Statistical Bulletin and an econometric technique such as: ADF test, Cointegration, and ECM were employed. The results indicated a positive contribution of exchange on the economy. The result further indicated that openness contributed negatively to the growth of the economy. Thus, government should make more effort to redesign the monetary policies so as to ensure stable exchange rate. Also, economic openness can be made to enhance economic growth a sustainable diversification effort. Oguntegbe and Alexander (2019) empirically studied the interest and exchange rate contributions to economic competitiveness in Nigeria. The data collected on interest rate, exchange rate and economic competitiveness (GDP) spanning (1981-2016) were examined. The result obtained from the OLS technique employed revealed that aforementioned economic variables contributed significantly to the feasible competitiveness of the economy. However, it was found that the contribution of the exchange rate to economic competitiveness was greater than that of interest rate and as such, the need for government to improve exchange rate system through viable policy formulation.

Lyndon and Ikechukwu (2019) carried out study to examine exchange rate volatility, balanced of trade and Nigeria's economy prosperity (GDP) spanning 2000-2017. The secondary data gathered which were extracted from CBN Statistical Bulletins annual reports. A descriptive statistics and multiple regression technique were employed. An empirical result obtained indicated that economic variables under study were

positive except balanced of trade which was insignificant in influencing economy prosperity in Nigeria. Therefore, the needs for adoption of suitable macroeconomic policies that would enhance stable exchange rate. Akinmulegun and Falana (2018) empirically investigated exchange rate fluctuation and industrial output in Nigeria (1986-2015). The secondary data extracted from NBS and CBN Statistical Bulletin on the economic variables under investigation were analysed using ADF and PP test for unit root, cointegration, Granger causality and Vector of ECM. 'The economic variables used were industrial output (GDP), exchange rate, inflation, interest rate and net exports'. It was found that exchange rate granger caused industrial output, that is, exchange rate positively and significantly influenced industrial output and the influence was more seen than the other variables examined in this study. Thus, it can be stressed that exchange rate has the capability of enhancing Nigeria's industrial output.

Ufoeze, Okuma, Nwakoby and Alajekwu (2018) studied exchange rate fluctuation and economic growth in Nigeria (1970-2012). The data collected on the macroeconomic variables used which includes: exchange rate, inflation, money supply and oil revenue and gross domestic product were gathered from Statistical Bulletin of CBN. A linear regression was fitted using least square method on the data collected. Diverse findings were obtained which indicated that a floating exchange rate was better than fixed exchange rate in determining a sustainable economic growth.

Micheal and Abiodun (2018) examined the parameters estimation for linear model when multicollinearity was observed. The study focused on the contribution of agriculture, industry and services to the overall GDP in Nigeria over a period of 1960-2011. Data extracted from the CBN website were analysed using multiple regression method and variance inflation factor (VIF) was used as a tool for detecting the presence of multicollinearity. After various transformations were carried out, the result of the differenced log-transformation of the components showed that the VIF reduced. It was further revealed that agriculture, industry and services were positively related to GDP during the period under study in Nigeria. The result also showed that industry had the highest contribution which was an indication that industry was key contributor to the Nigeria economy. The result also revealed that agriculture, industry and services played significant roles in the growth and development of Nigeria economy.

Alhassan, Balakarishnan and Jah (2019) carried out study to investigate multicollinearity in linear model: the effect on standard error of the exogeneous variables. An intercorrelation among six exogeneous variables and the particular consequence on the endogeneous variable were considered in the study. There are many measures in literature to detect multicollinearity in linear model with many explanatory variable based on the presence, degree and seriousness. In the study correlation method; variance inflation factor; tolerance level, conditional index number and eigen values were used to discover the presence of multicollinearity and its influence in the model.

In literature, we were unable to find a study that investigate the causal relationship between economic growth (RGDP) and its drivers such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) for Nigeria, thus, a gap in literature which is worth filling. We also aim to find an estimate of the parameters of linear model that show the relationship of RGDP with INDT, EXDT, RINR, REXR and OPEN under the violation of independency of explanatory variables (multicollinearity problem) using ridge regression technique in other to enhance the efficiency of the estimate which was majorly lacking in various work reviewed in this study.

Research Method

In this section, model specification and diagnostic techniques were discussed based on the macroeconomic data gathered from the CBN statistical bulletin that were used to investigate economic growth (RGDP) and its determinants which includes: internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR), and trade openness (OPEN) all measured in percentage between 1986Q1-2021Q1. The variables assumed a linear model stated in both functional and econometrical form as (1) and (2)

RGDP = F(INDT, EXDT, RINR, REXR, OPEN)	(1)
$RGDP = \alpha_0 + \alpha_1 INDT + \alpha_2 EXDT + \alpha_3 RINR + \alpha_4 REXR + \alpha_5 OPEN + \epsilon_i$	(2)

where, α_i and ϵ_i are the parameters to be estimated and error term respectively.

However, the multiple linear regression model stated in (1) and (2) were transformed and expressed in general form as given in (3) where Y represent the dependent variable RGDP and X represent the explanatory variables INDT, EXDT, RINR, REXR and OPEN.

$\mathbf{Y} = \mathbf{X}'\boldsymbol{\beta} + \boldsymbol{\varepsilon}$	(3)
The ordinary least square estimator of $oldsymbol{eta}$ is given in (4)	
$\widehat{\boldsymbol{\beta}} = (\boldsymbol{X}'\boldsymbol{X})^{-1}\boldsymbol{X}'\boldsymbol{Y}$	(4)
The covariance matrix of $oldsymbol{eta}$ can be obtained as given in (5)	
$\operatorname{Cov}(\widehat{\boldsymbol{\beta}}) = \sigma^2 (\boldsymbol{X}' \boldsymbol{X})^{-1}$	(5)

where *Y* are observational vectors of dimension $n \times 1$, *X* is an $n \times p$ data for matrix of independent variables, β are $p \times 1$ vector of regression coefficients and ε are an $n \times 1$ disturbance vectors. Under the assumption multicollinearity, correlation coefficients of independent variables are computed even though strong correlation coefficient does not necessarily imply the presence of multicollinearity, it can be a suspect and as such it can be ascertained by checking the variance inflation factor (VIF) and conditional index number (CN).

Variance Inflation Factor (VIF)

The VIF is given by (6)

$$VIF = \frac{1}{1 - R_i^2}, i = 1, 2, \dots, r$$
(6)

and R_i^2 is obtained by squaring the multiple correlation coefficients when X_1 is regressed on the remaining X_{1+i} independent variables. According to Allison (1999) and Freund and Littell (2000) as cited in Khalaf and Iguernane (2016) opined that VIF increased the variability of the estimated coefficients. Thus, it overstated the variance of the estimated parameters in comparison to what can be obtained when there was no correlation with any of the remaining variables present in fitting the model. Thus, VIF greater than 10 indicates a statistically significant multicollinearity. In such situation, the ordinary least square estimator do not possess the optimum statistical property hence, the need for alternative estimator that can address the situation. In this study a ridge regression estimation techniques is said to be considered and it performance is compared with the ordinary least square method by using a real data set that was scanty in previous studied.

Ridge Regression Technique

A strongly interrelated pairs of regressors, X'X is illconditioned and the variance of the ordinary least square estimator becomes large thus, the need to consider the ridge regression techniques given in (7) as

$$\widehat{\beta}_{RR} = (X'X + KI)^{-1}X'Y$$

Where, the constant $\mathbf{K} > 0$ and is called ridge constant parameter. As the constant \mathbf{K} increases from $0 \text{ to } \infty$, the estimated parameters reduces to become zero. Though ridge regression method provide a biased estimates, for a particular positive \mathbf{K} value, this estimator yields the smallest sum of square residual (SSR) or mean squared error (MSE) when compared with the OLS. Several methods for estimating \mathbf{K} has been proposed by (Hoerl and Kennard, 1970), (Hoerl *et al.*, 1975), (Mc Donald and Galarneau, 1975), (Hocking *et al.*, 1976), (Saleh and Kibria, 1993) and Khalf and Shukur, 2005). For example, in Hoerl and Kennard (1970), the value of \mathbf{K} that minimises the MSE was given in (8) as

$$\mathbf{K} = \frac{\hat{\sigma}^2}{\hat{\alpha}_{\max}} \tag{8}$$

where $\hat{\sigma}^2$ represents the error variance of model given in (1), $\hat{\alpha}_{max}$ is the maximum among elements of α and it is defined as $\alpha = D'\beta$ with **D** being an orthogonal matrix.

(7)

Results and Discussion

Data Exploration

The characteristics of the economic growth (RGDP) and its determinants such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) were described in this section using trend so as to explore the causal relationship among the aforementioned variables. Thus, it was revealed that INDT, EXDT, RINR, REXR, and OPEN had either inverse or direct relationship with the RGDP in Nigeria and as such the need to examine the descriptive characteristics and correlation of the variables. Fit a linear model for the economic variables and examine the violation of independency among the identified determinants of RGDP and the remedy when classical OLS method was used so as to ensure efficient estimate of the parameters.

Thus, in figure 1, the plot that shows the causal relationship between the economic variables under investigation was displayed. This was done to show how and the direction of relationship between the economic growth (RGDP) in Nigeria and its aforementioned drivers under consideration in this study.



Figure 1: The graph showing the trend of independent variables in relation to RGDP Source: Researcher's Computation, 2022

In Figure 1, the scattered plot that showed various trends in mean and variance of the independent variables such as INDT, EXDT, RINR, REXR and OPEN and how they were related to the RGDP during the period under study were plotted. Thus, in this study, a linear relationship was found between the identified determinants and the economy of Nigeria. To further establish linear relationship between economic growth and the aforementioned determinants, we carried out Kendall tau test for linear dependency which was presented in Table 1 below

Table 1: C	Correlations (Ke	endall's tau b C	orrelation Coeffic	ient for Linear De	ependency)	
	RGDP	INDT	EXDT	RINR	REXR	OPEN
RGDP	1.000	0.864	0.384	0.088	0.041	0.719
		0.000	0.000	0.122	0.474	0.000
INDT	0.864	1.000	0.439	0.026	0.046	0.731
	0.000		0.000	0.649	0.414	0.000
EXDT	0.384	0.439	1.000	0.212	-0.209	0.248
	0.000	0.000		0.000	0.000	0.000
RINR	0.088	0.026	0.212	1.000	-0.350	-0.044
	0.122	0.649	0.000		0.000	0.443
REXR	0.041	0.046	-0.209	-0.350	1.000	0.174
	0.474	0.414	0.000	0.000		0.002
OPEN	0.719	0.731	0.248	-0.044	0.174	1.000
	0.000	0.000	0.000	0.443	0.002	

Source: Researcher's Computation, 2022

The Kendall tau test presented in Table 1 further shown the evidence of linear dependency of the economic growth RGDP on the internal debt INDT), external debt (EXDT), interest rate RINR), exchange rate (REXR) and trade openness (OPEN) as the macroeconomic variables under consideration in Nigeria. From the Table 1, it can be observed that internal debt INDT), external debt (EXDT), interest rate RINR), exchange rate (REXR) and trade openness (OPEN) were positively related with economic growth (RGDP) in Nigeria. Also, in figure 2, the graph to examine the nature of distribution of the economic variables was considered.



Figure 2: The graph showing the normality of the variables Source: Researcher's Computation, 2022

In figure 2, the plot showed that economic growth (RGDP) and its determinants such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) were distributed normally. This was due to rejection of null hypothesis of not normally distributed as the probability of Chi-Square (0.3554 < 0.05). The Jarque-Bera value and the probability values (P-value > 0.05) in Table 1, also established that the variables are normally distributed in this study. In order to investigate the trend of independent variables in relation to RGPD, we plot the explanatory variables against the response variable. In Table 2 the descriptive statistic which was presented for the economic variables in this study. It consists of mean, minimum, maximum, standard deviation, variance, skewness and kurtosis.

Table 2: Descriptive Analysis

	RGDP	INDT	EXDT	RINR	REXR	OPEN
Mean	10.3046	6.6288	6.6573	3.1051	4.3175	0.1665
Median	10.2054	6.7393	6.4629	3.1139	4.3803	0.1200
Maximum	11.1422	9.0867	8.4950	3.5860	6.3197	0.4600
Minimum	9.6316	3.3478	3.7246	2.4849	2.7763	0.0100
Std. Dev.	0.4503	1.4988	1.0655	0.1929	0.6951	0.1302
Skewness	0.3710	-0.4095	-0.1634	-0.5734	-0.1748	0.6710
Kurtosis	1.8572	2.5576	2.7076	4.1714	3.6271	2.1246
Jarque-Bera	10.9083	5.0906	1.1299	15.7879	3.0287	15.0811
Probability	0.0043	0.0785	0.5684	0.0004	0.2120	0.0005
Sum	1452.950	934.6548	938.6716	437.8212	608.7708	23.4700
Sum Sq. Dev.	28.3891	314.4906	158.9331	5.2110	67.6489	2.3744
Observations	141	141	141	141	141	141

Source: Researcher's Computation, 2022

Table 2 showed the descriptive analysis of results of the economic variables such as RGDP, INDT, EXDT, RINR, REXR, and OPEN under investigation in this study. The average values of RGDP during the period under study stood at 10.3046 and it ranged from 9.6315 to 11.1422. The mean value of INDT and EXDT were 6.6288 and 6.6572 which were ranged between 3.3478 to 9.0867 and 3.7245 to 8.4950 respectively. While, the average values of RINR, REXH and OPEN were 3.1051, 4.3175 and 0.16645 respectively. It was observed that RINR, REXH and OPEN were ranged from 2.4849 to 3.5860, 2.7763 to 6.3197 and 0.01 to

0.46 in that order in the study period. The values 0.4503, 1.4988, 1.0655, 0.1929, 0.6951 and 0.1302 revealed the rate at which RGDP, INDT, EXDT, RINR, REXR and OPEN deviated from their respective mean values.

The skewness and kurtosis as shown in the result gave explanation about the distribution and shape of the economic variables under investigation. The skewness result showed that the RGDP (0.3710) and OPEN (0.6709) were positively skewed that is, skewed to the right of the mean and it was also discovered that INDT (-0.4095), EXDT (-0.1634), RINR (-0.5734) and REXR (0.1748) were negatively skewed that is skewed to the left of the mean. The kurtosis results revealed that all the economic variables under consideration were platykurtic with the kurtosis coefficient index less than 3 except RINR and REXR which were mesokurtic thus, emphasized the flattering beyond the level of normally distributed random variables.

Hence, to check for the independency in economic variables: INDT, EXDT, RINR, REXR, and OPEN used for determining economic growth (RGDP), we find the correlation between INDT, EXDT, RINR, REXR, and OPEN measured by the Pearson's coefficients of correlation which were presented in Table 3.

	(<u>u</u>	
	INDT	EXDT	RINR	REXR	OPEN
INDT	1.0000	0.6074(0000)	0.1276(0.132)	-0.0924(0.276)	0.8201(0.000)
EXDT	0.6074(0.000)	1.0000	0.3876(0.000)	-0.2898(0.000)	0.2534(0.002)
RINR	0.1276(0.132)	0.3876(0.000)	1.0000	-0.4594(0.000)	-0.0090(0.916)
REXR	-0.0924(0.276)	-0.2898(0.000)	-0.4594(0.000)	1.0000	0.2416(0.004)
OPEN	0.8201(0.000)	0.2534(0.002)	-0.0090(0.916)	0.2416(0.004)	1.0000

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Source: Researchers' Computation, 2022

The correlation coefficients presented in Table 3 showed the extent of relationship that exist between the economic variables under consideration such as INDT, EXDT, RINR, REXR and OPEN in Nigeria. From the Table 3, it was observed that INDT was found to be positively correlated with EXDT, RINR and OPEN with correlation coefficient of 0.61, 0.13 and 0.82 respectively. The study also revealed a positive correlation between the EXDT and RINR, EXDT and OPEN, REXR and OPEN with correlation coefficient of 0.39, 0.25 and 0.24 respectively. Thus, the high or strong correlation between the INDT and OPEN revealed the need to test for the presence of multicollinearity problem and thereafter, make appropriate correction to obtain a valid and best model for assessing the impact of the identified economic variables on RGDP in Nigeria.

Table 4 showed the fitted regression model for the economic variables considered in examining the contribution or the impact of each determinants and their significance which can be determined by the standard error test or *p*-value on RGDP the measured of economic growth in Nigeria during the period investigated.

	Coeff	Std Err	<i>P</i> -value of the <i>t</i> -statistic
Intercept	7.4666	0.2909	0.0000
INDT	0.2817	0.0216	0.0000
EXDT	-0.1128	0.0172	0.0000
RINR	0.3885	0.0721	0.0000
REXR	0.0998	0.0221	0.0000
OPEN	0.5078	0.2143	0.0192
Mean dependent var	10.2959	S.D. dependent var	0.4920
Sum squared resid	2.4208	S.E. of regression	0.1339
R-squared	0.9147	Adjusted R-squared	0.9116
F(5, 135)	289.6333	P-value(F)	0.0000
Log-likelihood	86.4884	Akaike criterion	-1.1417
Schwarz criterion	-1.0162	Hannan-Quinn	-1.0907
Rho	0.5748	Durbin-Watson	0.2124

Table 4: Result of the Estimation Techniques: Ordinary Least Square Method

Source: Researcher's Computation, 2022

In the Table 4, the result of the parameter estimation for the variables such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) used in assessing the growth of the economy (RGDP) in Nigeria were presented. The OLS method results revealed that INDT, EXDT, RINR, REXR and OPEN were positively related to RGDP except EXDT which was negatively related

to the RGDP. Specifically, INDT, RINR, REXR and OPEN increased economic growth RGDP by 28.2, 38.8, 9.9, and 50.8 percent respectively while, EXDT reduced growth of the economy (RGDP) by 11.3 percent. The standard error for INDT, EXDT, RINR, REXR and OPEN showed 0.022, 0.017, 0.072, 0.022 and 0.214 respectively and *p*-value of the *t*-statistic < 0.05 showed the statistical significance of the all estimated parameters. Also, the adjusted R-square of 0.912 as revealed 91 percent of variations in RGDP can be explained by changes in INDT, EXDT, RINR, REXR and OPEN. The F-statistic of 289.633 with *p*-value < 0.05 which measured the overall significance of the model revealed that the method was statistically significance in assessing the impact of INDT, EXDT, RINR, REXR and OPEN on RGDP in Nigeria. Thus, the high value of coefficient of determination of 91 percent from the Adjusted R-square according to Granger (2003) was an evidence to suspect for the presence of multicollinearity and as such the need for the test using variance inflation factor (VIF).

In Table 5 we therefore present the variance inflation factor of each determinants of economic growth under study to shows the economic variable(s) that caused the multicollinearity problem.

	VIF for OLS Regression	
INDT	14.2657	
EXDT	3.5290	
RINR	1.4369	
REXR	1.7571	
OPEN	9.5644	

Table 5: Variance Inflation Factor for the Ordinary Least Square Method

Source: Researcher's Computation, 2022

From Table 5, the result showed that VIF of 14.2657 > 10.00 and according to Allison (1999) and Freund and Littell (2000) as cited in Khalaf and Iguernane (2016) indicated the presence and statistical significance of multicollinearity caused by INDT. Based on this, we used a ridge regression technique as an alternative estimation technique to remedy the multicollinearity problem. The ridge regression was fitted using the appropriate ridge constant **K** to be chosen from the ridge trace statistic result.

In Table 6, we present the result of ridge trace which revealed the appropriate ridge constant **K** selected to fit the ridge regression model that addressed the problem of multicollinearity caused by the explanatory variables under investigation.

Table 6: Ridde Trace statistics of selected Hoerl and Kennard Ridde Constant	Table 6: F	Ridge Trace	statistics of	f selected Hoerl	l and Kennard Rido	e Constant K
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Constant K	0	0.0029	0.029	0.29	2.9	29	290
INDT	0.7743	0.7735	0.7658	0.7040	0.5114	0.3045	0.0770
EXDT	-0.1471	-0.1467	-0.1435	-0.1168	-0.0197	0.0813	0.0350
RINR	0.0994	0.0994	0.0993	0.0979	0.0822	0.0363	0.0111
REXR	0.1386	0.1385	0.1371	0.1258	0.0922	0.0512	0.0076
OPEN	0.3095	0.3101	0.3156	0.3586	0.4558	0.3259	0.0786

Source: Researcher's Computation, 2022

From In Table 6, the ridge constant **K** that produced the most efficient estimate of the parameters was 0.29. This was asymtontically chosen as the estimated parameters for each of the drivers of the economic growth (RGDP) under investigation were the same for the fitted ridge regression estimate in Table 7. The same result was also revealed in the ridge trace plot presented in figure 3 below



Figure 3: Ridge Trace Plot Source: Researcher's Computation, 2022

We then fit the ridge regression model with ridge constant \mathbf{K} = 0.29 presented in Table 6 which showed that the ridge trace plot for each of the economic variables used as the drivers of the economic growth (RGDP) either contrast or expand after the constant \mathbf{K} = 0.29 to show the efficiency of the plot at this level.

 Table 7: Result of the Estimation Techniques: Ridge Regression Method

RGDP	Coeff	Std Err	<i>P</i> -value
INDT	0.7040	0.1094	0.0000
EXDT	-0.1168	0.0598	0.0621
RINR	0.0979	0.0426	0.0301
REXR	0.1258	0.0448	0.0096
OPEN	0.3586	0.0907	0.0006
Mean dependent var	5.6102	S.D. dependent var	0.9670
Sum squared resid	0.9492	S.E. of regression	0.1949
R-squared	0.8973	Adjusted R-squared	0.8910
F(5, 135)	147.7685	P-value(F)	0.0000
Log-likelihood	29.5537	Akaike criterion	-93.6016
Schwarz criterion	-86.5956	Hannan-Quinn	-89.9494

Source: Researcher's Computation, 2022

In the Table 7, the result of the parameter estimation for the variables such as internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) used in examining the economic growth (RGDP) in Nigeria was presented. The estimation done using ridge regression technique to remedy the problem of multincollinearity revealed that INDT, RINR, REXR and OPEN were positively related to RGDP except EXDT which was negatively related to the RGDP as earlier observed from ordinary least square result. Specifically, the result indicated that INDT, RINR, REXR and OPEN increased economic growth (RGDP) in Nigeria by 70.4, 9.8, 12.6, and 35.9 percent respectively while, EXDT reduced the economic growth in Nigeria by 11.7 percent during the period under consideration. The respective standard error for INDT, EXDT, RINR, REXR and OPEN showed 0.109, 0.060, 0.043, 0.045 and 0.091 and P-values < 0.05 established the statistical significance of the estimated parameters of the model. Also, the adjusted R-square of 0.891 a measured of coefficient of determination revealed that 89 percent variations in economic growth (RGDP) can be explained by changes in internal debt (INDT), external debt (EXDT), interest rate (RINR), exchange rate (REXR) and trade openness (OPEN) respectively in Nigeria. The Fstatistic of 147.769 which measured the overall significance of the models revealed that ridge regression technique was statistically significance in examining the significance impact of INDT, EXDT, RINR, REXR and OPEN on RGDP in Nigeria. However, to examine whether the multicollinearity problem observed using ordinary least square method had been addressed, the test for collinearity among the explanatory variables was conducted through variance inflation factor (VIF) presented in the table 8 below.

Table 8: Variance Inflation Factor for the Ridge R	egression Technique
	VIF for Ridge Regression
INDT	9.143082
EXDT	2.733475
RINR	1.385869
REXR	1.534704
OPEN	6.28768

 Table 8: Variance Inflation Factor for the Ridge Regression Technique

Source: Researcher's Computation, 2022

In the table 8, the result of variance inflation factor (VIF) used in examining for the presence of multicollinearity was presented and the VIF for the INDT, EXDT, RINR, REXR and OPEN were 9.1431, 2.7335, 1.3859, 1.5347 and 6.2877 respectively. Thus, it can be emphasized the multicollinearity problem had been sorted out since all the VIF statistic < 10.00 for all the explanatory variables under investigation. Hence, the ridge regression technique and the selected ridge constant \mathbf{K} = 0.29 optimally addressed the problem of multicollinearity in the economic data used in this study and as such the efficiency of the estimation and the prediction and forecasting of economic growth RGDP for the nest quarter can be better obtained.

Conclusion

An examination of an efficient estimator for the parameters of an economic growth (RGDP) and it determinants such as INDT, EXDT, RINR, REXR and OPEN in the presence of multicollinearity problem was thoroughly investigated using an ordinary least square and ridge regression techniques. The results showed that multicollinearity was caused by the INDT as revealed by the variance inflation factor. It was also observed in the study that the ordinary least square estimation method under estimate the standard error of the parameters as result of the multicollinearity problem among the explanatory variables. However, it was evidence with the result obtained from the ridge regression method that the multicollinearity problem had been addressed as the variance inflation factor for the explanatory variables or determinants of the RGDP were all less than 10. Also, the standard error of the parameters or the determinants of the RGDP were better estimated when the ridge regression constant k was 0.29 as indicated by ridge trace which Hoerl and Kennard (1970 emphasized to produce minimum means square of error and when the ridge regression constant k was zero, it was observed that the parameters estimated were the same with the ordinary least square regression method. Therefore, based on the findings from the adopted two methods, it can be concluded that ridge regression technique was more efficient in estimating the determinants of economic growth (RGDP) under investigation in Nigeria in the presence of multicollinearity. Hence, this served as a great benefit to the policy makers as the study provide a better understanding of the contribution each of the aforementioned determinants contributed to the growth of the economy and the aforementioned determinants and in particular the negative influence of external debt on the growth of the economy in Nigeria. Also, it would be a benefit to the researchers as it engendered the understanding of the appropriate estimation technique to be used when the presence of multicollinearity was established in fitting a linear model.

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