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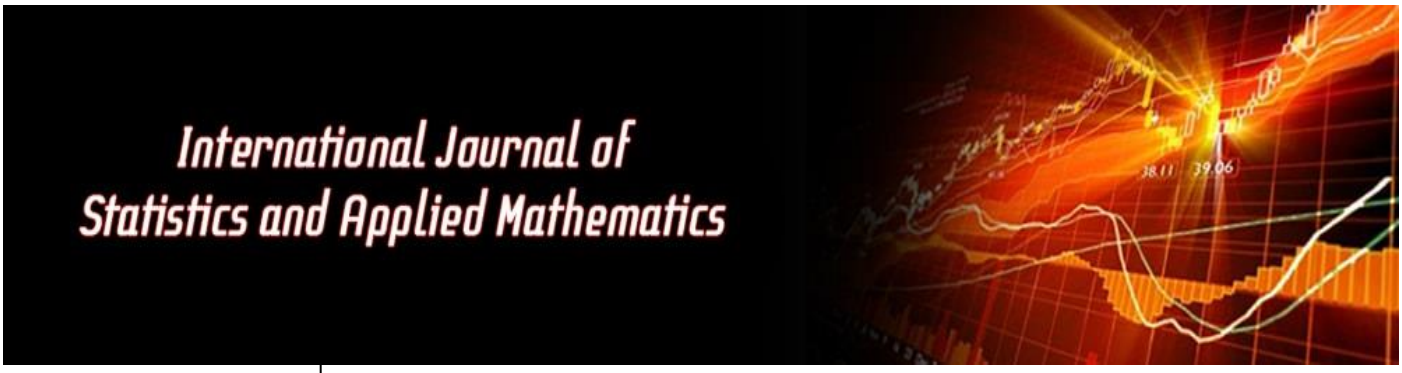

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Seun Adebowale Adebanjo
Statistical Training and Consultation, Nigeria

Corresponding Author:
Seun Adebowale Adebanjo
Statistical Training and Consultation, Nigeria

Modelling the relationship between confirmed cases of COVID-19, consumer price index and Nigeria economic growth: A multiple regression model approach

Seun Adebowale Adebanjo

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Abstract
The focus of this project work is on modeling the relationship between confirmed COVID-19 cases, consumer price index (CPI) and economic growth in Nigeria. Economic growth can be accurately captured by the country's gross domestic product per capita. It is notable that the pandemic has weakened the global economy, among other emerging economies. Nigeria has experienced serious retardation in her economic growth since the emergence of coronavirus disease in February, 2020 and we can see that the total gross domestic product per capita of $2229.85 in 2019 drop to $2148.91 at the end of 2020 due to COVID-19 impact and consequently prompt the Nigeria Government to take a lock down measure so as to contain the spread of the virus. Numerous studies have been conducted regarding this disease and this work goes further to fit a multiple regression to better describe the relationship between cases of the disease and Nigeria's economic growth. The regression model shows a significant linear relationship between cases of COVID-19, consumer price index, and gross domestic product per capita which suggests that the model is valid and suitable for predicting future growth in Nigeria. The multiple R-square of 0.712 is evidence that a about 71.2% of the variation in per capita GDP can be explained by the CPI and confirmed cases. The correlation analysis between confirmed cases of COVID-19 and the country's GDP per capita indicate a negative correlation between them which suggests that the higher the country's monthly confirmed cases of COVID-19, the lower will be its economic growth. The fitted model is robust, valid, reliable, and works well as the underlying assumptions about normality, multicollinearity, and homoscedasticity are satisfied.

Keywords: Economic growth, regression model, GDP per capita, CPI, correlation analysis, R-square, COVID-19

Introduction
The goal of this study is to study the connection between confirmed cases of COVID-19, consumer price index (CPI) and economic growth. With GDP per capita, this study adequately measures economic growth. Due to the outrageous spread of the virus and thus crippling economic activities of every infected nation, including Nigeria, the COVID-19 pandemic is known to have caused a very serious effect on global economic growth (Kolawole, S. K, 2020) [2]. Research has shown and it is clear that the greater the spread of the virus, the greater the decline in the economic growth of the country (Fernandes, N, 2020) [12]. The growing fear of not contracting the disease has become even more deadly than the virus itself, and this has prompted the Nigerian federal government to take some action through television and the media, such as initial full national lock-down and security protocol sensitization. The lockdown was gradually easier to partially lock down and then enforce the safety protocol that included regular hand washing, using facemask, and maintaining social distance in order to contain the spread of the pandemic. In 2020, as compared to what we have in 2019 due to the COVID-19 pandemic, the GDP per capita declined to $2148.91 (World Bank, 2020) [19, 21] and consequently led to the Nigerian GDP contracting twice in 2020, resulting in our practical economic recession (Zainab Ahmed, 2020) [31]. The consumer price index is an inflation measure and rises to 1.61% by December 2020 compared to 0.85% in December 2019, which causes the entire citizen untold hardship as food and other commodity prices suddenly rise.

The virus has further led to bankruptcy for many businesses in Nigeria, and others are folding up. The government decided to provide the survival fund to private industries in order to minimize massive layoffs of employees and to encourage other investors to continue in business by creating a sustainable environment for them to thrive in an effort to revive the Nigerian economy from recession. In addition, there are other measures adopted by the government and other private industries, such as working from home policy to contain the spread of the corona virus and then ensure business continuity and growth.

The aim of this research paper is to model the relationship between confirmed cases of COVID-19, consumer price index (CPI) and economic growth.

Meanwhile, as Nigeria recorded a sudden increase in the confirmed cases of COVID-19 in December 2020, the second wave of the COVID-19 also emerges and this makes the government place movement restrictions and further strict penalties on those who do not comply with the safety precaution of COVID-19 to allow them to contain the virus' further spread and achieve economic growth and survival (PTF, 2020) [32].

Research Gap

The Consumer Price Index (CPI) is a good gauge of inflation in a country. The sudden hike in price of commodities and low supply is an indication of inflation growth and this usually cause untold hardship on average Nigeria as feeding will be difficult and then result to serious struggle in order to survive. The occurrence of COVID-19 cases in Nigeria has caused the country's CPI to rise and has negatively affected economic growth, leading to the need to develop a model that can predict Nigeria's economic growth. On top of containing the COVID-19 pandemic, the government will also need to develop a decisive approach that will restore Nigeria's economy from the current recession.

Statement of problem

The aim of this study is to model the relationship between confirmed cases of COVID-19, consumer price index and Nigeria Economic growth. The variables of interest are confirmed cases of COVID-19, economic growth which is adequately measure by the gross domestic product per capita (GDP Per capita) and consumer price index (CPI). The dependent variable is the GDP per capita while the independent variables are confirmed cases of COVID-19 and consumer price index. The data for this study was collected from reliable sources like national bureau of statistics for CPI, data.worldbank.org for GDP per capita and world health organization for confirmed cases of COVID-19. The rise in confirmed cases of COVID-19 has cause a decline in the Nigeria economic growth with a decline in her GDP per capita income during the year 2020 that COVID-19 emerges in Nigeria. This cause a GDP contraction and practically make Nigeria to be in recession. In a bit for the country to come out of the recession and to contain the spread of the pandemic, the Nigeria government has ensure provision of good fiscal policies, strict compliance to COVID-19 protocols and also provide emergency funds to the most vulnerable and then survival fund to small and medium scale (SME) industries.

Definition of terms

Confirmed cases of COVID-19: This is the total number of people infected by the coronavirus disease in Nigeria.

Economic growth: This is an indication of positive or negative growth of country economy. The rise in the country GDP per capita is an indication of positive economic growth while the decline in the GDP per capita is negative growth or Nigeria economic retardation.

GDP per capita: This is a crucial part or indicator of the economic strength or growth of a country.

CPI: This is referred to as the consumer price index and it is a very good measure or index of inflation of a country.

Aim and objectives

The aim of this research paper is to model the relationship between confirmed cases of COVID-19, consumer price index (CPI) and economic growth. The following objectives are needed to achieve the aim of this study.

- To investigate the relationship between GDP per capita and confirmed cases of COVID-19
- To examine the impact of CPI on GDP per capita
- To establish a linear relationship among the confirmed cases of COVID-19, CPI and GDP per capita
- To fit a model that is suitable to predict the Nigeria Economic growth
- To proffer useful recommendations

Research hypothesis

H_1: There is a significant relationship between GDP per capita and confirmed cases of COVID-19

H_2: CPI has significant impact on GDP per capita

H_3: There is a significant linear relationship among the confirmed cases of COVID-19, CPI and GDP per capita.

Literature review

In just a decade, Nigeria experienced two successive economic crises. The economic crisis of 2009 was caused by the aftermath of the global financial crisis that occur within 2007 to 2008, lax borrowing practices, poor financial management of 5 banks and poor corporate governance (Sanusi, L. S, 2010) [30]. Banks have been a major factor in the 2009 crisis. On the other hand, the 2016 economic crisis was caused by an abrupt and unexpected fall in oil prices, which severely affected Nigeria's oil revenues (Adeniran and Sadiq, 2018) [4]. This led to a massive balance of payment deficits, combined with a disproportionately high debt burden, which necessitated a second recession in a decade. The literature shows that economic crises have significant consequences. Carneiro, A & Varejão, J. (2014) [29] found that the economic crisis in Portugal led to job losses due to the collapse of existing firms, an increase in unemployment, a freeze on minimum wages and also an increase in temporary employment. Cheong, K. S. (2002) [9] shows that income inequality in the South Korean economy increased during the economic crisis, while Giannakis (2017) [16] found in their analysis of the Greek economic crisis that the countryside was more resistant to recession than the city. Other adverse effects include: high homicide-related mortality rates, alcohol dependence during economic instability, and the collapse of many small and medium-sized enterprises (Soininen, J., Puumalainen, K., Sjögrén, H., & Syrjä, 2012, Chinazzi, M & Viboud, C. (2020) [18, 10] shows how the COVID-19 pandemic and lock-down restrictions have negatively affected African countries economically. There is no known literature on the impact of a health crisis on a damaged economy. There is limited research on the effects of coronavirus or COVID-19 on economic activities and performance in Nigeria. A limited number of Nigerian COVID-19 studies have been reported in the literature. Olapegba, P. (2020) [2] investigated the knowledge of Nigerians about COVID-19. Researchers find that some Nigerians have misconceptions about COVID-19, such as some respondents believe that COVID-19 is a

Chinese bioweapon. These misperceptions prevent preventive measures from being taken. They recommend that increasing evidence-based campaigns should be intensified to reinforce precautionary measures. Ozili, P.K. (2020) [1] report that Nigeria hosts the highest number of COVID-19 cases in Africa, and the third highest in the world. Ohia *et al*. predict that COVID-19 will have a devastating influence on African populations because of their weak health systems. They argue that Nigeria's current health care system is incapable of caring for an increasing number of HIV-infected patients. They recommend that the Nigerian government explore low-hanging fruits to address the COVID-19 pandemic. Jacob, O. N. (2020) [17] show that the COVID-19 pandemic affected higher institutions in Nigeria through school closures, reduction of international education, disruption of higher institution academic calendars, cancelation of local and international conferences, deportation of teachers, and loss of human power in educational institutions. Adegboye (2020) [3] examine the lower early transmission of COVID-19 in Nigeria and show that the cases of COVID-19 in Nigeria were lower than expected. Impact of the COVID-19 report on the Nigerian Stock Exchange from 2 January 2020 to 16 April 2020. The results showed a loss of stock returns and a high volatility of stock returns during the period during which COVID was implemented.

Research Methodology

The statistical tools adopted for this research work are multiple regression model and correlation analysis. Multiple regression model is predicting the dependent variable with more than one independent variables. Regression is very good for testing the effect or impact of independent variables on dependent variable using T test {t = Bi/Se (Bi)} and the coefficient estimates or parameters (Bi) that are significant will be consider the important variable that can predict the dependent variable. We can express the multiple regression model as:

$$Y = B_o + B_1X_1 + B_2X_2 + \ldots\ldots\ldots B_nX_n + Ɛ$$

Where, Y is the dependent variable (GDP Per capita) while X1 to Xn are the independent variables but we have two independent variables, X1= CPI and confirmed cases= X2 that explain the dependent variable (GDP Per capita) in this project. The Bo is an intercept which is the value of the GDP Per capita when X1 = CPI and confirmed cases = X2 are held constant. B1 to Bn are the slope or coefficient estimates of the independent variables in the model while Ɛ is the residual error or error term that takes care of all the unaccounted factor that is not included in the model. It is important to note that for us to have a suitable regression model that can predict GDP per capita which is a strong indicator of economic growth, the following OLS (ordinary least square) assumptions should be satisfy:

- **Assumption of linearity**: The fitted model should be linear in parameters.
- **Assumption of normality**: The residual error should be approximately normally distributed as we cannot have a perfect normality in practice.
- **Assumption of homoscedasticity**: The error term is expected to have a constant variance and violation of this assumptions is called Heteroscedasticity.
- **There should not be a significant outlier**: Outlier is an extreme observation that is not in accordance with the rest observations.
- **There should not be multicollinearity**: This is another very important OLS assumption which must be carefully observed as the presence of multicollinearity usually give a misleading p-values and R-square. Multicollinearity is said to occur when we have two or more independent variables that are highly linearly correlated. We usually measure this with variance inflation factor (VIF) in practice. VIF = 1/Tolerance and Tolerance = 1 – R-square. R-square is the coefficient of determination. When VIF of the independent variables are less than 5 (VIF<5), it means the model is free from the problem of multicollinearity but if VIF >5, it is an indication of presence of multicollinearity and when VIF>10, it is an indication of severe multicollinearity (Hagan, John; McCabe, Brendan, 1975).

Meanwhile, the first thing you need to check before choosing regression model is that your dependent variable should be continuous (ratio or interval scale) while the independent variables can either be continuous or categorical (ordinal or nominal scale).

Besides, the correlation analysis is a measure of the strength of association between two variables. Pearson moment correlation is applied in this work because the variables are ratio scale. The range of correlation coefficient, R is between -1 and +1 (-1<R<1) where -1 indicate a perfect negative correlation and +1 indicate perfect negative correlation. When correlation coefficient R is less than 0.5, it indicates a weak correlation and above 0.6 indicate a strong correlation. The statistical software used for this research analysis are E Views version 10.0 and SPSS version 26.0.

Result and Interpretation

This project work investigates modeling the relationship between confirmed COVID-19 cases, consumer price index and economic growth in Nigeria. The data for this study was collected from reliable sources like national bureau of statistics for CPI, data.worldbank.org for GDP per capita and world health organization for confirmed cases of COVID-19. This chapter deals with the analysis of the data as well as the interpretation of the results.

Table 1: Descriptive statistics

	Confirmed_Cases_COVID_19	CPI	GDP_Per_Capita
Mean	97.08333	310.6855	182.4480
Median	0.000000	308.8159	182.4480
Maximum	490.0000	355.9105	185.8200
Minimum	0.000000	276.6007	179.0760
Std. Dev.	157.5130	23.47426	3.444524
Skewness	1.547102	0.308678	-9.13E-19
Kurtosis	4.096875	2.044959	1.000000
Sum	2330.000	7456.452	4378.752
Sum Sq. Dev.	570637.8	12673.94	272.8892
Observations	24	24	24

From the table 1, we can see that consumer price index (CPI) has the highest mean of 310.6855 while confirmed cases of COVID-19 has the lowest mean of 97.08. Meanwhile, the confirmed cases of COVID-19 have the highest standard deviation of about 157.5 and GDP per capita has the least standard deviation of about 3.4. This simply tells us that confirmed cases of COVID-19 has the highest variability while GDP Per capita has the least variability from the mean. The high mean value of CPI indicate that we have high occurrence of inflationary growth in Nigeria as well as high variability of COVID-19 which is due to it spread and extension of the virus to second wave. This however in agreement with the presidential task force report which states that Nigeria recorded a sudden increase in the confirmed cases of COVID-19 in December 2020, the second wave of the COVID-19 also emerges and this makes the government place movement restrictions and further strict penalties on those who do not comply with the safety precaution of COVID-19 to allow them to contain the virus' further spread and achieve economic growth and survival (PTF, 2020) [32].

Table 2: Multiple regression analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	217.4399	7.020882	30.97045	0.0000
CPI	-0.111843	0.023280	-4.804195	0.0001
Confirmed_Cases_COVID_19	-0.002513	0.003469	-0.724283	0.4769
R-squared	0.712446	Mean dependent var		182.4480
Adjusted R-squared	0.685060	S.D. dependent var		3.444524
S.E. of regression	1.933052	Akaike info criterion		4.272546
Sum squared resid	78.47048	Schwarz criterion		4.419802
Log likelihood	-48.27055	Hannan-Quinn criter.		4.311613
F-statistic	26.01484	Durbin-Watson stat		0.609255
Prob(F-statistic)	0.000002			

Dependent Variable: GDP_PER_CAPITA
Method: Least Squares
Date: 03/03/21 Time: 16:38
Sample: 1 24
Included observations: 24

The regression model in table 2 is fitted as GDP Per Capita = 217.4399 – 0.1118CP1 – 0.0025Confirm case. This tells us that for 1 unit increase in consumer price index (CPI), GDP per capita will decline by about 0.1 USD. For 1 unit increase in confirmed cases of COVID-19, GDP Per Capita will decline by about 0.0025 which agrees with the literature state by Jacob, O. N. (2020) [17] which show that the COVID-19 pandemic affected higher institutions in Nigeria through school closures, reduction of international education, disruption of higher institution academic calendars, cancelation of local and international conferences, deportation of teachers, and loss of human power in educational institutions. Besides, the consumer price index P = 0.0001<0.01 significant level and this implies that consumer price index (being a measure of inflation) is statistically significant and hence has negative significant impact on the Nigeria Economic growth. This agrees with the fact that sudden hike in price of commodities and low supply is an indication of inflation growth and this usually cause untold hardship on average Nigeria as feeding will be difficult and then result to serious struggle in order to survive. The overall regression model P = 0.000002<0.01 which indicate that the fitted regression model is statistically significant and this indicate that there is a significant linear relationship among the confirmed cases of COVID-19, CPI and GDP per capita. This suggest that the model is a good fit for that data and can be used for future prediction. More so, R-square = 0.712 which indicate that about 71.2% variation in GDP per capita can be explained consumer price index and confirmed cases of COVID-19 while the remaining 28.8% can be attributed to other extraneous factors. The R-square is relatively high which is a pointer to model adequacy.

Table 3: Relationship between GDP Per Capita and Confirmed cases of COVID-19

Correlations			
		GDP Per capita	Confirmed Cases COVID-19
GDP Per capita	Pearson Correlation	1	-.630**
	Sig. (2-tailed)		.001
	N	24	24
Confirmed Cases COVID-19	Pearson Correlation	-.630**	1
	Sig. (2-tailed)	.001	
	N	24	24

**. Correlation is significant at the 0.01 level (2-tailed).

From table 3, the correlation coefficient, R = -0.63 this implies a strong negative correlation or relationship between GDP Per Capita and Confirmed cases of COVID-19 which indicate that the higher the confirmed cases of COVID-19, the lower will be the GDP per capita and vice versa while P = 0.001<0.01 this implies that there is a statistically significant relationship between GDP Per Capita and Confirmed cases of COVID-19.

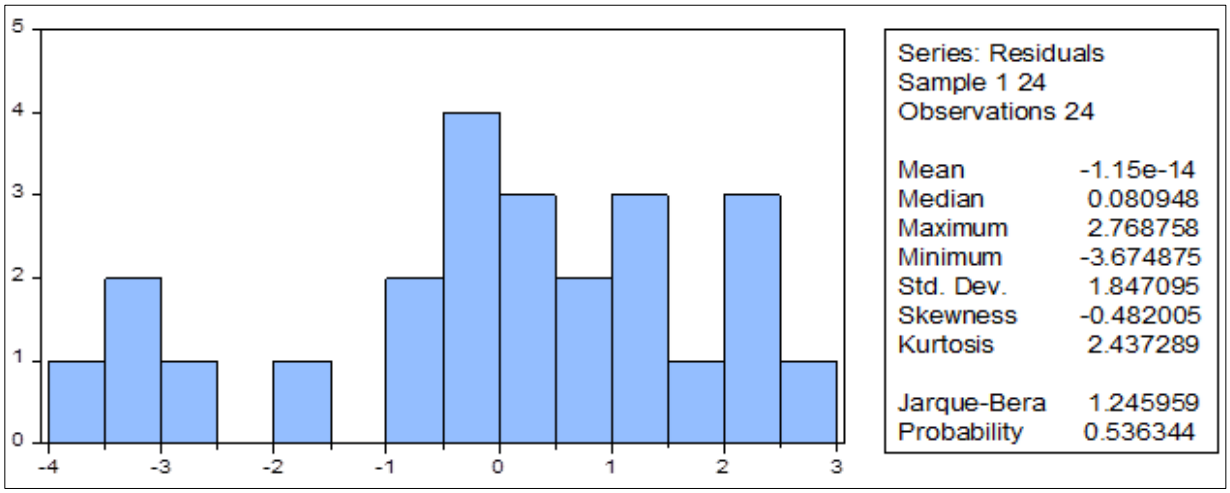

Fig 1: Normality test

The test of normality using Jarque-Bera in figure 1 shows that P = 0.536344 > 0.05 significant level indicate that the residual error is approximately normally distributed which satisfy the ordinary least square (OLS) assumption that back up the model validity.

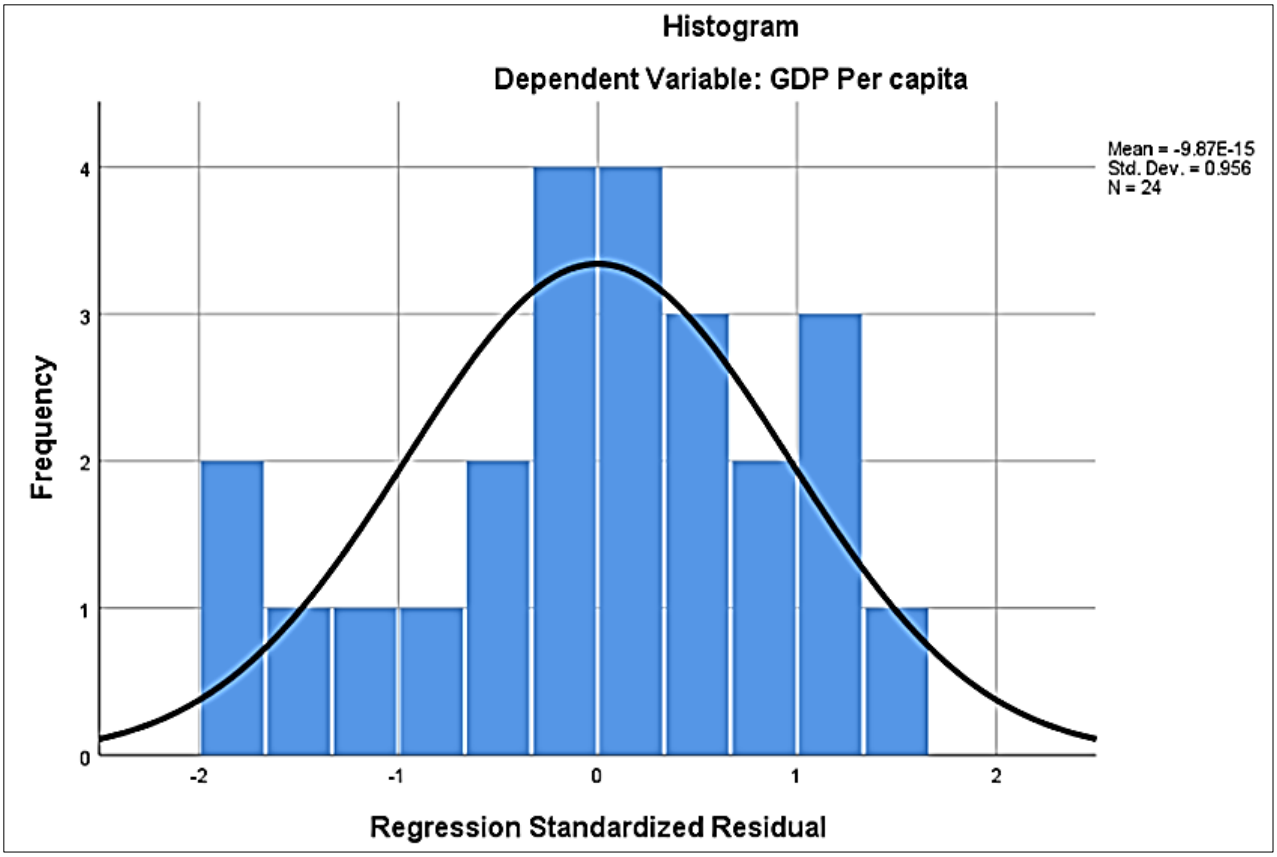

Fig 2: Histogram

The above histogram graph in figure 2 also satisfies the underlying assumptions that the residual should be normally distributed and hence demonstrated by the curve.

Table 4: Multicollinearity test

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	49.29278	316.5976	NA
CPI	0.000542	337.8397	1.838229
Confirmed_Cases_COVID_19	1.20E-05	2.566913	1.838229

Variance Inflation Factors
Date: 03/03/21 Time: 16:41
Sample: 1 24
Included observations: 24

The above shows the multicollinearity test and we can see that the variance inflation factor (VIF) for the two independent or explanatory variables (CPI and Confirmed cases of COVID-19) are both less that 5 (That is VIF = 1.838<5) indicate that the model does not suffer multicollinearity problem and this means that the model is robust, reliable and not misleading.

Table 5: Heteroscedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.501999	Prob. F (2,21)	0.1060
Obs*R-squared	4.618366	Prob. Chi-Square (2)	0.0993
Scaled explained SS	2.541082	Prob. Chi-Square (2)	0.2807

The above is a test of Heteroscedasticity in table 4, 5 which is one of the assumptions of OLS regression model and we can see that $p>0.05$ which implies that there is no heteroscedasticity problem. This implies that the assumption of homoscedasticity (constant variance of the residual or error term) is satisfy and the model does not occur problem of heteroscedasticity.

Summary of findings, Recommendations and Conclusion

Summary of findings

This research work aims to model the relationship between confirmed cases of COVID-19, consumer price index and Nigeria Economic growth. The fitted regression model indicates that for 1unit increase in consumer price index (CPI), GDP per capita will decline by about 0.1 USD. For 1 unit increase in confirmed cases of COVID-19, GDP Per Capita will decline by about 0.0025 which agrees with the literature state by Jacob, O.N. (2020) [17] which show that the COVID-19 pandemic affected higher institutions in Nigeria through school closures, reduction of international education, disruption of higher institution academic calendars, cancelation of local and international conferences, deportation of teachers, and loss of human power in educational institutions. Besides, the consumer price index P = 0.0001<0.01 significant level and this implies that consumer price index (being a measure of inflation) is statistically significant and hence has negative significant impact on the Nigeria Economic growth. This agrees with the fact that sudden hike in price of commodities and low supply is an indication of inflation growth and this usually cause untold hardship on average Nigeria as feeding will be difficult and then result to serious struggle in order to survive. The overall regression model P = 0.000002<0.01 which indicate that the fitted regression model is statistically significant and this indicate that there is a significant linear relationship among the confirmed cases of COVID-19, CPI and GDP per capita. This suggest that the model is a good fit for that data and can be used for future prediction. More so, R-square = 0.712 which indicate that about 71.2% variation in GDP per capita can be explained consumer price index and confirmed cases of COVID-19 while the remaining 28.8% can be attributed to other extraneous factors. The R-square is relatively high which is a pointer to model adequacy. The underlying assumptions that support the application of the model were satisfied and this make the model very robust and reliable. Meanwhile, Pearson correlation coefficient indicate that there is a strong negative relationship between GDP Per Capita and Confirmed cases of COVID-19 which tells us that the higher the confirmed cases of COVID-19, the lower will be the GDP per capita and vice versa.

Recommendations

In the light of the above, the following recommendations were made in order to sustain Nigeria economy from the surge of corona virus pandemic;

- Government should provide a relief fund for all small-scale industries and business owner so as to cushion the adverse effect of COVID-19 on their business.
- There should be strict compliance of the entire citizen to general COVID-19 precautions and safety rules like the use of face mask, washing of hand with soap and water, covering your nose with bent elbow when sneezing and maintain social distance so as to contain the spread of the COVID-19 pandemic.
- Government should provide empowerment program that will provide more job opportunities and gainfully engage the youth which will minimize crime rate and alleviate poverty.
- Government should develop a suitable and sustainable fiscal policy that will increase the public revenue, minimize debt and revive the economy from current recession.

Conclusion

The relationship between confirmed cases of COVID-19, consumer price index and Nigeria's economic growth is explored in depth in this study. The spread of the virus has thrown our country into recession twice in 2020, causing untold hardship for all citizens, contributing to high levels of crime, the burning of police stations, and the destruction of government property due to hunger, poverty, and high levels of unemployment as many industries are unable to accommodate many employees, resulting in mass layoffs. The significant negative correlation between confirmed cases of COVID-19 and GDP per capita means that the higher the confirmed cases of COVID-19, the lower the country's GDP per capita. As a result, this research emphasized the above recommendations in order to keep Nigeria's economy afloat in the wake of the corona virus pandemic.

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