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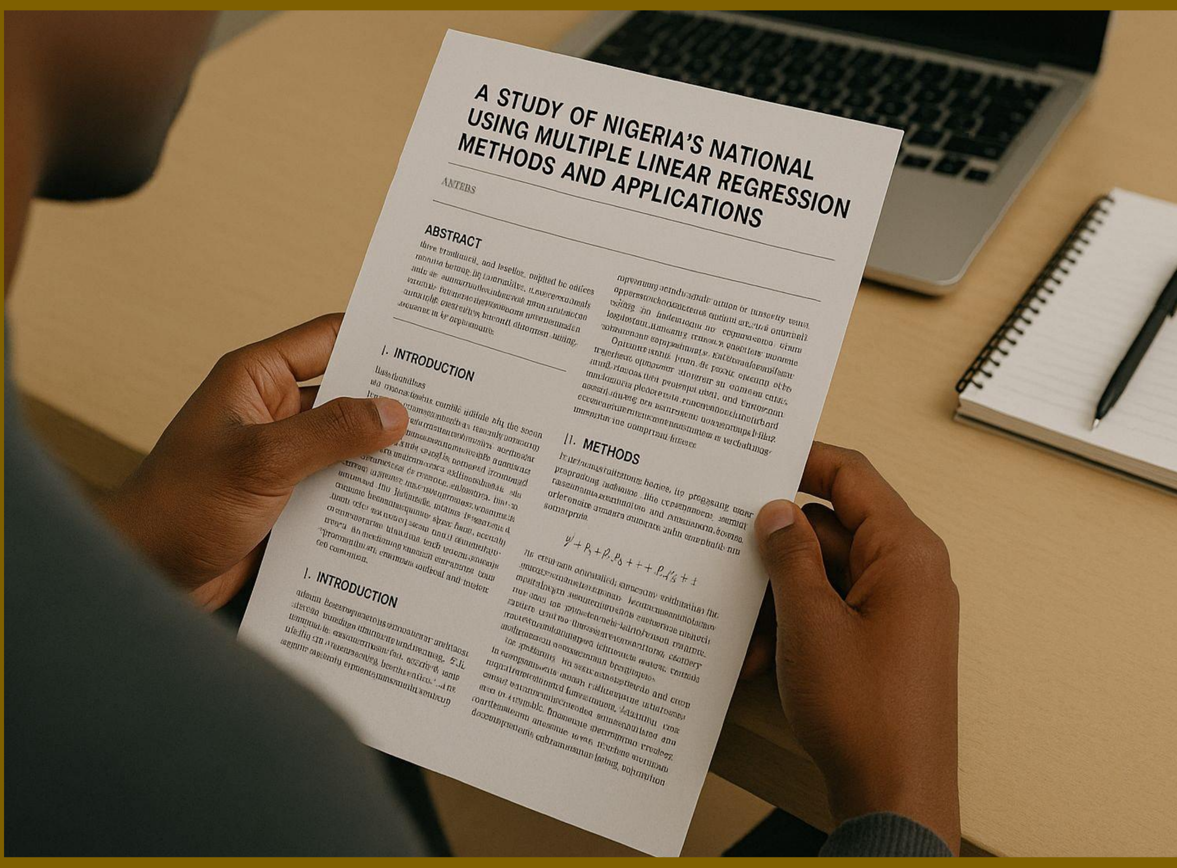

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ABSTRACT
*This study investigates how various macroeconomic variables relate to national income using regression analysis. National income, a key measure of a country's economic performance, is shaped by multiple factors, including investment, government spending, exports, and consumption. By applying a regression model, the study aims to quantify the influence of these factors on national income and to determine which variables are most impactful. Utilizing historical data from different time periods within the country, the analysis enables a comparative assessment of how these variables affect national income. The results indicate that investment and government expenditure are the strongest predictors of national income, while the effects of exports and consumption vary with the context. The research contributes to a deeper understanding of economic dynamics and offers actionable insights for policymakers aiming to promote growth and stability.****Keywords**: Macroeconomic variables, National income, Investment, Export, Regression model.*

1.0 INTRODUCTION

Regression analysis in Nigeria dates back to the early 2000s, particularly in studies addressing national income, economic growth, and the link between government expenditure and development. Researchers such as Taiwo and Agbatogun (2011) applied regression techniques to assess government expenditure and its effect on economic growth. Other works, including (Michael *et al*., 2024), have investigated how agriculture, industry, and the service sector influence economic growth using regression methods.

The concept of regression has its roots in the 19th century with Sir Francis Galton, who introduced "regression toward the mean" (Galton, 2017). The approach was subsequently formalized by Pearson and Fisher, who laid out its mathematical foundations (Fisher, 2018).

Linear regression assumes a linear relationship among variables and remains popular for its simplicity and interpretability (James *et al.*, 2021). Recent advances include robust regression techniques designed to mitigate the influence of outliers (Huber & Ronchetti, 2019). Regression models are widely used for forecasting economic trends and stock prices (Stock & Watson, 2019). Contemporary studies also apply machine learning augmented regression for predicting crypto currency movements (Smith & Johnson, 2023).

Regression has evolved into a versatile tool across disciplines, from predicting stock market trajectories (Smith & Johnson, 2023) to optimizing personalized healthcare interventions (Chen *et al.*, 2022).

National income, commonly represented by Gross Domestic Product (GDP) or Gross National Product (GNP), reflects the total value of goods and services produced in a country over a given period. It is a key indicator of a country's economic health and performance. In the context of national income modeling, the dependent variable is typically national income (GDP or GNP).

Independent variables may include factors such as investment (I), government expenditure (G), taxation policy, the savings rate, labor force, technology, and international trade (exports and imports). Simple regression analyzes the relationship between a single independent variable and national income, while multiple regression examines several independent variables simultaneously to assess their combined impact on national income.

Modeling national income often involves established frameworks like the Keynesian consumption function or, in more advanced setups, the Solow growth model. These approaches help estimate how consumption, investment, and government spending influence national income. Regression analysis is a fundamental statistical method used to explore relationships between variables and to make forecasts. In the context of national income, regression helps illuminate how different economic factors collectively contribute to the total value of goods and services produced by a country in a given period, typically measured as Gross Domestic Product (GDP) or Gross National Product (GNP).

National income is a broad and important economic indicator that reflects a nation's economic activity, prosperity, and overall health. It includes earnings from domestic and foreign sources, such as wages, profits, rents, and taxes, minus subsidies. Economists and policymakers are keen to understand the drivers of fluctuations in national income to inform economic planning, decision-making, and forecasting (Masood *et al.*, 2012).

Alisha (2020) used variables including the exchange rate, interest rate, inflation rate, and trade balance, drawing data from the Central Bank of Nigeria's statistical bulletin and publications from the National Bureau of Statistics to examine how exchange rate fluctuations affect Nigeria's economic growth. The analysis employed several methods beyond ordinary least squares (OLS), including the Augmented Dickey-Fuller (ADF) test, co-integration, and Granger causality tests, in addition to traditional regression approaches.

The findings indicate that exchange rates and inflation rates negatively affect GDP, while interest rates have a positive effect. Adeniran, Yusuf, and Adeyemi (2014) used secondary data from the Central Bank of Nigeria Statistical Bulletin and applied correlation analysis and ordinary least squares (OLS) regression to study how changes in exchange rates influenced Nigeria's economic growth from 1986 to 2013. Their results align with earlier research suggesting that developing countries generally benefit from flexible exchange rate regimes, showing that exchange rates have a positive but modest impact on economic growth. Additionally, their study suggests that although interest rates and inflation typically hinder economic growth, the effects are not uniformly large.

The exchange rate is found to significantly influence both short- and long-term macroeconomic growth and development goals, as noted in the literature (Ehikioya, 2019; Alagidede & Ibrahim, 2017). Recent studies have examined the relationship between the exchange rate and economic growth (Morina *et al.*, 2020; Ioan *et al.*, 2020). Morina *et al.*, (2020) analyzed the effects of real exchange rate volatility and concluded that growth benefits from relatively low exchange rate volatility. Their findings also highlight that trade openness and gross capital formation support long-run growth in Central and Eastern European economies when using a fixed-effects framework.

In a study focusing on South Africa and Nigeria, (Balcilar *et al.*, 2019) reported that prices are stickier in South Africa than in Nigeria, in the context of currency rate volatility and inflation. Munthali *et al.*, (2010) acknowledged that real effective exchange rate shocks adversely affect Malawi's GDP, with a weak but statistically significant relationship between these variables. Mahoney and colleagues argued that real exchange rate depreciation could spur inflation but may also boost exports and improve economic performance, referencing a study on how currency rate fluctuations influence inflation and Zimbabwe's economic growth. However, that discussion did not explicitly address the direct link between Zimbabwe's GDP and exchange rate devaluation.

After examining the relationship between GDP, exchange rate pass-through, and copper prices in Zambia, (Roger *et al.*, 2019) concluded that a decline in inflation served as a reliable indicator of exchange rate volatility. Overall, there are differing viewpoints on the connections among exchange rate volatility, inflation, interest rates, and economic growth. Nevertheless, the majority of studies indicate a negative relationship between inflation and GDP or between exchange rate volatility and economic growth.

In Nigeria, regression analysis has been a vital method for examining national income dynamics, especially given the country's economic challenges such as inflation, unemployment, and oil-reliant revenue. Numerous studies have explored the relationship between national income (measured as GDP or GNP) and macroeconomic variables like consumption expenditure, savings, and government spending.

Okeke (2012) conducted a regression analysis of Nigeria's national income for (1992–2011), with consumption expenditure as a key predictor. Using simple linear regression and correlation analysis, the study found a strong positive relationship between gross national income and consumption expenditure. The results also revealed significant differences between government and private consumption expenditures, as confirmed by a Student's t-test. While this study demonstrates the predictive power of regression for modeling national income, its limitation lies in examining only a single predictor, potentially neglecting other macroeconomic factors.

Adeyemi (2019) analyzed national income over (1998–2003), investigating the relationships among disposable income, savings, and government final expenditure. Employing multiple regression analysis, the study identified a linear association between these variables and national income, providing support for Wagner's law in the Nigerian context. The analysis used primary data from the Federal Office of Statistics and time-series regression, yielding robust findings. However, the short time frame (1998–2003) restricts the generalizability to longer horizons.

More recently, (Olowolaju, 2022) analyzed national income and total government expenditure over the

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period (1970–2014), employing time-series methods and Granger causality tests. The findings indicated cointegration between GDP and government expenditure, supporting Wagner's law but not Keynesian views, since the causal direction ran from GDP to expenditure rather than the other way around. The study also used advanced regression techniques, such as error correction models, to address non-stationarity in the data, resulting in a more robust analysis than earlier work.

Regression analysis has also been applied to related Nigerian economic issues. For example, (Eze *et al.*, 2023) employed ordinary least squares (OLS) and probit regression to examine the impact of financial inclusion on poverty alleviation, finding that greater financial access significantly reduces poverty rates and, indirectly, supports national income growth by boosting economic participation. Similarly, Edori et al. (2017) used regression models to assess tax system inefficiencies, identifying challenges such as complex tax laws and weak administration that hinder revenue generation and, in turn, affect national income indirectly.

2.0 MATERIALS AND METHODS

The data used was obtained from secondary sources, namely: CBN Statistical Bulletin, International Financial Statistics, World Bank and OECD Account Data files. The dataset covers a period of 9 years (2007-2016), with annual observations for variables such as, Consumption, Government expenditure, Investment, Import and Export. We adopted multiple linear regression models. The choice of multiple linear regression models is because the regression model involves more than a single independent variable (The equation for multiple linear regressions is given as follows:

$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 .. + \beta_n x_n + \varepsilon ..$ (i)

Where;

y = National Income (dependent variable)

β_O= intercept term,

$\beta_1, \beta_2 \dots \beta_n$= regression coefficients to be determined,

$X_1\ X_2 \dots X_n$= set of explanatory variables

We re-specify the model to capture the objectives of our study. $\text{GDP}_t = \beta_0 + \beta_1 \cdot \text{Consumption}_t + \beta_2 \cdot \text{Government Expenditure}_t + \beta_3 \cdot \text{Investment}_t + \beta_4 \cdot \text{Import}_t + \beta_5 \cdot \text{Export}_t + \varepsilon_t$

Where;

GDP_t Is the dependent variable (national income), Consumption_t , $\text{Government Expenditure}_t$, Investment_t , Import_t and Export_t are the independent variables, ε Is the Error term. Considering the above description we have arrive at the followings,

y is an n×1 response

X is the n×6 design matrix with a column of ones for the intercept and column for $x_1 \dots\dots\dots\dots x_5$

β is the 6×1 vector of the parameters $[\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5]^T$

ε_t is the n×1 vector of an errors

$$X = \begin{bmatrix} \mathbf{1} & \boldsymbol{x_{11}} & \boldsymbol{x_{12}} & \boldsymbol{x_{13}} & \boldsymbol{x_{14}} & \boldsymbol{x_{15}} \\ \mathbf{1} & \boldsymbol{x_{21}} & \boldsymbol{x_{22}} & \boldsymbol{x_{23}} & \boldsymbol{x_{24}} & \boldsymbol{x_{25}} \\ \mathbf{1} & \boldsymbol{x_{31}} & \boldsymbol{x_{32}} & \boldsymbol{x_{33}} & \boldsymbol{x_{34}} & \boldsymbol{x_{35}} \\ \mathbf{1} & \boldsymbol{x_{41}} & \boldsymbol{x_{42}} & \boldsymbol{x_{43}} & \boldsymbol{x_{44}} & \boldsymbol{x_{45}} \\ \mathbf{1} & \boldsymbol{x_{51}} & \boldsymbol{x_{52}} & \boldsymbol{x_{53}} & \boldsymbol{x_{54}} & \boldsymbol{x_{55}} \end{bmatrix}$$

$$\beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \end{bmatrix}$$

Deducting from the matrix of X above, the summarized version of equation (i) is given in equation (ii) as

$y = X\beta + \varepsilon \dots\dots\dots\dots\dots$(ii)

And the sum of squares is given in equation (iii) as

$S(\beta) = (y - X\beta)^T (y - X\beta) \dots\dots\dots\dots$(iii)

Taking the derivatives of equation (iii) with respect to β equation (iv)is Obtain as

$X^T y = X^T X \beta \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$(iv)

From equation (iv) we obtain

$$\widehat{\boldsymbol{\beta}} = (X^T X)^{-1} X^T y \dots\dots\dots\dots\dots\dots\dots\dots \text{(v)}$$

In a generalized direction

$(X^T X)_{ij} = \sum_{t=1}^{n} xt_i xt_j$ where i,j $\in$ {1,2 … … … … 6}

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$$X^T X = \begin{bmatrix} \sum 1 & \sum xt_1 & \sum xt_2 & \sum xt_3 & \sum xt_4 & \sum xt_5 \\ \sum xt_1 & \sum x^2t_1 & \sum xt_1xt_2 & \sum xt_1xt_3 & \sum xt_1xt_4 & \sum xt_1xt_5 \\ \sum xt_2 & \sum xt_1xt_2 & \sum x^2t_2 & \sum xt_2xt_3 & \sum xt_2xt_4 & \sum xt_2xt_5 \\ \sum xt_3 & \sum xt_1xt_3 & \sum xt_2xt_3 & \sum x^2t_3 & \sum xt_3xt_4 & \sum xt_3xt_5 \\ \sum xt_4 & \sum xt_1xt_4 & \sum xt_2xt_4 & \sum xt_3xt_4 & \sum x^2t_4 & \sum xt_4xt_5 \\ \sum xt_5 & \sum xt_1xt_5 & \sum xt_2xt_5 & \sum xt_3xt_5 & \sum xt_4xt_5 & \sum x^2t_5 \end{bmatrix}$$

Similarly, $(X^T y)_i = \sum_{t=1}^{n} xt_i y_{t,}$ where i = 1, 2,…………6

Therefore,

$(X^T y)_1 = \sum_{t=1}^{n} y_t,$

$(X^T y)_2 = \sum_{t=1}^{n} xt_1 y_{t,}$

$(X^T y)_3 = \sum_{t=1}^{n} xt_2 y_t,$

$(X^T y)_4 = \sum_{t=1}^{n} xt_3 y_t,$

$(X^T y)_5 = \sum_{t=1}^{n} xt_4 y_t,$

$(X^T y)_6 = \sum_{t=1}^{n} xt_5 y_t$

Through the above we obtain the followings estimates of the model parameters as

$\hat{\boldsymbol{\beta}}_0 = [(X^T X)^{-1} X^T y]_1$ ……………….(vi)

$\hat{\boldsymbol{\beta}}_1 = [(X^T X)^{-1} X^T y]_2$ …………...….(vii)

$\hat{\boldsymbol{\beta}}_2 = [(X^T X)^{-1} X^T y]_3$ ………………..(viii)

$\hat{\boldsymbol{\beta}}_3 = [(X^T X)^{-1} X^T y]_4$ …………………(ix)

$\hat{\boldsymbol{\beta}}_4 = [(X^T X)^{-1} X^T y]_5$ ………………...(x)

$\hat{\boldsymbol{\beta}}_5 = [(X^T X)^{-1} X^T y]_6$ ……………….(xi)

3.0 RESULTS, DISCUSSION AND CONCLUSIO

TABLE 1 OVERALL R AND SOME PROPERTIES

	R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.999	.999	.999	243923.255 40	.999	13689.7 59	5	32	.000

i. R (Multiple Correlation Coefficient): Measures the strength and direction of the linear relationship between dependent and independent variables. From the above table the R (0.999) value indicate a very strong relationship between the dependent variable and the independent variables

ii. R² (Coefficient of Determination): Represents the proportion of variance in the dependent variable explained by the independent variable(s). Higher R^2 indicates a better fit. From the table above the R^2 value (0.99) indicate that the model fit the data extremely well.

iii. Adjusted R^2 (0.999): Adjusted version of R^2 that accounts for the number of predictors, preventing over estimation in multiple regression models. The fit remain extremely good after adjusting

iv. Std. Error of the Estimate: Measures the average deviation of observed values from the predicted values, indicating the model's accuracy.

v. R^2 Change (0.999): Difference in R^2 when adding more predictors to the model, showing their incremental explanatory power.

vi. F Change: Measures whether the addition of a predictor significantly improves the model fit. The F-change (13689.759) indicates that the model is highly significant and the predictors are highly relevant.

vii. **Significance of F (0.000): P-value testing whether the overall regression model is statistically significant.**

Table 2: ANOVA (Analysis of Variance)

Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	1629041744766740.500	5	325808348953348.100	5006.540	.000
	Residual	2082449408334.295	32	65076544010.447		
	Total	1631124194175074.800	37			

Significance (Sign.): P-value for each predictor, indicating statistical significance. The **p-value** is **0.000**, which is less than the significance level of 0.05. Therefore, we reject the null hypothesis and conclude that the model is statistically significant. This means that the independent variables in the model significantly explain the variance in the dependent variable.

TABLE 3 THE MULTIPLE REGRESSION MODEL

model	Coefficient(β_i)	SE	T	p-value
intercept	8162417.888	2645929.276	3.085	0.003899740
X_1	2.085	0.726	2.872	0.006797890
X_2	0.0000000003	0.000	8.881	0.000000001
X_3	1.068	0.006	167.776	0.000000000
X_4	11096.115	355.567	31.207	0.000000000
X_5	6.740	1.464	4.604	0.000050002

The table above represent the regression model parameters with standard errors for each of the predictors, t-statistic for each of the predictors as well as p-values for each of the predictors which are all less than 0.05 indicating that the predictors are statistically significance in influencing the dependent variable.

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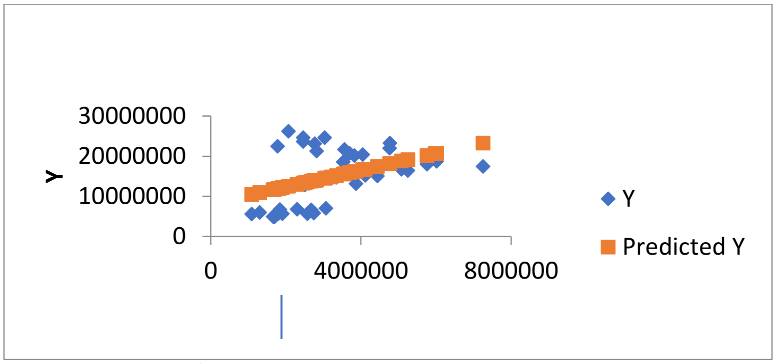

Figure 3.1 Line graph for the First variable (X_1)

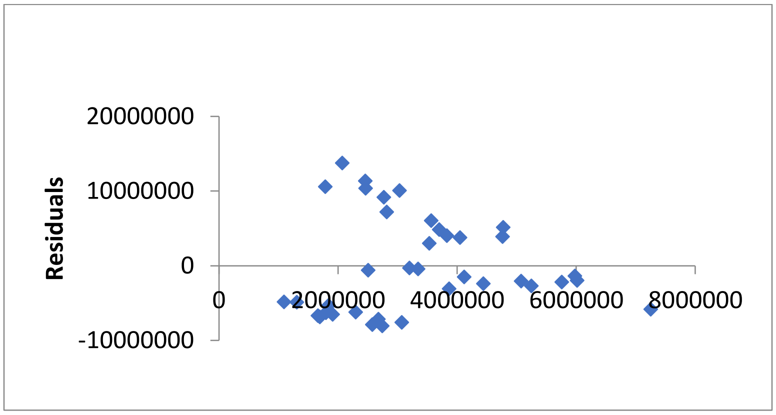

Figure 3.2 Residual graph for the First variable (X_1)

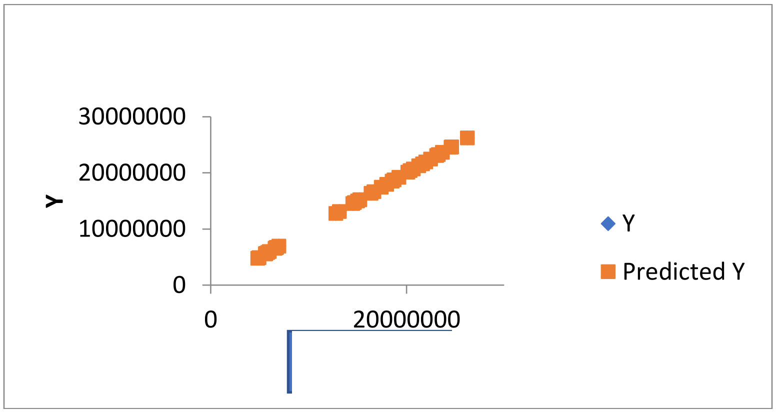

Figure 3.3 Line graph for the Second variable (X_2)

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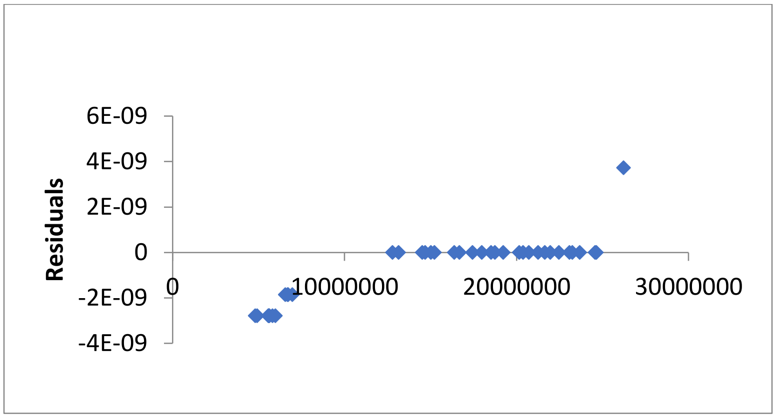

Figure 3.4 Residual graph for the Second variable (X_2)

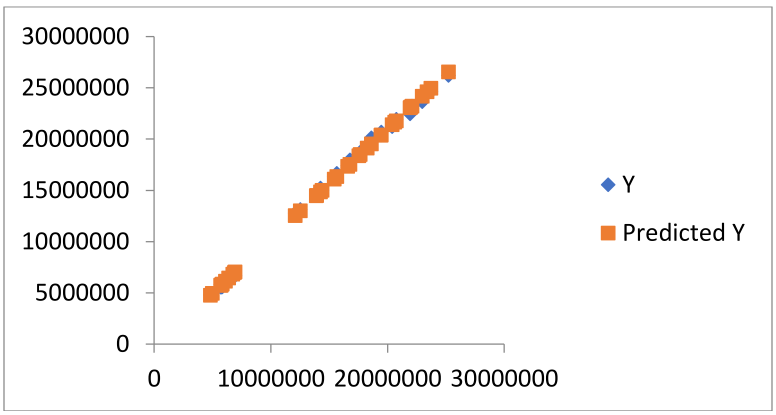

Figure 3.5 Line graph for the Third variable (X_3)

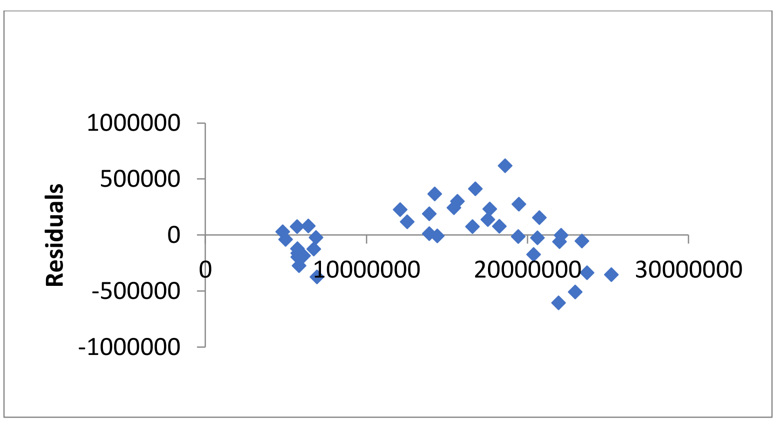

Figure 3.6 Residual graph for the third variable (X_3)

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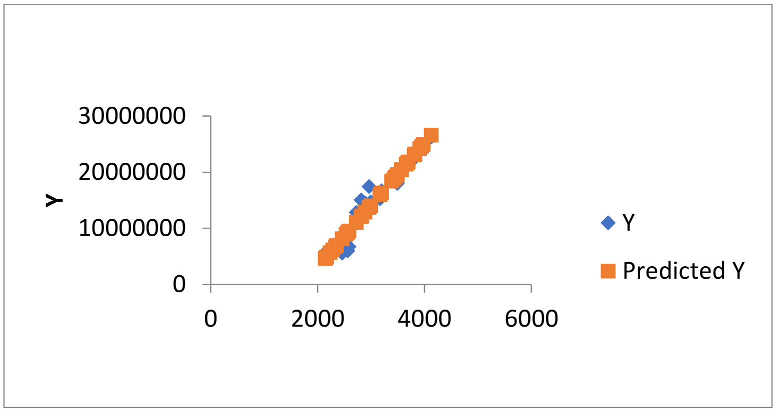

Figure 3.7 Line graph for the Fourth variable (X_4)

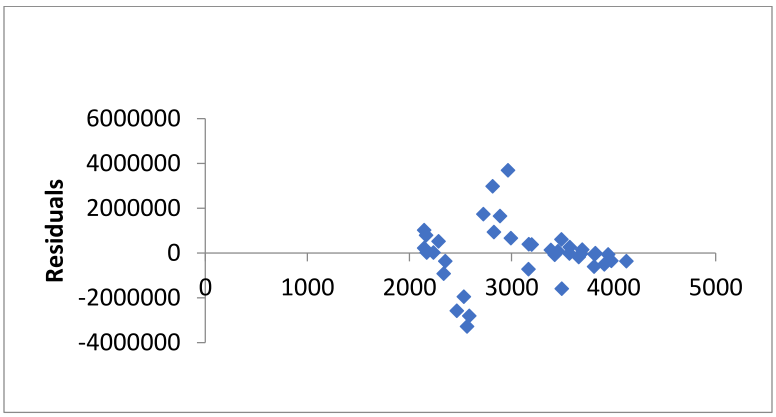

Figure 3.8 Residual graph for the Fourth variable (X_4)

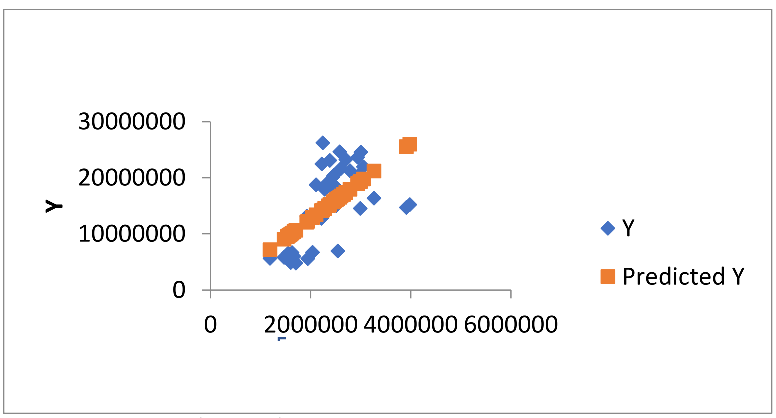

Figure 3.9 Line graph for the Fifth variable (X_5)

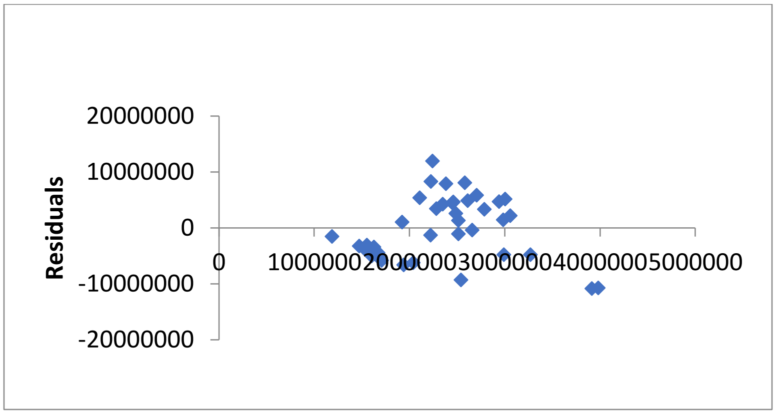

Figure 3.10 Residual graph for the Fifth variable (X_5)

The graphs above (3.1-3.10) are the line graphs as well as the residual graphs for each of the predictors' variables against the response variable.

3.1 CONCLUSION

The results indicate that investment and government expenditure are the strongest predictors of national income, while the effects of exports and consumption vary with the context. The research contributes to a deeper understanding of economic dynamics and offers actionable insights for policymakers aiming to promote growth and stability.

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