

Artificial Intelligence as a Tool for Forecasting the Effects of Foreign Debt Risk on Economic Growth in Nigeria

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Abstract: Artificial Intelligence (AI) encompasses a broad spectrum of technologies that replicate human reasoning and decision-making processes. In Nigeria, foreign borrowing remains an important instrument for supporting economic growth but overdependence often creates sustainability concerns. This study explores how artificial intelligence can be a tool for forecasting the effects of foreign debt risk on economic growth in Nigeria. The study adopts an ex-post facto descriptive research design and relies on secondary time series data from 2006 to 2024, sourced from official publications of bulletins of Central Bank of Nigeria, Budget office of the Federation and Office of the Accountant General of the federation. Variables considered include foreign debt service payment, total foreign debt stock and exchange rate fluctuations as proxies for foreign debt risk with Gross Domestic Product (GDP) serving as the proxy for Economic Growth. Analytical methods combined conventional econometric models (simple and multiple regression analysis of ordinary least square technique and ANOVA) with AI- driven approaches (Neural Network). The study concludes that foreign debt when strategically managed, support growth while exchange rate volatility significantly heightens repayment pressures and undermines investment flows. The study recommends that economic policy through the Debt Management Office should prioritize prudent debt management and sustainable borrowing practices and stabilize exchange rates to safeguard long-term growth.

Keywords: Artificial Intelligence, Foreign Debt, Foreign Debt Risk, Gross Domestic Product, Economic Growth.

1. Introduction

Artificial Intelligence has surfaced as a sudden change force capable of boosting productivity, spurring innovation and reshaping global labor markets. However, the rate of adoption differs sharply across advanced, emerging and low-income economies due to variations in infrastructure, institutional capacity and human capital. Nations with robust digital systems and skilled labour are better positioned to leverage AI for growth, while others lag behind, potentially worsening global inequality (Cerutti et al 2025).

The duty of foreign debt in financing economic progress has remained an important subject of discussion in Nigeria and across developing economies. External borrowing is often necessary to bridge savings-investment gaps, finance infrastructural development and stabilize fiscal imbalances. However when not properly managed, foreign debt can escalate into unsustainable levels resulting in high debt servicing burdens, macroeconomic instability and stunted economic growth. Foreign debt risk are those risks which arises from currency risk, vicious cycle of debt, long gestation period, Solvency risk, Liquidity Risk, Interest rate risk, and Credit/default risk. According to Ntekpere and Olayinka (2020), anytime the expenditure exceeds the estimated income, government usually applies to get credit facilities from either through foreign debt or domestic debt, so that government spending can be sponsored. The spending of government is an important function that has to be carried out through provision of socio and economic basic amenities. This spending is widely classified into recurrent and capital spending (Onyiah, Ugwoke and Nwangwu, (2024).

External debt or foreign debts are specifically the financial responsibilities that accrue to loan facilitators that are not members of the borrowing country. The sources of incurring external debts or foreign debts are through Multilateral agencies such as International Monetary Fund, International Bank for Reconstruction and Development, International Development Association, African Development Bank Group; Bilateral agencies such as France (Agence Francaise Development), Japan (Japan International Cooperation Agency), Exim Bank of China; Non-Paris group such as Non-Paris Commercial group (Eurobonds, Diaspora Bond) and Non-Paris Bilateral group (Ntekpere and Olayinka 2020).

Statement of the Problem

According to Debt Management Office DMO (2006), between 1985 and 2001, Nigeria's investments in capital projects and economic change have reduced as a result of the use of US \$32billion for servicing of debt. This shows that a high portion of Nigeria's revenue was committed to debt servicing. Despite the Paris Club's debt forgiveness that saved the country from the annual \$2.3 billion that ordinarily would have been transferred to servicing its debt, Nigeria has not made any positive progress to reduce the high rate of unemployment and improve poor living standard as the effect of that debt forgiveness

was not felt. With this debt relief it was anticipated that Nigeria would move towards economic recovery as government earmarked that the money will be devoted to those areas that involves improvement in agriculture, health, employment generation, wealth creation, education, constant water supply, massive nationwide road construction and power generation. However, the needed results were not achieved as expected as external debt profile continued to rise (Ijeoma, 2013).

Nigeria's economy remains highly volatile with frequent fluctuations in oil revenues, exchange rates and inflationary pressures. Conventional approaches to analyzing foreign debt risk have primarily relied on econometric models and statistical techniques. These uncertainties make it increasingly difficult for conventional forecasting models to provide reliable early warning signals about debt. While useful, these traditional models often struggle with capturing the complexity, volatility and non-linear interactions between debt variables and growth indicators in a rapidly changing economic environment. Consequently, policy makers often lack the accurate timely and forward-looking information needed to formulate effective debt management strategies. Existing studies have examined AI applications in other fields such as fintech, customer analytics, health and risk management by providing advanced predictive analytics, pattern recognition and real time decision making support, yet limited attention has been paid to the integration of AI into foreign debt risk analysis. This leaves a gap in literature on how AI's predictive capacity could improve Nigeria's debt sustainability strategies (Afolabi & Ajibade, 2021).

Objectives of the Study

The main aim of this study is to assess how artificial intelligence can be a tool for forecasting the effects of foreign debt risk on economic growth in Nigeria. Specifically the study seeks to:

- i. Examine the effect of foreign debt service payment on Gross Domestic Product (GDP) in Nigeria using both traditional econometric techniques and AI-driven predictive models.
- ii. Determine the effect of total foreign debt stock and exchange rate fluctuations on Gross Domestic Product (GDP) in Nigeria and assess how artificial intelligence enhances the forecasting accuracy of these relationships.

Conceptual Framework

Artificial Intelligence

Artificial Intelligence (AI) is the design of systems that replicate human-like reasoning, problem-solving and learning capabilities through computational models and algorithms (Adebayo and Chukwu, 2022). It incorporates machine learning, automation, robotics and natural language processing (Ibrahim et al., 2023; Yusuf and Salami, 2025). Within the

financial sector, AI is applied in credit risk evaluation, fraud detection and portfolio optimization, enabling faster and more adaptive decision-making (Chaboud et al., 2014; Okonkwo and Adeyemi, 2024). In the context of risk management, Artificial Intelligence leverages past data to recognize trends and forecast potential risks, thereby supporting proactive mitigation strategies for financial institutions such as banks, insurers and investment firms (Huang et al., 2020).

Artificial Intelligence encompasses diverse technologies that allow machines to simulate human reasoning and decision making (Cazzaniga et al., 2024). The development of generative AI, particularly large language models and generative pre-trained transformers, has significantly advanced technological capabilities, enabling performance that in some cases exceeds human cognitive functions (IMF WEO, 2024). Evidence from an IBM global survey in 2023 further shows that adoption is widespread among large organizations with over 1,000 employees 42 % of IT professionals confirmed active AI deployment, while another 40% indicated they were experimenting with its use (Chang, et al. 2025).

Foreign Debt Service Payment

Foreign debt service payment represents the aggregate amount of money a country pays within a particular year to fulfill its obligations on foreign loans, including both the repayment of principal and the payment of interest. These obligations may arise from borrowings obtained from multilateral financial institutions, foreign governments, bilateral creditors, and international commercial lenders (World Bank, 2023). The management of external debt servicing is an important aspect of fiscal policy because the proportion of public revenue devoted to debt obligations determines the resources that remain available for financing domestic economic and social programmes. When debt-service commitments become substantial, government expenditure on infrastructure, education, healthcare, and other development-oriented activities may be adversely affected.

Nigeria has experienced a considerable increase in the burden associated with servicing its external debt in recent years. The rising level of external obligations has placed additional pressure on government finances, particularly in an environment characterized by relatively weak revenue generation. According to the Debt Management Office (DMO, 2024), debt-service commitments constitute a significant financial obligation for the Nigerian government and have increasingly competed with other public expenditure needs. As more government resources are allocated to meeting external debt obligations, the funds available for productive investment and the provision of essential public services may become increasingly constrained.

The cost of servicing Nigeria's foreign debt is also influenced by developments in both domestic and international financial markets. The Central Bank of Nigeria (CBN, 2023) identifies exchange-rate movements and changes in global financial conditions as important factors affecting the country's external debt obligations. Since external debts are predominantly denominated in foreign currencies, a depreciation of the naira increases the amount of domestic currency required to meet the same foreign-currency debt obligation. In addition, increases in international interest rates can raise borrowing costs and place further pressure on countries that depend on international capital markets. For Nigeria, these challenges are particularly important because the country's ability to meet external debt obligations depends substantially on the availability of foreign-exchange earnings and adequate government revenue.

The implications of a rising foreign debt burden can be explained by the debt-overhang hypothesis. Krugman (1988) posits that excessive debt can discourage investment when investors anticipate that a significant portion of future economic returns may be used to meet existing debt obligations. Under such circumstances, a high debt burden can reduce investment incentives and adversely affect the prospects for economic growth. Recent studies have likewise examined the relationship between external debt and economic performance, emphasizing that the consequences of indebtedness are influenced by the size of the debt burden, the cost of servicing it, and the ability of the borrowing country to generate sufficient income and foreign exchange to meet its obligations (Yusuf & Mohd, 2024).

A persistent increase in external debt-service obligations may further expose a country to a cycle of continuous borrowing. When available government revenue is insufficient to meet existing obligations and finance essential expenditures simultaneously, the government may resort to additional borrowing to refinance or repay maturing debts. Such a pattern can intensify fiscal pressure, increase vulnerability to external economic shocks, and reduce the resources available for investment in productive sectors. Oyamendan et al. (2025) and Harsono et al. (2024) highlight the potential macroeconomic consequences of a growing debt burden, particularly when debt-service commitments reduce government capacity to undertake development-enhancing expenditure.

Consequently, external debt service payment has become an important issue in Nigeria's fiscal and macroeconomic management. Although external borrowing can provide governments with resources for financing infrastructure and other development projects, an excessive debt-service burden can limit the fiscal space required for such investments. The increasing resources devoted to servicing external obligations may therefore

constrain productive public expenditure, weaken the government's ability to finance development programmes, and potentially affect the country's long-term economic growth and fiscal sustainability.

Foreign debt stock

According to Ogbeifun, (2007) and (Omagbemi, 2016) in Onyiah, Ugwoke and Nwangwu (2024), as the society evolves into modernization, the needs and wants of the state continues to rise, thereby making the government to spend more so as to meet up with these needs. These needs include infrastructural investments, natural disasters and disease control, fiscal and monetary policy stability to mention but a few. For this reason, these economic needs therefore are generally met through revenues arising from fees, duties, penalties, taxes, property and enterprise revenues and fiscal revenues. Financing these needs from revenues been generated by government alone poses a huge challenge to every government that comes to power in Nigeria because the estimated expenditure usually surpasses the estimated income (budget deficits). Hence, the government reverts to borrowing Foreign debt represents financial resources obtained from international lenders which governments use to fund infrastructure, stabilize fiscal positions or address budget deficits (Aybarc, 2019). While foreign loans can accelerate development, they also generate long-term repayment responsibilities, exposing nations to risks if loan terms are unfavorable or funds are mismanaged (Ogbeifun, 2007; Omagbemi, 2016)

Foreign debt stock is described as loan received from an external source and not locally generated but put into use by a country. Government borrowing often referred to as public or sovereign debt, serves as a key instrument for funding economic growth and development initiatives. Yet, maintaining the ability to meet repayment obligations and ensuring that the debt level remains sustainable is crucial. When countries fall into debt distress, the consequences can be severe undermining macroeconomic stability and delaying progress for many years. For this reason, assisting member states in managing debt-related risks and addressing debt distress remains a central focus of the IMF's mandate (IMF, 2025).

Exchange Rate Fluctuation and Foreign debt Risk

Foreign debt risk arises when fluctuations in currency values (For instance, if Nigeria borrows \$100 million from the United State of America, at an interest rate of 5% per year when the Naira-dollar ratio is 1:1, then the annual interest payment is \$5 million, or N5 million. If the naira reduces in value unexpectedly and the Naira-dollar ratio becomes 1.5:1, then the annual payment denominated in dollar increases to N7.5 million), interest rates or liquidity creates repayment challenges. Foreign debt risk also occurs whenever there is Vicious Cycle of Debt. This risk means a cycle of constant loan acquisition, gathering of payment burden, and subsequent default. Vicious Cycle of Debt is caused by

the need for budget deficit financing which degenerates into borrowing more money to repay previous loans. Long gestation period also leads to external debt risk because it takes time for projects to start bringing a return on the investment from the first date the project was executed. Through Interest Rate risk, foreign debt risk occur from the global interest rates which will increase the cost of servicing variable rate debt. Through Liquidity Risk, a country may lack sufficient foreign exchange reserves to meet debt obligation when due. Through Solvency risk, the total debt of a country exceeds its ability to repay in the long run. Through Credit/default risk, a country may fail to fulfill its debt obligations for both interest and principal. Foreign debt risk also involves risk of misappropriation of borrowed funds and risk of embezzlement of borrowed funds (Onisanwaa and Adaji, 2018).

Aliyu (2011) in Nwobia et al (2020) noted that fluctuations in exchange rates can significantly influence the direction of a country's international trade. An appreciation in the value of a domestic currency tends to make imported goods relatively cheaper, thereby encouraging imports, while simultaneously making exports more expensive to foreign buyers and potentially reducing export demand. Conversely, a depreciation of the domestic currency generally makes exports more competitive in international markets and raises the domestic price of imported goods, which can discourage imports. Depreciation may therefore encourage consumers and producers to substitute domestically produced goods for foreign products. Through these changes in import and export activities, exchange-rate movements can affect income distribution between trading nations and ultimately influence economic growth.

Exchange rates involve two currencies: the domestic currency and a foreign currency, and they may be expressed through either direct or indirect quotations. A direct quotation indicates the amount of domestic currency needed to purchase one unit of a foreign currency. An indirect quotation, on the other hand, expresses the value of one unit of the domestic currency in terms of a foreign currency. Where an exchange rate involves two foreign currencies and neither of them is the domestic currency of the country in which the quotation is made, the resulting rate is commonly referred to as a cross exchange rate or cross rate (Nwobia et al, 2020).

Overall, the exchange rate serves as a mechanism for establishing the relative value of currencies and facilitating international economic transactions. In Nigeria, fluctuations in the naira exchange rate are particularly important because they affect the prices of imported inputs and finished goods, the competitiveness of Nigerian exports, international financial obligations and, more broadly, the country's economic performance (Nwobia et al, 2020).

Ezu (2012) in Nwobia et al (2020) describes the exchange rate as the value or price of one country's currency measured against the currency of another country. In other words, it represents the number of units of one currency required to acquire a specified quantity of another currency. Powell (1993) similarly explains the exchange rate as the external value of a currency, which may be expressed in relation to an artificial benchmark such as a weighted average or basket of major international trading currencies.

From these perspectives, exchange rate can generally be understood as the amount of a country's domestic currency required to obtain a given amount of another country's currency. In the Nigerian context, it refers particularly to the value of the naira relative to major foreign currencies, including the United States dollar, British pound sterling and other internationally traded currencies. Consequently, the exchange rate is an important economic variable because movements in the value of the naira have implications for international trade, investment, production and overall economic performance.

Theoretical Framework

The theories adopted for this study are Technology Acceptance model (TAM), Debt Overhang Theory and The Optimal Currency Area (OCA) theory.

Technology Acceptance model (TAM)

The Technology Acceptance Model (TAM) was introduced by Davis in 1989. The reason why TAM is underpinned as a one of the theories of this study is because TAM explains technology adoption based on two factors which include perceived ease of use and perceived usefulness. Perceived ease of use means the extent to which users agree in adopting a technology that will be free from stress, while perceived usefulness is the extent to which users believe the technology will enhance their performance or provide value. In this study, the model underscores how policymakers may be inclined to adopt AI if it is both practical and effective in strengthening debt risk analysis (Davis, 1989).

The Debt Overhang Theory

The Debt overhang theory was propounded by Howard in 1972. This theory argues that excessive external debt discourages investment and surpasses growth because future revenues are pre-committed to debt servicing. In such cases, government face limited fiscal space, reducing their ability to stimulate development (Coccia, 2017; Yusuf & Mohammed, 2021). The reason why this study is also anchored on this theory is because the theory submits that debt service will strangle investments and hinder economic growth if a country is highly indebted to the level that the debt is more than its ability to pay (Gordon & Cosim, 2018).

Optimal Currency Area (OCA) Theory

The Optimal Currency Area (OCA) theory was developed principally by Mundell (1961) and further advanced by McKinnon (1963). The theory provides a framework for understanding the relationship between exchange-rate arrangements, international trade, and the stabilization of economic fluctuations. Its central arguments are built around the symmetry of economic shocks among countries, the degree of openness of an economy, and the mobility of labour across economic boundaries (Nwobia et al, 2020). According to the OCA theory, adopting a fixed exchange-rate system can contribute positively to trade and economic growth because it reduces uncertainty associated with fluctuations in currency values. With greater exchange-rate stability, businesses engaged in international transactions may face lower hedging costs and greater certainty in planning cross-border activities. A fixed exchange-rate arrangement can also stimulate investment by reducing the exchange-rate risk premium incorporated into interest rates, thereby potentially lowering the cost of financing investment (Nwobia et al, 2020).

Despite these potential advantages, the theory also recognizes that a fixed exchange-rate regime may have adverse consequences for trade and economic growth under certain circumstances. When countries experience economic shocks that require adjustments in relative prices, a rigid exchange-rate system may prevent or delay the adjustment of the exchange rate. Consequently, the necessary changes in relative prices may occur more slowly, which can hinder the economy's ability to respond effectively to economic disturbances. Thus, the OCA theory highlights a fundamental trade-off between the benefits of exchange-rate stability and the flexibility required to accommodate economic shocks and maintain macroeconomic stability (Nwobia et al, 2020).

Empirical Framework

Grace et al (2019) investigated how external debt impacts Nigeria's economic growth using data from 1981 to 2017. Their findings showed a negative link between external borrowing and growth performance, suggesting that debt can hinder development if not efficiently managed.

In a related study, Muhammad and Abdullah (2020) applied debt servicing and economic growth between 1985 and 2018. Their results indicated that although debt servicing exerted adverse effects on growth, the impact was not statistically significant in both the short and long run.

Ohiomu (2020) also examined the nexus between foreign debt and growth in Nigeria, applying ARDL techniques for policy evaluation. The study highlighted the presence of a debt overhang, showing that high debt levels reduce the incentives for investment, thereby constraining growth.

Zhang and Lee (2023) explored AI applications in optimizing risk management for investment portfolios. By employing deep learning models and sentiment analysis, they demonstrated that AI-based systems enhanced portfolio performance by delivering higher risk-adjusted returns compared to traditional assessment tools. Their findings point to AI's potential to improve financial forecasting and decision-making.

Onyiah, Ugwoke and Nwangwu (2024), assessed the Effects of Tax Revenue and External Debt on Economic Growth in Nigeria. The time series from 2006 to 2022 was used. Simple and Multiple regression analysis methods of Ordinary Least Square was used to analyze the data while in order to test the hypothesis Analysis of variance (ANOVA) was used. Findings of the research showed that Tax Revenue and External Debt have a significant positive effect on Gross Domestic Product (GDP) in Nigeria.

Haosen et al. (2024) conducted a research on leveraging AI for risk management engineering in financial services. The data collected were analyzed using a systematic structured analysis. The application of AI and risk management engineering proved effective and significantly interrelated. The study concluded that AI had a significant effect on risk management engineering of financial services.

Summary of Literature Review

The reviewed studies provide mixed evidence on the relationship between external debt and economic growth. Some research (Grace et.al., 2019; Ohiomu, 2020) stresses the dangers of excessive borrowing, pointing to debt overhang effects. Others (Ajayi & Oke, 2012; Adofu & Abula, 2010) acknowledge the positive contributions of debt to growth when loans are tied to infrastructure and productivity- enhancing projects.

However, very few studies integrate Artificial Intelligence into the discussion of debt risk analysis. While AI's benefits have been proven in financial markets, credit scoring and portfolio risk management (Zhang and Lee, 2023; Haosen et al., 2024), its application in forecasting foreign debt sustainability remains limited in Nigeria. This gap underscores the reason for the present study which combines traditional econometric techniques with AI models to improve forecasting accuracy and policy relevance.

Methodology

Ex post facto descriptive research design was adopted for the study. Secondary data were sourced from National Bureau of Statistics, various issues of statistical bulletin of the Central bank of Nigeria, Office of the Accountant General of the federation and the published annual reports of budget office of the federation (BOF). The data consists of annual time series from 2006 to 2024. Gross Domestic Product (GDP) as the dependent variable was used as a proxy for Economic Growth while Foreign Debt service payment; Total Foreign Debt Stock and Exchange Rate Fluctuations as the independent variables

were used as proxies for foreign debt risk. The data generated were analyzed using both traditional econometric techniques (simple and multiple regression analysis methods of ordinary least square technique) and AI-driven predictive models (Neural Network). To test the hypothesis, Analysis of Variance (ANOVA) was used.

Data Presentation

Table 1

Foreign Debt service payment, Total Foreign debt stock in US dollars, Exchange Rate Fluctuations, Total external debt stock and GDP at current Market prices from 2006 to 2024

Year	Foreign Debt service payment (EXDSP) in N billion	Total Foreign debt stock in US dollars in Million	Exchange Rate Fluctuations (ERF) \$US to Naira	Total Foreign debt stock (TEDS) in N billion	GDP at current Market prices
2006	3,545	3,546.07	128.65	456,201.91	30,375.18
2007	3,654	3,798.14	125.81	477,843.99	34,675.94
2008	3,947	3,745.74	118.55	444,057.48	39,954.21
2009	28,365	3,947.00	148.91	587,747.77	43,461.46
2010	54,238	4,600.00	150.30	691,380.00	55,469.35
2011	4,951	5,700.00	153.90	877,230.00	63,713.36
2012	55,958	6,527.00	157.75	1,029,634.25	72,599.63
2013	59,176	6,920.00	161.50	1,117,580.00	81,009.96
2014	71,200	9,377.11	167.17	1,567,571.48	90,136.98
2015	95,362	6,359.00	232.40	1,477,832.00	95,177.74
2016	147,532	11,406.28	455.26	5,192,823.03	102,575.42
2017	184,135	18,913.44	362.83	6,862,363.44	114,899.25
2018	220,384	25,274.36	363.46	9,186,218.89	129,086.91
2019	225,401	27,676.14	360.25	9,970,329.44	145,639.14
2020	295,101	31,985.17	386.01	12,346,595.47	154,252.32
2021	332,433	38,391.32	414.34	15,907,059.53	176,075.50
2022	387,995	41,694.91	450.71	18,792,312.89	214,298.03
2023	655,760	42,500.00	899.24	38,220,000,000.00	363,820.00
2024	827,096	78,547.00	1,482.27	1,164,278,620.00	187,640.00

Source: Statistical bulletin of Central Bank of Nigeria (various years), Budget office of the Federation and Office of the Accountant General of the federation

Data Analysis and Interpretation

Using traditional econometric techniques

Effect of Foreign Debt Service Payment on Gross Domestic Product (GDP) in Nigeria.

Table 2										
Model Summary of the first Independent Variable (Foreign debt service payment)										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.858 ^a	.735	.720	42876.82661	.735	47.244	1	17	.000	1.873
a. Predictors: (Constant), EXDSP										
b. Dependent Variable: GDP										
Source: Researcher's computation (2025)										

Table 3						
Coefficients of the first Independent Variable (Foreign debt service payment)						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	56972.721	13011.996		4.378	.000
	EXDSP	.000	.000	.858	6.873	.000
a. Dependent Variable: GDP						
Source: Researcher's computation (2025)						

Table 2 of the model summary of the multiple regression results of $R = 0.858$ showed a strong positive relationship between Foreign debt service payment and GDP. It means that about 85.8% of the variation in GDP is linearly associated with external debt service payments. This suggests that as foreign debt service payment rises, GDP tends to rise as well. R^2 of 0.735 means that 73.5% of the variation in GDP is explained by foreign debt service payment. The adjusted R Square value of 0.7 and above depicts strong relationship between the variables, 0.5 to 0.7 depicts moderate relationship between the variables while below 0.5 shows weak relationship. Hence Adjusted R square of 0.720 is the adjusted number of predictors in the model which still explains about 72% of the variability in GDP, which depicts strong relationship between the variables. Based on the above analysis, the regression model reveals a strong and statistically significant relationship between External debt service payment and the Gross domestic product in

Nigeria. The test for autocorrelation in a regression model's output is known as Durbin-Watson (DW). In Table 2 the DW statistics is 1.873. Figures below 2.0 reveals that there is positive autocorrelation and above 2.0 reveals negative autocorrelation. This indicates that there is a positive autocorrelation between foreign debt service payment and the Gross domestic product (GDP) in Nigeria.

In table 3, the coefficient of foreign debt service payment which depicts that External debt service payment has a significant positive effect on the Gross domestic product (GDP) as shown by a coefficient (0.858) at a 5% level of significance. This means that a 1% rise in the foreign debt service payment will induce a 0.743% rise in Gross domestic product (GDP) while a 1% reduction in the foreign debt service payment will induce a 0.880% reduction in Gross domestic product (GDP). The coefficient of external debt service payment has a high significant positive effect on the Gross domestic product (GDP) as shown by a coefficient (0.858) at a 5% level of significance.

Using Neural Network

Table 4			
Case Processing Summary			
		N	Percent
Sample	Training	12	63.2%
	Testing	7	36.8%
Valid		19	100.0%
Excluded		0	
Total		19	

Source: Researcher's SPSS computation (2025)

Interpretation: In table 4, both training set and testing set amounted to 100%. No case was excluded. Enough cases were used to train and some small data reserved for testing. Thus results will be illustrative and not robust.

Table 5		
Model Summary and Quality		
Training	Sum of Squares Error	.366
	Relative Error	.067
	Stopping Rule Used	1 consecutive step(s) with no decrease in error ^a
	Training Time	0:00:00.00
Testing	Sum of Squares Error	8.235
	Relative Error	.334
Dependent Variable: GDP		
Source: Researcher's SPSS computation (2025)		

Interpretation: The model fits well, with only small difference between training and testing. There is no serious over fitting

Table 6

Network Information

Input Layer	Covariates	1	EXDSP
	Number of Units ^a		1
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1 ^a		3
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	GDP
	Number of Units		1
	Rescaling Method for Scale Dependents		Standardized
	Activation Function		Identity
	Error Function		Sum of Squares
a. Excluding the bias unit			
Source: Researcher's SPSS computation (2025)			

Interpretation: The network is simple and enough to capture a nonlinear mapping

Table 7		
Independent Variable Importance		
	Importance	Normalized Importance
EXDSP	1.000	100.0%

Source: Researcher's SPSS computation (2025)

Interpretation: Foreign Debt service payment (EXDSP) = 100%. This means that debt service strongly influences GDP in this model

Using traditional econometric techniques

Effects of Total foreign Debt Stock and Exchange Rate Fluctuations on Gross Domestic Product (GDP) In Nigeria

Table 8
Model Summary of the second Independent Variables (Total foreign Debt Stock and Exchange Rate Fluctuations)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. Change	
1	.867 _a	.751	.720	42848.34527	.751	24.165	2	16	.000	.538

a. Predictors: (Constant), ERF, TEDS

b. Dependent Variable: GDP

Source: Researcher's SPSS computation (2025)

Table 9
Coefficients of the second Independent Variable (Total foreign Debt Stock and Exchange Rate Fluctuations)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	63846.444	14724.227		4.336	.001
	TEDS	5.071E-006	.000	.548	3.986	.001
	ERF	116.325	33.400	.479	3.483	.003

a. Dependent Variable: GDP

Source: Researcher's SPSS computation (2025)

Table 8 of the model summary of the second Independent Variables (Total foreign Debt Stock and Exchange Rate Fluctuations) multiple regression results of $R = 0.867$ revealed a strong positive relationship between Total foreign Debt Stock and Exchange Rate Fluctuations and GDP. This suggests that as Total foreign Debt Stock increases and Exchange Rate Fluctuations increases, GDP tends to increase as well. R^2 of 0.751 means that 75.1% of the variation in GDP is explained by Total foreign Debt Stock and Exchange Rate Fluctuations. The adjusted R Square value of 0.7 and above depicts strong relationship between the variables, 0.5 to 0.7 depicts moderate relationship between the variables while below 0.5 shows weak relationship. Hence Adjusted R square of 0.720 is the adjusted number of predictors in the model which still explains about 72% of the variability in GDP, which depicts strong relationship between the variables. Based on the above analysis, the regression model reveals a strong and statistically significant relationship between Total foreign Debt Stock, Exchange Rate Fluctuations and the Gross domestic product in Nigeria. The test for autocorrelation in a regression model's output is

known as Durbin-Watson (DW). In Table 8 the DW statistics is 0.538. Figures less than 2.0 mean there is positive autocorrelation while Figures more than 2.0 reveals negative autocorrelation. This reveals that there is a positive autocorrelation between Total foreign Debt Stock, Exchange Rate Fluctuations and the Gross domestic product (GDP) in Nigeria.

In table 9, the coefficient of Total foreign Debt Stock and Exchange Rate Fluctuations which depicts that Total foreign Debt Stock and Exchange Rate Fluctuations clearly has a moderate and significant effect on the Gross domestic product (GDP) as indicated by a coefficient (0.548 and 0.479) at a 5% level of significance. This means that a 1% increase in the Total foreign Debt Stock and Exchange Rate Fluctuations will induce a 0.548% and 0.479% increase in Gross domestic product (GDP) and also 1% decrease in the Total foreign Debt Stock and Exchange Rate Fluctuations will induce a 0.548% and 0.479% decrease in Gross domestic product (GDP). The coefficient of Total foreign Debt Stock and Exchange Rate Fluctuations clearly has a moderate and high significant effect on the Gross domestic product (GDP) as indicated by a coefficient (0.548% and 0.479%) at a 5% level of significance. This further shows that external debt stock has a stronger influence on GDP than exchange rate.

Using Neural Network to assess how artificial intelligence enhances the forecasting accuracy of Effects of Total foreign Debt Stock and Exchange Rate Fluctuations on Gross Domestic Product (GDP) in Nigeria

Table 10			
Case Processing Summary			
		N	Percent
Sample	Training	15	78.9%
	Testing	4	21.1%
Valid		19	100.0%
Excluded		0	
Total		19	

Source: Researcher's SPSS computation (2025)

Interpretation: In table 10, both training set and testing set amounted to 100%. No case was excluded. Enough cases were used to train and some small data reserved for testing. Thus results will be illustrative and not robust.

Table 11 Model Summary and Quality		
Training	Sum of Squares Error	.615
	Relative Error	.088
	Stopping Rule Used	1 consecutive step(s) with no decrease in error ^a
	Training Time	0:00:00.00
Testing	Sum of Squares Error	.088
	Relative Error	.522
Dependent Variable: GDP		
a. Error computations are based on the testing sample.		

Source: Researcher's SPSS computation (2025)

Interpretation: The model fits well, with only small difference between training and testing. There is no serious over fitting.

Table 12			
Network Information			
Input Layer	Covariates	1	TEDS
		2	ERF
	Number of Units		2
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1 ^a		3
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	GDP
		Number of Units	
	Rescaling Method for Scale Dependents		Standardized
	Activation Function		Identity
	Error Function		Sum of Squares
a. Excluding the bias unit			

Source: Researcher's SPSS computation (2025)

Interpretation: The network is simple and enough to capture a nonlinear mapping

Table 13		
Independent Variable Importance		
	Importance	Normalized Importance
TEDS	.630	100.0%
ERF	.370	58.8%

Source: Researcher's SPSS computation (2025)

Interpretation: Total Foreign debt stock (TEDS) = 100%. This means that increase in foreign debt stock strongly influences GDP in this model (through financing infrastructure and investment) or negatively (through repayment burden). Exchange Rate Fluctuations (ERF) = 58.8%. Exchange Rate Fluctuations is a secondary driver compared to foreign debt. This means that sharp depreciation increases debt service cost (since debt is in foreign currency) while indirectly influencing GDP in this model.

Test of Hypotheses

Hypothesis One

- i. Foreign debt service payment has no significant effect on Gross Domestic Product (GDP) in Nigeria.
- ii. Foreign debt service payment has a significant effect on Gross Domestic Product (GDP) in Nigeria.

Table 14						
ANOVA of hypothesis one						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	86853676476.719	1	86853676476.719	47.244	.000 ^b
	Residual	31253178426.611	17	1838422260.389		
	Total	118106854903.330	18			
a. Dependent Variable: GDP						
b. Predictors: (Constant), EXDSP						

Source: Researcher's SPSS computation (2025)

From the ANOVA table 14 which uses the computed F-value to test the acceptability of the model from a statistical perspective, the decision criterion is stated below as follows:

F calculated > Sig value	Reject the null hypothesis
F calculated < Sig value	Accept the null hypothesis

Decision: Since the F cal. (47.244) is greater than the Sig. value (.000) at a 5% level of significance and 2 degrees of freedom, we reject the null hypothesis and accept the alternate hypothesis that foreign debt service payment has a significant effect on Gross Domestic Product (GDP) in Nigeria.

Hypothesis Two

- i. Total foreign debt stock and exchange rate fluctuations have no significant effect on Gross Domestic Product (GDP) in Nigeria.
- ii. Total foreign debt stock and exchange rate fluctuations have a significant effect on Gross Domestic Product (GDP) in Nigeria.

Table 15						
ANOVA of hypothesis Two						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	88731163821.535	2	44365581910.768	24.165	.000 ^b
	Residual	29375691081.795	16	1835980692.612		
	Total	118106854903.330	18			
a. Dependent Variable: GDP						
b. Predictors: (Constant), ERF, TEDS						

Source: Researcher's SPSS computation (2025)

From the ANOVA table 15 which uses the computed F-value to test the acceptability of the model from a statistical perspective, the decision criterion is stated below as follows:

F calculated > Sig value Reject the null hypothesis
 F calculated < Sig value Accept the null hypothesis

Decision: Since the F cal. (12.165) is greater than the Sig. value (.000) at a 5% level of significance and 2 degrees of freedom, we reject the null hypothesis and accept the alternate hypothesis that Total foreign debt stock and exchange rate fluctuations have a significant effect on Gross Domestic Product (GDP) in Nigeria.

Results and Discussion of Findings

Using traditional econometric techniques

The outcome of the test of hypothesis one revealed that foreign debt service payment has a significant effect on Gross Domestic Product (GDP) in Nigeria. This means that Nigeria's external debt, when managed and serviced can be channeled into productive sectors that boost economic growth. This also means that whereas R^2 is 73.5% in table 2, it shows that Nigeria's GDP growth is highly dependent on debt service. This is potentially risky because as Nigeria is confronted with foreign exchange shortages, global interest

rate hikes and declining oil revenues, it may struggle to service debt and still maintain GDP growth.

Overall Interpretation using AI-driven Model (Neural Network)

The Neural Network successfully mapped foreign debt service and GDP. Model quality is high (low errors and high predictive accuracy). Debt service payments have a clear positive but non linear effect on GDP. At very high debt service levels, GDP growth slows, showing possible diminishing returns (captured by non linear activation).

The findings agree with the results of several scholars like Adepoju et al (2007) and Ajayi & Oke (2012). Adepoju et al (2007) did a study on the Effect of foreign Debt Management on Sustainable Economic Growth and Development: Lessons from Nigeria. The study revealed that debt service payments significantly reduce funds available for capital formation and infrastructure investment which can impair GDP growth. Ajayi & Oke (2012) investigated on effect of external debt on economic growth and development of Nigeria. The study found a significant positive impact of external debt on GDP in the short term but warned of long- term risks if not managed sustainably.

Using traditional econometric techniques

The outcome of the test of hypothesis two revealed that Total foreign debt stock and exchange rate fluctuations have a significant effect on Gross Domestic Product (GDP) in Nigeria. This means that Nigeria's external borrowing has contributed positively to GDP growth likely by financing capital projects, infrastructure and budgetary support. This further means that exchange rate depreciation has made Nigeria exports more competitive, increasing foreign earnings. In table 5, the coefficient of Total foreign Debt Stock and Exchange Rate Fluctuations which depicts that Total foreign Debt Stock and Exchange Rate Fluctuations clearly has a moderate and significant effect on the Gross domestic product (GDP) as indicated by a coefficient (0.548 and 0.479) at a 5% level of significance. This means that a 1% increase in the Total foreign Debt Stock and Exchange Rate Fluctuations will induce a 0.548% and 0.479% increase in Gross domestic product (GDP) and also 1% decrease in the Total foreign Debt Stock and Exchange Rate Fluctuations will induce a 0.548% and 0.479% decrease in Gross domestic product (GDP). The coefficient of Total foreign Debt Stock and Exchange Rate Fluctuations clearly has a moderate and high significant effect on the Gross domestic product (GDP) as indicated by a coefficient (0.548% and 0.479%) at a 5% level of significance. This further shows that external debt stock has a stronger influence on GDP than exchange rate.

Overall Interpretation using AI-driven Model (Neural Network)

Total Foreign debt stock (TEDS) is 100%. This means that increase in foreign debt stock strongly influences GDP in this model (through financing infrastructure and investment) or negatively (through repayment burden). Exchange Rate Fluctuations (ERF) = 58.8%.

Exchange Rate Fluctuations is a secondary driver compared to foreign debt. This means that sharp depreciation increases debt service cost (since debt is in foreign currency) while indirectly influencing GDP in this model.

The result is in consonant with the findings of several scholars like Adofu & Abula (2010) and Ajayi & Oke (2012). Adofu & Abula (2010) did a study on domestic debt and the Nigerian economy. The study found that external borrowing when used for infrastructural development had a positive impact of GDP when funds were properly managed and invested in productive ventures. Ajayi & Oke (2012) conducted a study on effect of external debt on economic growth and development of Nigeria. The study found a significant positive impact of external debt on GDP in the short term but warned of long- term risks if not managed sustainably.

Summary of findings, Conclusion, Recommendations and Policy Implication

Summary of findings

The study summarizes that foreign debt service payment has a significant effect on Gross Domestic Product (GDP) in Nigeria. The study also summarizes that Total foreign debt stock and exchange rate fluctuations have a significant effect on Gross Domestic Product (GDP) in Nigeria.

Conclusion

The study employed both traditional econometric techniques and AI-driven predictive models to examine the effects of foreign debt service payment, total foreign debt stock and exchange rate fluctuations on Nigeria's Gross Domestic Product. The study concludes that foreign debt contribute to economic growth when efficiently managed; excessive debt accumulation without productive deployment poses risks to long-term stability. The study also concludes that fluctuations in the exchange rate represent a major factor affecting debt repayment cost, investment flows and ultimately GDP performance.

Recommendations

The study recommends that economic policy through the Debt Management Office should prioritize prudent debt management and sustainable borrowing practices while simultaneously pursuing strategies to stabilize the exchange rate. Together these measures will mitigate macroeconomic risks and enhance long-term growth prospects. The study also recommends that the federal government should strengthen domestic production, diversify exports and improve Nigeria's foreign reserves to cushion against external shocks.

Policy Implication

While foreign debt servicing correlates with higher GDP (likely due to financing economic activities), excessive debt servicing may weigh on growth and therefore careful debt management is needed.

Debt Management Priority: Since foreign debt stock has the largest effect, Nigeria must implement strict borrowing guidelines and ensure loans are tied to productive GDP-enhancing projects.

Exchange Rate Stabilization: Given that exchange rate fluctuations significantly affect repayment costs, stabilizing the naira is equally important. Therefore the government must adopt policies that reduce volatility by boosting exports, diversifying reserves and attracting foreign investment in order to minimize shocks to GDP.

Risk of Overdependence: Excessive reliance on foreign debt without matching growth in export earnings may lead to vulnerability, as exchange rate depreciation can magnify debt burdens.

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