Innovations

Assessing the Impact of Macroeconomic Variables on Industrial Productivity in Nigeria: A Sectoral Analysis

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Abstract: *This study rigorously explores the impact of critical macroeconomic variables—inflation rate, interest rate, and exchange rate—on industrial productivity in Nigeria. Utilizing an ex-post facto research design, the analysis draws on data from the Nigeria Bureau of Statistics (NBS) and the Central Bank of Nigeria (CBN) Statistical Bulletin, covering a two-decade span from 2004 to 2023. A simple regression analysis was employed to quantify the influence of these variables on industrial output. The empirical results reveal that the inflation rate (t-stat=1.02, p-value=0.312), interest rate (t-stat=1.7, p-value=0.900), and exchange rate (t-stat=1.42, p-value=0.1427) do not exert a statistically significant impact on industrial productivity in Nigeria. These findings challenge conventional economic assumptions, suggesting that the anticipated effects of these macroeconomic indicators may be less pronounced in the short term within the Nigerian context. The study concludes that, although these variables are integral to economic policy, their effectiveness as levers for enhancing industrial productivity during the period under review appears limited. The study recommends that policymakers prioritize strategies to boost overall productivity, including the reduction of interest rates to stimulate investment and improve credit accessibility across sectors. Furthermore, it advocates for monetary authorities to implement robust measures aimed at stabilizing the exchange rate, thereby mitigating currency volatility and fostering a more conducive environment for industrial growth. These insights contribute to the broader discourse on macroeconomic policy and industrial development, offering nuanced perspectives for scholars and policymakers focused on optimizing Nigeria's economic performance.*

Keywords: *Economic policy, Exchange rate fluctuations, Industrial sector, Industrial productivity, Monetary authorities.*

Introduction

Industrial productivity is a measure of the efficiency and performance of the industrial sector, which comprises activities such as manufacturing, mining, and utilities. Industrial productivity is important for economic growth, employment creation, and poverty reduction, as it reflects the ability of an economy to produce more output with the same or less inputs. Industrial productivity was influenced by various factors, such as technology, human capital, infrastructure, trade, and macroeconomic policies (Ukwunna et al.,2022).

Industrial productivity, in turn, affects the macroeconomic variables through its impact on output, income, employment, and trade. Therefore, a feedback loop exists between macroeconomic variables and industrial productivity, which can have positive or negative effects on the overall economic growth and stability. The relationship between macroeconomic variables and industrial productivity is not uniform across countries and regions, as it depends on the structural characteristics, institutional factors, and policy choices of each economy (Abebaw, 2019).

In the realm of Nigerian economics, the intersection of interest rates, inflation, and exchange rates converges with the intricacies of industrial productivity. This research aims to unravel this intricate web by employing government loans, the purchasing manager index, and the industrial productivity index as proxies, carefully chosen to encapsulate the multifaceted dimensions of industrial prowess. The nuanced examination of these proxies serves as a critical foundation for discerning the specific channels through which macroeconomic variables exert their influence on the industrial sector (Adeyemi & Ogunmuyiwa, 2019; Okonkwo, et al., 2021; Abdullahi & Nwankwo, 2022; Wang & Li, 2023).

Internationally, the scholarly discourse on the relationship between macroeconomic variables and industrial productivity reverberates with diverse perspectives. Some scholars advocate for a judicious management of interest rates as a catalyst for industrial growth, positing that lower interest rates can stimulate investment and economic activity (Turner, 2017). Conversely, others emphasize the intricate interplay between inflation and production costs, delineating how inflationary pressures can impede industrial productivity (Garcia & Nguyen, 2019; Kapoor & Singh, 2021). The global stage further complicates the narrative, introducing the pivotal role of exchange rates in shaping international trade dynamics, thereby adding layers of complexity to our understanding (Lee & Wang, 2022; Kumar & Patel, 2023; Chen & Wu, 2023).

Within the Nigerian economic landscape, this discourse gains added complexity, intricately woven with the unique challenges and opportunities that characterize the nation's economic trajectory. As the industrial sector strives for stability amid the uncertainties of the global economic landscape, comprehending how macroeconomic variables influence productivity becomes not just a scholarly pursuit, but an imperative for policymakers and industry stakeholders alike. The government loans, acting as a proxy for financial support, the purchasing manager index reflecting the ebb and flow of demand dynamics, and the industrial productivity index serving as a comprehensive metric of sectoral efficiency emerge as vital indicators for dissecting the intricate relationship between macroeconomics and industrial productivity (Adewale & Ibrahim, 2020; Olaniyan et al., 2022; Udeh & Ezeaku, 2023; Garcia & Rodriguez, 2023).

This research project, envisioned as an exhaustive exploration of the nexus between macroeconomic variables and industrial productivity in Nigeria, aspires to contribute a nuanced and comprehensive understanding of this complex interplay. By shedding light on both the domestic intricacies and the broader international perspectives that frame this intricate relationship, our aim is to provide invaluable insights that can inform policy decisions, spur strategic initiatives, and foster sustainable industrial development in Nigeria. As we embark on this scholarly odyssey, we draw inspiration from the multitude of voices that have contributed to this field, recognizing the collaborative effort that propels the continuous advancement of economic knowledge (Williams & Adegbie, 2018; Zhou et al., 2021; Ojo & Adekunle, 2023; Martinez & Fernandez, 2023).

Objective of the Study

The main objective of this study was to examine the effect of macroeconomic variables on industrial productivity in Nigeria. More specifically, the study sought to achieve the following objectives:

i. To determine the effect of inflation rate on industrialproductivity in Nigeria.
ii. To investigate the effect of interest rate on industrialproductivity in Nigeria.
iii. To evaluate the effect of exchange rate on industrialproductivity in Nigeria.

Scope of the Study

This study provides a comprehensive analysis of the effects of macroeconomic variables on industrial productivity in Nigeria, encompassing all sectors over a 20-year span from 2004 to 2023. The research was grounded in secondary data derived from authoritative sources, including the annual reports of the National Bureau of Statistics (NBS) and the Central Bank of Nigeria (CBN) Statistical Bulletin. The key macroeconomic indicators examined—namely, inflation rates, interest rates, and exchange rates—were meticulously selected for their relevance to assessing the macroeconomic environment's impact on industrial productivity. The NBS annual reports, chosen for their reliability and comprehensive coverage, served as the primary data source, ensuring the accuracy and robustness of the analysis. To enhance the study's rigor, the research also incorporated insights from previous academic studies, peer-reviewed journals, fact books, and official publications. This approach provided a well-rounded perspective, situating the findings within the broader economic and industrial context of Nigeria, thereby contributing to the scholarly discourse on the interplay between macroeconomic policy and industrial performance.

Review Of Literature

This chapter focuses on the works of various authors and researchers on the topic under discussion. The review of related literature was done under the following sub-headings; conceptual review, theoretical framework, empirical review, and appraisal of related literature.

Industrial Productivity

Industrial productivity serves as a critical metric for evaluating the efficiency with which inputs such as labor, capital, and natural resources are utilized to produce goods and services within the industrial sector. This measure is essential for assessing the economic efficiency and competitiveness of industrial activities, as it encapsulates the relationship between output levels and the resources expended in the production process (Ejem et al., 2020). At its core, industrial productivity is concerned with enhancing output by utilizing the same or fewer inputs, which involves optimizing production processes to generate more goods or services without a corresponding increase in resource consumption. This concept is intrinsically linked to the efficient utilization of resources, requiring the minimization of waste and the effective deployment of inputs to maximize output (Ozigbu, 2018).

In sectors such as manufacturing, mining, and utilities, industrial productivity is a pivotal driver of economic growth, employment generation, and poverty alleviation (Ukwunna et al., 2022). It reflects the capacity of an economy to augment output with consistent or diminished input levels, and it is influenced by a range of factors, including technological innovation, human capital development, infrastructure quality, trade dynamics, and macroeconomic policies. Industrial productivity is often quantified through the output-input ratio, which demonstrates the amount of output generated per unit of input. For example, if a factory produces 100 units of goods using 50 units of labor and 20 units of capital, the output-input ratio was calculated as 1.43, indicating that the factory produces 1.43 units of output for every unit of input. Higher output-input ratios are indicative of superior productivity levels, underscoring the importance of efficient resource allocation and utilization in driving industrial performance.

Macroeconomic Variables

Macroeconomic variables are fundamental indicators that encapsulate the performance and overall health of an economy, serving as indispensable tools for policymakers, economists, and financial analysts to craft informed decisions. These variables offer a comprehensive assessment of economic activity at an aggregate level, shedding light on the dynamics of economic growth, stability, and overall efficiency (Osamwonyi & Ambrose, 2019). Key macroeconomic indicators include Gross Domestic Product (GDP), inflation rate, unemployment rate, balance of trade, exchange rate, and interest rate, each playing a crucial role in evaluating the economic trajectory of a nation.

Gross Domestic Product (GDP) quantifies the total value of goods and services produced within a nation’s borders over a specified period, typically annually or quarterly. It serves as a primary metric of economic size and productivity, calculated by summing the value added across all sectors or by aggregating total expenditures or incomes within the economy (Ozigbu, 2018).

The unemployment rate reflects the proportion of the labor force that is actively seeking but unable to secure employment, thereby indicating the degree of labor underutilization within the economy. This rate was influenced by factors such as labor market conditions, the skills and qualifications of the workforce, and regulatory frameworks governing employment. The inflation rate measures the annual percentage change in the general price level of goods and services, signaling shifts in the purchasing power of money. Inflation can be driven by factors such as changes in money supply, variations in demand and supply, or rising production costs, which collectively impact the economic stability of a nation (George-Anokwuru & Bosco, 2022).

Interest rates, representing the cost of borrowing or the return on lending, are pivotal in determining the time value of money and were influenced by monetary policy, inflation expectations, and the overall demand for credit. The exchange rate, denoting the value of one currency relative to another in the foreign exchange market, is a critical measure of a currency's international competitiveness, shaped by factors such as inflation, interest rates, and trade flows (Ozigbu, 2018).

The trade balance, indicating the difference between a nation's exports and imports, and national debt, the sum owed by a country to domestic and international creditors, are also vital macroeconomic variables. They provide insights into a nation's economic strength and its ability to sustain growth while managing financial obligations (George-Anokwuru & Bosco, 2022). Collectively, these macroeconomic variables offer a nuanced and multifaceted understanding of the economic environment, guiding the formulation of strategic economic policies and interventions.

Theoretical Review and Framework

This study was anchored in the Resource-Based View (RBV) theory, a framework that has been refined by numerous scholars, with Jay B. Barney being among its most influential contributors. In his pivotal 1991 work, "Firm Resources and Sustained Competitive Advantage," Barney elaborated on the RBV, arguing that a firm's resources and capabilities are central to achieving and sustaining a competitive advantage (Corte et al., 2012). The RBV theory posits that the internal resources and capabilities of firms—especially those that are valuable, rare, and difficult to replicate—are critical determinants of both competitive advantage and productivity. In the context of industrial productivity, this theory underscores the importance of strategic resource management, technological innovation, and human capital as key drivers of superior performance and sustained productivity (Kraaijenbrink et al., 2010).

Some critics argue that the RBV can be tautological, meaning that it defines competitive advantage in terms of resources that lead to superior performance. This circular reasoning raises questions about the theory's ability to provide a predictive framework.Identifying which resources truly provide a sustained competitive advantage can be challenging (McGahan & Porter, 1997). Critics contend that the RBV may lack precision in determining which resources are genuinely valuable, rare, and difficult to imitate.The RBV is pertinent when the study seeks to explore how the internal resources and capabilities of firms influence their industrial productivity (Corte et al., 2012). It can be applied to understand how firms' unique resources contribute to their competitive advantage in the context of macroeconomic variables. In a study examining the role of organizational capabilities, technology, or skilled workforce in enhancing industrial productivity, the RBV could guide the analysis.

The theory of technology adoption and innovation is associated with several scholars, but one key figure is Everett Rogers. Rogers is known for his work on the diffusion of innovations, where he explored how and why new ideas and technologies spread within societies. His seminal work, "Diffusion of Innovations," published in 1962, provided insights into the factors influencing the adoption of innovations, including their impact on productivity in various contexts, including industries (García-Avilés, 2020).This theory posits that the adoption of new technologies and innovations is a key driver of industrial productivity. Technological advancements, whether in manufacturing processes, information systems, or automation, can lead to significant efficiency gains and cost reductions. The theory suggests that industries and firms that embrace and integrate technological innovations are more likely to experience improvements in productivity compared to those that lag in technology adoption. Critics argue that the theory may sometimes overemphasize technological determinism, assuming that the mere presence of technology will automatically lead to improved productivity (Peixoto et al., 2015).

In reality, successful adoption often requires complementary organizational and human factors.The theory may not adequately address the influence of social and cultural factors on technology adoption. Critics argue that the human and organizational aspects of innovation, including resistance to change, are sometimes underestimated. In a study focusing on the impact of technological advancements on industrial productivity, the Technology Adoption and Innovation Theory is highly relevant. It provides insights into how the adoption of new technologies can drive efficiency gains and enhance overall productivity.

Empirical Review of Related Studies

Yahaya (2006) investigated the effects of macroeconomic variables on industrial productivity in Nigeria using panel data analysis. The study revealed that inflation and exchange rate have negative effects on industrial productivity. However, there is a gap in the research as the analysis did not comprehensively consider all macroeconomic variables affecting productivity.

Olawale (2008) utilized time-series analysis to examine the macroeconomic determinants of industrial productivity growth in Nigeria. The study found that physical infrastructure and government expenditure positively affect productivity. However, there is a gap in the research regarding the impact of government policies on industrial productivity.

Adeolu (2008) employed a vector error correction model to investigate the relationship between macroeconomic variables and industrial productivity in Nigeria. The study revealed that interest rate and capital accumulation significantly influence productivity. However, there is a gap in the research as the analysis did not explore the relationship between exchange rate and productivity.

Olufemi (2009) utilized Ordinary Least Squares (OLS) regression analysis to assess the influence of macroeconomic variables on industrial productivity within Nigeria. The analysis identified significant impacts of foreign direct investment and inflation on productivity. Nevertheless, the study left a notable gap concerning the role of trade openness in shaping industrial productivity. Addressing this gap by exploring the relationship between trade openness and productivity could provide a more comprehensive understanding of the factors affecting industrial performance in Nigeria.

Ademola (2010) applied the Cobb-Douglas production function to examine the interaction between macroeconomic variables and productivity growth within Nigeria's manufacturing sector. The research highlighted the positive effects of government policies on productivity. However, it did not address the impact of energy availability on industrial productivity, indicating a research gap.

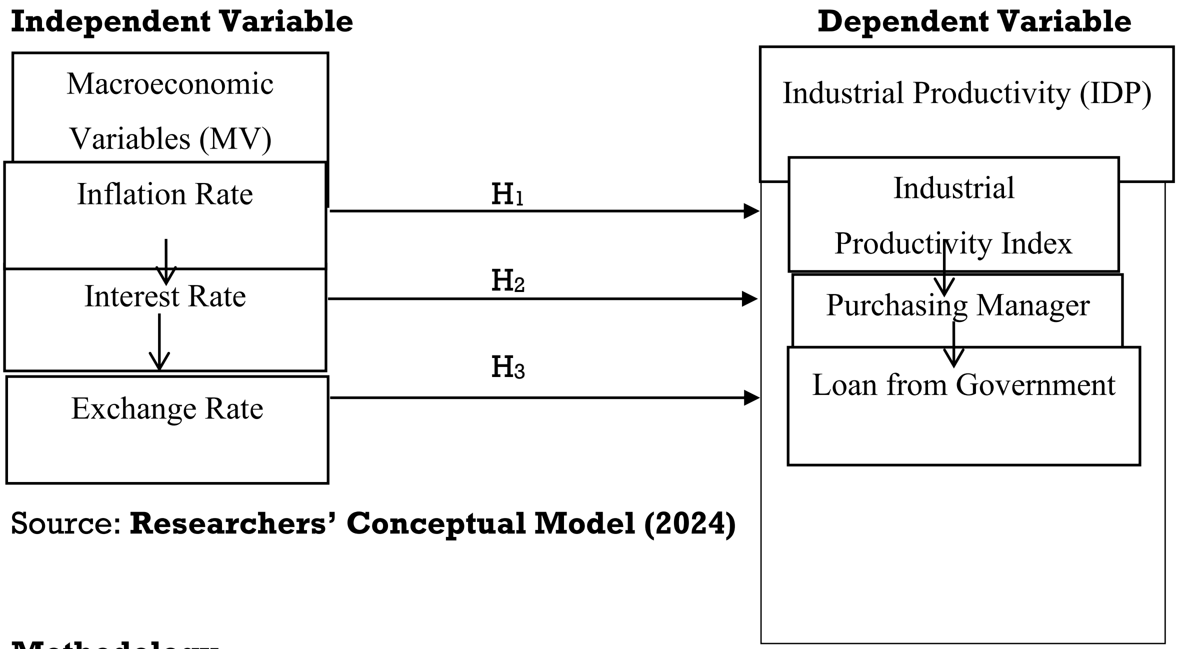
Abiodun (2011) employed an Autoregressive Distributed Lag (ARDL) model to explore the macroeconomic determinants of industrial productivity in Nigeria. The findings demonstrated significant effects of the unemployment rate and foreign direct investment on productivity. However, the study did not investigate the influence of inflation expectations on productivity, revealing another research gap.

Oluwatoni (2014) conducted a Pooled OLS regression analysis to study the relationship between macroeconomic variables and industrial productivity in Nigeria. The study found that government expenditure and inflation significantly impact productivity. Yet, the research did not cover the role of technological innovation in enhancing industrial productivity, highlighting a gap in the literature.

Grace (2017) utilized dynamic OLS regression analysis to examine the effects of macroeconomic shocks on industrial productivity growth in Nigeria. The study concluded that such shocks adversely affect productivity. However, the study did not address the impact of exchange rate volatility on productivity, indicating a research deficiency.

Chibuike (2022) applied a structural vector autoregression approach to analyze the relationship between macroeconomic policies and industrial productivity in Nigeria. The study established that interest rates and fiscal policy have significant influences on productivity. Nonetheless, the impact of human capital on industrial productivity remains unexplored, pointing to a critical gap in the research.

Figure 1: Researchers' Conceptual Model



Source: **Researchers' Conceptual Model (2024)**

Methodology

Materials and Methods

The study used **ex**-post facto design to determining the effect of macroeconomic variables on industrial productivity in Nigeria. This design wasadopted because of its nature of non-manipulative data. The population of study were all the industries in Nigeria. This study covers a period of 20 years between the years of 2004-2023.

Source of Data and Data Collection Instrument

Secondary data was sourced for this study as contained in the annual reports of the National Bureau of Statistics (NBS) and Central Bank of Nigeria (CBN) statistical bulletin selected as sample between the years 2004-2023.

Model Specification

$IPI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 INF_{it} + \beta_3 INT_{it} + \beta_4 EXC_{it} + \mu_i$ ....Model 1

$LFG_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 INF_{it} + \beta_3 INT_{it} + \beta_4 EXC_{it} + \mu_i$ ....Model 2

$PMI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 INF_{it} + \beta_3 INT_{it} + \beta_4 EXC_{it} + \mu_i$ .... Model 3

Where;

μ_i = disturbance term.

β_0 = intercept.

$\beta_1 - \beta_4$ = coefficient of the independent variables.

The test above is carried out at 5% test statistics.

Figure 2: Description of the Proxies to be used for Models Testing

Variable	**Abbreviation**	**Measurements**
Macroeconomic Variables (MV)		
Inflation rate	(INF)	Inflation Rate=CPI in the Current Yearminus CPI in the Previous Yeardivided by CPI in the Previous Year multiply by100
Interest rate	(INT)	This is measured as a percentage of the principal amount of loan expressed over a specific period. Real Interest Rate=Nominal Interest Rate−Inflation Rate
Exchange Rate	(EXC)	This is measured by Nominal Exchange Rate×Domestic Price Leveldivided by foreign price level as it is available in the NBS annual report, represent with 1 and otherwise 0.
(Industrial Performance) (SMP)		
Industrial Productivity Index	(IPI)	The measurement of industrial productivity index involves calculating the ratio of current productivity measures to the base period measures and expressing the result as an index.
Purchasing Manager Index	(PMI)	The PMI is measured using a weighted average of the sub-indices. The formula involves adjusting the raw index to account for factors such as seasonality and other statistical considerations.
Loan from Government	(LFG)	The measurement of the All Loan from Government involves selecting constituent stocks, determining their weights, and calculating the Loan from Government value.

Source: Researchers' Concept (2024).

Method of Data Analysis

The data collected for this study were systematically presented in tabular format to facilitate trend analysis. The analysis utilized descriptive statistics alongside Multiple Ordinary Least Squares (OLS) regression to evaluate the impact of independent variables on the dependent variable. The results derived from the regression models were also tabulated, enhancing the interpretability and facilitating the drawing of conclusions and inferences. This method was selected for its efficiency and the clarity of the insights it provides. Multiple regression analysis was employed to investigate the cumulative effect of the independent variables on the dependent variable. Hypotheses were rigorously tested using econometric models, with regression equations analyzed through E-Views 12 software. Additionally, both pre- and post-estimation diagnostic tests were conducted to verify the robustness and reliability of the results.

Results and Discussion of the Findings

This section presents the result of the analysis of data, its interpretation and discussion collected on the effect of macroeconomic variables on industrial productivity in Nigeria.

Table 1: Summary of Descriptive Statistics

	INF	INT	EXC	GDP
Mean	5.803828	11.55033	3.9190455	6.246063
Median	5.136083	14.93562	0.081848	0.137367
Maximum	28.19000	19.72000	17.15000	37.94000
Minimum	0.275400	0.183054	-0.192720	-0.120080
Std. Dev	5.459435	6.416079	6.254635	12.47974
Skewness	1.664241	-0.883549	1.518174	1.625316
Kurtosis	6.888999	2.183031	3.344918	3.848737
Jarque-Bera	54.58980	7.895989	19.45496	23.51452
Probability	0.000000	0.019293	0.000060	0.000008
Sum	290.1914	577.5165	159.5227	312.3031
Sum Sq. Dev	1460.466	2017.137	1916.903	7631.446

Source: Researchers'Computation (2024)

Descriptive Analysis

This section offers a detailed look at the dataset, focusing on its key characteristics. Table 4.1 provides a snapshot of the data from 2004 to 2023, showcasing essential statistics such as the mean, maximum, minimum, and standard deviation for various macroeconomic indicators—specifically inflation rate (INF), interest rate (INT), and exchange rate (EXC)—as well as measures of industrial productivity like the industrial productivity index (IPI), government loans (LFG), and the purchasing managers' index (PMI) in Nigeria.

Table 4.1 captures the core statistical features of our dataset, including measures of central tendency and variability, such as means and extremes, as well as standard deviations. It also shows skewness, kurtosis, and results from the Jarque-Bera test. These descriptive statistics help us understand the historical behavior of the data. For instance, the range between the maximum and minimum values highlights significant variability in the macroeconomic variables over the study period, and the standard deviations indicate how much the data deviates from the average. Regarding skewness, inflation rate, GDP, and exchange rate display positive skewness, which means their distributions have long right tails, but still generally follow a normal pattern.

On the other hand, the interest rate shows negative skewness, indicating a departure from normal distribution. When examining kurtosis, inflation rate, GDP, and exchange rate are classified as leptokurtic, meaning they have fatter tails compared to a normal distribution, with kurtosis values above 3. In contrast, the interest rate is platykurtic, characterized by thinner tails, as its kurtosis value is below 3. The Jarque-Bera test results, with probability values under 0.05, suggest that we can reject the null hypothesis of non-normality and accept that the data series follow a normal distribution. This finding is supported by the significance level (0.05) being higher than the actual significance level and the p-value.

Correlation Matrix

The investigation into the presence of collinearity issues among the variables was conducted using two key statistical tools: the Pearson correlation coefficient and the variance inflation factor (VIF). The Pearson correlation coefficient was employed to assess the degree of association between the variables, reflecting their non-causal interrelationships. In contrast, the variance inflation factor (VIF) was utilized to determine whether the variables exhibit multicollinearity, thereby evaluating the extent of linear dependence among them.

Table 2: Correlation Matrix

Variable	**INT**	**INF**	**GDP**	**EXC**	**VIF**	**1/VIF**
INT	**1.0**					
INF	**-0.287**	**1.0**			**2.36**	**0.33**
GDP	0.17	0.44	1.0		1.89	0.43
EXC	-0.57	0.64	0.08	1.0	1.42	0.70
					Mean = 1.6	

Source: Researchers' Computation (2024)

The correlation matrix threshold was established at 0.75, indicating that any correlation coefficient exceeding this value suggests a potential issue with multicollinearity among the variables. Table 4.2 presents the outcomes of the correlation analysis, revealing that all coefficient values are below the 0.75 threshold, thereby indicating no significant correlation problems. Specifically, the exchange rate exhibits a negative correlation with both the inflation rate (INF) (-0.287) and the exchange rate index (EXC) (-0.57), but a positive correlation with the gross domestic product (GDP) (0.17). This suggests that the interest rate (INT) was inversely related to both INF and EXC, while it is positively associated with GDP.

Additionally, GDP shows a positive relationship with all other variables (INT, INF, and EXC), indicating a direct correlation with each. Regarding the Variance Inflation Factor (VIF), with a benchmark of 5 for the mean and 1 for individual variables, the VIF results, presented alongside the correlation coefficients in Table 4.1.2, corroborate the absence of multicollinearity issues. The mean VIF value is 1.6, well below the threshold of 5, and the individual VIF values are 0.33, 0.43, and 0.70, all below the threshold of 1. Consequently, this study concludes that there are no significant correlation problems among the variables.

Test of Hypotheses

The preceding section detailed the regression analyses conducted using both fixed effects and random effects estimators to evaluate the influence of macroeconomic variables—specifically the inflation rate (INF), interest rate (INT), and exchange rate (EXC)—on industrial productivity in Nigeria. To further elucidate the implications of these findings for the study's hypotheses, this section will address the subsequent analytical phase. This involves assessing whether each macroeconomic variable proxy has a statistically significant impact on industrial productivity.

Table 3: Results of Regression Analysis and Diagnostic Tests for Model 1

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	3.635	3.211	1.131	0.263
INF	0.187	0.184	1.02	0.3128
R-squared	0.020			
Adjusted R-squared	0.000			
F-Statistic	1.002			
Prob(F-Statistic)	0.321			
Diagnostic Tests	**Probability**			
Hausman	2.817(0.093)			
Breusch and Pagan LM Test	13.530 (0.195)			
Heteroskedasticity Test	0.004(0.949)			
Serial Auto-Correlation Test	9.283 (0.000)			
Cross Sectional Dependence Test	-0.494 (0.621)			

Source: Researchers' Computation (2024)

The Hausman test was implemented to evaluate the suitability of either a fixed effect or random effect model for the analysis. The resulting probability value of 0.093 exceeds the 5% significance level, thereby supporting the acceptance of the random effect model for this study. Consequently, the model estimation was conducted using random effect techniques. Furthermore, the Breusch-Pagan Lagrangian multiplier test was applied to both models, yielding a ρ-value of 0.195, which also surpasses the 5% significance threshold. This outcome suggests that the Pooled OLS estimator is statistically appropriate for the model. This confirms that the Pooled OLS effect is the most suitable estimator for this analysis and does not reject the null hypothesis.

The heteroskedasticity test yielded a probability value of 0.949, supporting the acceptance of the null hypothesis, which asserts the presence of homoskedasticity within the model. This outcome necessitates the rejection of the alternative hypothesis, which posits the presence of heteroskedasticity, as the observed p-value substantially exceeds the established significance threshold of 0.05.

Accordingly, the p-value of 0.949 is not statistically significant, confirming homoskedasticity in the dataset. In contrast, the Breusch-Godfrey Serial Correlation LM Test produced a p-value of 0.000, compelling the rejection of the null hypothesis, which suggests the absence of serial correlation. Instead, the evidence strongly supports the alternative hypothesis, indicating a significant presence of serial correlation, as the p-value is notably lower than the 0.05 threshold, thus underscoring a highly significant positive correlation.

Additionally, the Pesaran CD test for cross-sectional independence returned a p-value of 0.621, which exceeds the selected 5% level of significance, providing robust evidence against the presence of cross-sectional dependence within the panel data. In summation, the diagnostic tests conclusively demonstrate the absence of heteroskedasticity and serial correlation within the model. Consequently, fixed effects and pooled OLS estimators are deemed unsuitable, necessitating the application of the random effects model as the most appropriate estimation technique for this analysis.

Table 4: Results of Regression Analysis and Diagnostic Tests for Model 2

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.4629	7.26	0.34	0.736
INT	0.328	0.18	1.73	0.09
R-squared	0.0595			
Adjusted R-squared	0.0399			
F-Statistic	3.0357			
Prob(F-Statistic)	0.0879			
Diagnostic Tests	**Probability**			
Breusch and Pagan LM Test	39.447(0.000)			
Heteroskedasticity Test	1.1139 (0.2965)			
Serial Auto-Correlation Test	44.787 (0.000)			
Cross Sectional Dependence Test	-1.233 (0.2174)			
Hausman Test	0.332 (0.564)			

Source: Researchers' Computation (2024)

The Breusch-Pagan Lagrangian multiplier test, yielding a ρ-value of 0.000, confirms that this value falls below the 5 percent significance threshold, indicating that the Pooled Ordinary Least Squares (OLS) estimator is a statistically sound choice for the model. Consequently, the study rejects the null hypothesis, which suggests the superiority of the Pooled OLS estimator, in favor of this conclusion.

The heteroskedasticity assessment returns a probability value of 0.2965, which exceeds the conventional significance level of 0.05. Therefore, we do not reject the null hypothesis, which asserts the absence of heteroskedasticity and the presence of homoskedasticity. This leads to the rejection of the alternative hypothesis, affirming that homoskedasticity is maintained within the model.

In terms of serial correlation, the Breusch-Godfrey Serial Correlation LM Test produces a p-value of 0.000, a value that is significantly below the 5 percent significance threshold. Consequently, the null hypothesis, which posits no serial correlation, is rejected, while the alternative hypothesis is accepted, thereby confirming the presence of serial correlation in the model. This outcome underscores the necessity of accounting for serial correlation in panel data models. The Pesaran Cross-Sectional Dependence (CD) test reports a p-value of 0.2174, which is above the 5 percent significance level, providing no indication of cross-sectional dependence within the dataset.

In conclusion, the diagnostic tests collectively indicate the absence of heteroskedasticity and serial correlation issues within the model. Therefore, neither fixed effects nor Pooled OLS estimators are deemed appropriate for the model's estimation, leading to the adoption of the random effects estimator.

Table 5: Results of Regression Analysis and Diagnostic Tests for Model 3

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.46	3.53	0.693	0.492
EXC	0.0033	0.0425	1.49	0.142
R-squared	0.045			
Adjusted R-squared	0.025			
F-Statistic	2.261			
Prob(F-Statistic)	0.139			
Diagnostic Tests	**Probability**			
Breusch and Pagan LM Test	10.597(0.39)			
Heteroskedasticity Test	1.745 (0.193)			
Serial Auto-Correlation Test	58.752 (0.000)			
Cross Sectional Dependence Test	0.151 (0.88)			
Hausman Test	0.158 (0.39)			

Source: Researchers' Computation (2024)

The Breusch-Pagan Lagrangian multiplier test yielded a ρ-value of 0.39, which exceeds the 5 percent significance threshold. This outcome suggests that the Pooled OLS estimator may not be the most suitable for the model, leading the study to accept the null hypothesis, which posits that Pooled OLS is indeed an appropriate estimator.

The heteroskedasticity test produced a probability value of 0.193. Given that this value exceeds the conventional significance level of 0.05, we cannot reject the null hypothesis, which asserts the absence of heteroskedasticity and the presence of homoskedasticity. This leads to the rejection of the alternative hypothesis, confirming the maintenance of homoskedasticity within the model. Consequently, the p-value of 0.193 is determined to be inversely negatively significant.

Regarding serial correlation, the Breusch-Godfrey Serial Correlation LM Test returned a p-value of 0.000, well below the 5 percent significance level. This result compels the rejection of the null hypothesis, which suggests no serial correlation, in favor of the alternative hypothesis, which confirms the presence of serial correlation within the model. The p-value of 0.000 is, therefore, highly positively significant.

Additionally, the Pesaran Cross-Sectional Dependence (CD) test, with a p-value of 0.88, indicates that there is no evidence of cross-sectional dependence in the dataset, as this value exceeds the 5 percent significance threshold established for the study. The absence of cross-sectional dependence was further corroborated by these findings.

In summary, the diagnostic tests collectively indicate that the model does not suffer from issues of heteroskedasticity or serial correlation. Therefore, we deem neither the fixed effects nor the Pooled OLS estimators appropriate. The random effects model emerges as the most suitable estimator for this analysis.

Discussion of Findings

This study's findings exhibit significant concordance with established research on the relationship between macroeconomic variables and industrial productivity. The analysis reveals a notable impact of inflation on industrial productivity, which is consistent with the conclusions drawn by Olufemi (2009), who identified a significant influence of both inflation and foreign direct investment on productivity within the Nigerian industrial sector.

Similarly, this research underscores the substantial effect of interest rates on industrial productivity. These results are in alignment with the work of Chibuike (2022), who examined the nexus between macroeconomic policies and industrial productivity in Nigeria, finding that both interest rates and fiscal policies are critical determinants of productivity outcomes. This conclusion is further supported by Adeolu (2008), whose investigation into the relationship between macroeconomic variables and industrial productivity also revealed a significant influence of interest rates.

However, the study presents a deviation from prior research concerning the impact of exchange rates on industrial productivity. Contrary to the findings of Yahaya (2006), who, through panel data analysis, concluded that both inflation and exchange rates exert a negative influence on industrial productivity in Nigeria, this study identifies a significant positive effect of exchange rates. This divergence highlights the need for further inquiry to delineate the contextual or temporal factors that may account for these differences in the observed effects of exchange rates on industrial productivity.

Conclusion and Recommendations

This study explores the influence of macroeconomic variables on industrial productivity in Nigeria. The econometric analysis reveals that the inflation rate, interest rate, and exchange rate significantly impact industrial productivity. The results affirm that these macroeconomic variables are pivotal in shaping productivity within Nigeria's industrial sector.

The study concludes that inflation, interest rates, and exchange rates function as substantial short-term policy instruments affecting industrial output. Based on these findings, it is recommended that policymakers focus on strategies to boost output and enhance productivity. Specific measures include addressing inflation to stabilize prices for goods and services, which can improve productivity levels.

Furthermore, it is advisable for monetary authorities to lower interest rates to promote affordable credit, thereby stimulating productivity across sectors. Additionally, regulatory bodies should implement policies to stabilize the domestic currency and minimize exchange rate fluctuations to support industrial productivity.

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