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Impact of Brain Drain on the Non- Manufacturing Sector Output in Nigeria (1990-2023)

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ABSTRACT
Many developing countries, including Nigeria, are experiencing significant levels of brain drain across several sectors, such as health, education, and technology. In Nigeria, the exodus of skilled professionals—popularly known as the "Japa Syndrome"—has continued unabated despite several government interventions and policies. This study, therefore, examined the impact of brain drain on Nigeria's non-manufacturing sector output over the period 1990–2023, utilizing time series data and applying the Autoregressive Distributed Lag (ARDL) model. The empirical results revealed that while net migration rate (a proxy for brain drain) has an insignificant short-run effect, it exerted a significant negative influence on non-manufacturing output in the long run. Conversely, per capita income and unemployment rates were found to positively influence sectoral output over time. This implied that although brain drain diminishes productive capacity in the long term, rising income and employment may support temporary resilience. The study concluded that sustainable economic growth requires the retention of skilled labor and recommends holistic strategies including improved working conditions, investment in human capital, and equitable wealth distribution to reduce outward migration and strengthen the non-manufacturing sector.

Keywords: Non- Manufacturing sector output, Brain drain, Net migration rates, Per capita income, Unemployment rate and ARDL
JEL Classifications: O14, F22, J61, O15, J64, and C51

I.INTRODUCTION

Brain drains, or human capital flight, refers to the large-scale migration of skilled professionals, particularly from developing to developed nations. This phenomenon has been a major issue since the mid-20th century, accelerating with globalization, technological advancements, and increasing demand for skilled labor in developed countries.Themodern concept of brain drain became widely recognized in the 1960s when the United Kingdom witnessed a significant loss of its scientists and healthcare professionals to the United States and Canada (Docquier& Rapoport, 2012). Post-World War II reconstruction efforts in Western nations attracted a vast number of skilled individuals from developing countries, leading to a substantial migration wave. This trend intensified with globalization and advancements in communication and transport, making migration easier and more attractive for skilled workers (Bhargava &Docquier, 2008).

Africa, as a continent has lost millions of professionals over the past few decades, particularly in healthcare and engineering (Adepoju, 2008). Countries like India, Pakistan, and Bangladesh have seen a mass exodus of doctors, IT experts, and engineers to the US, UK, and Canada (Khadria, 2004).Nations such as Mexico and Brazil have also experienced significant outflows of skilled workers, especially to North America and Europe (Pellegrino, 2001). On the receiving end, the United States, Canada, Australia, and Western European countries have been the biggest beneficiaries, attracting top talent from developing regions (Lowell, 2001).

Nigeria has experienced brain drain since the 1980s, largely due to economic downturns, political instability, and worsening working conditions for professionals. The introduction of the Structural Adjustment Program (SAP) in 1986, which devalued the Nigerian currency and led to austerity measures, triggered a wave of migration as professionals sought better opportunities abroad (Okafor, 2012).During the military regimes of the 1990s, poor governance, corruption, and human rights abuses further worsened the situation, causing even more professionals to leave the country (Adebayo, 2011). This trend has continued into the

21st century, with economic mismanagement and insecurity exacerbating the problem. Nigeria faces a severe shortage of doctors and nurses. According to the Nigerian Medical Association (NMA), over 75,000 Nigerian doctors work abroad, mainly in the UK, US, and Canada, while fewer than 35,000 remain in Nigeria to serve a population of over 200 million (WHO, 2021). The doctor-to-patient ratio in Nigeria is 1:5,000, far worse than the WHO-recommended ratio of 1:600 (Ogundipe, 2020).

Nigerian universities lose thousands of lecturers and researchers to foreign institutions due to poor salaries, inadequate funding, and lack of research grants (Eme, 2014). This has led to brain waste, where professionals who remain in Nigeria are unable to fully utilize their expertise due to poor working conditions. Nigeria's booming tech industry has also been affected. Many software engineers and IT professionals have left for better-paying jobs in Europe and North America (Adeyemi, 2022). The term "Japa Syndrome", which describes the mass migration of Nigerian professionals, has become a popular expression, particularly in tech and finance circles (Uwaleke, 2023). The non-manufacturing sector encompasses industries such as agriculture, mining, and services. Agriculture remains a cornerstone of Nigeria's economy, providing employment for a large portion of the population and contributing to food security. The mining sector, particularly oil and gas, is a significant revenue generator for the country. The services sector, including finance, telecommunications, and education, has been growing rapidly and contributing substantially to the GDP.

However, these sectors also suffer from the loss of skilled professionals due to brain drain, affecting their performance and growth potential (Ogbuabor&Malaolu, 2021).The agricultural sector in Nigeria, for example, is highly dependent on skilled professionals such as agronomists, agricultural engineers, and extension workers to implement modern farming techniques and improve productivity. The loss of these professionals to brain drain hampers the sector's ability to adopt new technologies and practices, which are essential for increasing agricultural output and ensuring food security (Eme, Onyishi, & Uche, 2020). Similarly, the oil and gas industry, which is a major contributor to Nigeria's revenue, requires highly specialized engineers and geologists. The emigration of these professionals to countries with better working conditions and higher salaries affects the sector's ability to explore and develop new resources efficiently (Igbatayo, 2021). In the non-manufacturing sector, the impact of brain drain is significant. The agricultural sector, for example, needs agronomists, agricultural engineers, and extension workers to implement modern farming techniques and improve productivity. The loss of these professionals hampers the sector's ability to adopt new technologies and practices, affecting food security and rural development. Similarly, the oil and gas industry require highly specialized engineers and geologists.

The emigration of these professionals to countries with better working conditions and higher salaries affects the sector's ability to explore and develop new resources efficiently (Adewale, 2020). Nigeria loses billions of dollars annually due to the migration of skilled labor, as investments in education and training do not yield returns for the economy (Akinyemi, 2013). With fewer medical professionals, healthcare delivery is severely compromised, increasing mortality rates (Ogunyemi, 2021). The loss of academics and scientists has led to a decline in innovation and research output (Oluwatobi &Olurinola, 2015). It is against this backdrop that the current study investigated the impact of brain drain on the non - manufacturing sector output in Nigeria between 1990 and 2023. The study achieved the following specific objectives, which includes to:examines the impact of net migration rate on manufacturing sector output in Nigeria; investigates the effect of per capita income on manufacturing sector output in Nigeria and analyze the effect of unemploymentrate on manufacturing sector output in Nigeria.

The following formulated hypotheses guided the study:
H_{01}: Net migration rate has no significant impact on manufacturing sector output in Nigeria
H_{02}: Per capita income has no significant effect on manufacturing sector output in Nigeria
H_{03}: Unemployment rate has no significant effect on manufacturing sector output in Nigeria
The rest of the paper was structured as follows. The next is section two which explained the conceptual framework, as well as the review of empirical findings and theoretical basis. Section three described the methodology of this study including data issues and preliminary analyses. Section four presented and discussed the results; while section five concluded the paper with policy recommendations.

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II.LITERATURE REVIEW

Conceptual Review

Brain drain refers to the large-scale emigration of skilled professionals, particularly from developing countries to more developed nations, in search of better career opportunities and improved living conditions (Docquier& Rapoport, 2012). It is often associated with the loss of valuable human capital in key sectors such as healthcare, education, science, and technology.From an economic standpoint, brain drain is defined as the "migration of highly educated individuals from a less developed economy to an advanced economy, leading to a shortage of skilled labour and a decrease in the country's productive capacity" (Beine*et al.*, 2008).According to Eme (2014), brain drain is not just an economic issue but also a sociopolitical phenomenon, as it is often driven by factors such as poor governance, lack of research funding, and political instability.In the healthcare sector, brain drain is described as the "continuous movement of trained medical professionals from low-income to high-income countries, leading to a significant gap in healthcare service delivery" (Okafor, 2019). Similarly, in academia, it refers to the loss of university professors and researchers to foreign institutions due to better funding and job security (Adepoju, 2018). The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines brain drain as the "systematic migration of talent and knowledge from developing nations to wealthier nations, often resulting in a permanent loss of skilled professionals in the home country" (UNESCO, 2021). In Nigeria, brain drain syndrome is popularly known or nicknamed 'JAPA' (a Yoruba word which means to run or to flee) according to Nnoruga and Osigwe (2023): it is the exodus of middle- class and highly skilled Nigerians to other countries of the world.

On the other hand, non-manufacturing sector output refers to the total economic contribution of industries that do not engage in physical goods production but rather provide services, trade, and other non-industrial activities (National Bureau of Statistics [NBS], 2020). Non-manufacturing sectors refer to all other industries outside the manufacturing sector, including services, agriculture, mining, and construction. These sectors are equally important for economic growth and development, contributing to job creation, income generation, and overall economic stability (World Bank, 2021). Uchenna (2022) defines non-manufacturing sector output as the "aggregate economic productivity of service-based industries, which contribute significantly to GDP without direct engagement in industrial production." In Nigeria, this sector accounts for over 50% of the country's GDP, making it a key driver of economic growth. The non-manufacturing sectors in Nigeria play a vital role in the country's economy, particularly agriculture and services. However, these sectors also suffer from the adverse effects of brain drain, which results in a shortage of skilled professionals needed to drive growth and innovation (Afolayan*et al.,* 2021).

Empirical Review

Olowolaju*et al.* (2025) investigated the growing crisis of brain drain in Nigeria's healthcare sector, characterizing it as an "unsung epidemic." It employed the push-pull theory of migration to examine why healthcare professionals are emigrating in increasing numbers. The paper also discussed the negative impact on research, innovation, and healthcare education. While the Nigerian government has implemented reforms such as national health policies, increased funding, and partnerships, these have not significantly stemmed the outflow. The study offered recommendations like improving working conditions, offering career development, and incentivizing return migration. It concluded that only a multifaceted, sustained policy approach can reverse this trend. Ultimately, brain drain is shown to undermine both healthcare delivery and national development goals.

Adebogun*et al.* (2024) explored the critical issue of brain drain in Nigeria, focusing specifically on Lagos State between 2015 and 2023. The study adopted the push-pull theory that was propounded in 1966 by Everett Spurgeon Lee. Also, data was collected using qualitative method and 11 interviewees were interviewed while data were also collected from secondary sources. The result of the study revealed that the government's neglect of human capital investment has reduced economic growth and caused citizens to seek opportunities abroad. The study concluded by emphasizing the need for investment in human capital development through employment, training, healthcare, infrastructural development and technological advancement to eradicate brain drain and foster a more inclusive society. This study recommended the diversification of its economy, reduce corruption and invest in human capital development.

Agbonkhese (2023) investigated the factors driving the exodus of IT professionals from Nigeria and the impact of this migration on the country's economy. The study analyzed the root causes of this migration and assess its effects on various sectors such as IT, banking, healthcare, and defense within Nigeria.Focusing on Nigeria, the study identified poor remuneration, lack of job satisfaction, inadequate working conditions, insecurity, and poor governance as th primary factors driving IT professionals to leave the country. Methodologically, the study employed a comprehensive literature review, relying on secondary data sources such as academic studies, government reports, and news articles. The study's limitations include its focus on Nigeria, which limited the generalizability of its findings to other countries with similar migration patterns.

Adjei-Mensah (2023) explored the reasons behind the emigration of health professionals from Ghana, particularly following the COVID-19 pandemic. The study aimed to identify the primary factors contributing to brain drain, assess their impact on Ghana's health sector, and propose solutions to retain skilled professionals. Conducted in the Greater Accra Region, the research focused on health workers in public hospitals and used a survey method with stratified random sampling to gather data from 400 participants. The study revealed that low remuneration, inadequate staff development opportunities, poor working conditions, political interference, and personal ambitions significantly contributed to brain drain. These factors had adversely affected healthcare delivery in Ghana, especially during the pandemic.

Nnoruga and Osigwe (2023) examined the significant impact of brain drain on Nigeria's nation-building efforts, focusing on the loss of skilled professionals and its consequences for human capital development and economic growth. The study explored the causes and effects of brain drain, highlighting how factors such as political instability, economic challenges, corruption, and inadequate infrastructure drive skilled professionals to emigrate. Grounded in theories such as the Theory of Reasoned Action (TRA) and the Push-Pull Theory, the study analyzes how individuals' decisions to migrate are influenced by both adverse conditions in Nigeria and attractive opportunities abroad. The authors utilized a qualitative approach, drawn on secondary data from existing literature to explore the socio-economic and political conditions contributing to this emigration trend. Findings indicated that brain drain severely undermines Nigeria's development by creating critical gaps in sectors like healthcare, education, and technology, further exacerbating the country's underdevelopment. The study suggested that improving Nigeria's socio-political environment, reducing corruption, and enhancing economic management are crucial steps to mitigate brain drain.

Ikpesu*et al.* (2022) examined the effects of remittances, human capital flight, and brain drain on sustainable economic growth in Sub-Saharan Africa (SSA), particularly in relation to the Sustainable Development Goals (SDGs) for 2030. Analyzing data from ten SSA countries, including Nigeria, Ghana, and South Africa, the study used GDP per capita as the dependent variable while considering factors such as brain drain, remittances, corruption perception, income inequality, poverty, and trade. Using the panel ARDL and ECM methods on data from 2006 to 2020, the study found that while remittances contribute to economic stability, skilled labor migration hinders long-term sustainable growth and SDG attainment.

Ajayi *et al.* (2022) explored the factors driving the emigration of healthcare professionals from public teaching hospitals. Using hierarchical multiple regression analysis, the study examined how career development, autonomy, low wages, and political instability influence brain drain. Based on a survey of 356 hospital staff, findings showed that career growth opportunities, greater autonomy, and low salaries significantly increased the likelihood of emigration. Political instability was also a key factor, as professionals sought more stable work environments abroad. The study called for further research on additional causes and long-term effects of brain drain in Nigeria's healthcare sector.

Sehar *et al.* (2021) examined the impact of intellectual brain drain on economic growth in developing countries, with a focus on Pakistan. The study highlighted how skilled migration hampers development and proposed strategic compensation as a theoretical solution to retain intellectual talent. However, the lack of empirical validation raised concerns about the practical applicability of these strategies. Additionally, while the study focused on Pakistan, its findings may not be universally applicable to other developing nations.

Tasinda*etal.* (2021) investigated the effects of Chinese foreign direct investment (FDI), remittances, and foreign aid on human capital growth (HCG) and brain drain in five African countries (Nigeria, Kenya, Ghana, South Africa, and

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Morocco) from 2009 to 2018. Using secondary data and autoregressive distributed lag (ARDL) modeling, the study found that while these factors positively influenced HCG in the long run, their short-term impact was insignificant. Similarly, remittances, Chinese FDI, and foreign aid reduced brain drain over time but had no immediate effect. The study provides key insights into the role of external financial inflows in mitigating brain drain and fostering human capital development.

Osigbesan (2021) examined the impact of medical brain drain on Nigeria's healthcare sector using a heuristic phenomenological approach. The study explored the lived experiences of 12 Nigerian healthcare practitioners who migrated to the United States, guided by the push-pull theory. The research focused on understanding the reasons behind their emigration and its effects on the Nigerian healthcare system. Qualitative data was collected and analyzed, providing insights into the factors driving medical professionals to leave and the broader implications for healthcare in Nigeria.

Oliinyk*et al.* (2021) explored the relationship between the migration of highly skilled workers, economic growth (measured by GNI per capita), and national competitiveness. Using data from developed countries, the study employed correlation-regression analysis, modeling, and cluster analysis via STATISTICA. The findings revealed that the immigration of highly educated workers significantly enhances a country's competitiveness and economic development. This conclusion was supported by case studies and talent migration indicators, including the Human Flight and Brain Drain sub-index (Fragile States Index), the Brain Gain sub-index (Global Talent Competitiveness Index), and the Highly Educated Workers sub-index (OECD).

Okolo and Lawrence (2021) examined the factors influencing brain drain among mental health professionals in specialist healthcare facilities in Benin. Using a cross-sectional predictive research design, the study surveyed 299 respondents from two institutions: Federal Neuro-Psychiatric Hospital Benin and the University of Benin Teaching Hospital. The findings showed significant relationships between migration intentions and conditions of service, professional development, and access to foreign technology. The study concluded that improving service conditions could help reduce brain drain among mental health professionals in Nigeria.

Kousar *et al.* (2020) examined the macroeconomic factors influencing the emigration of skilled professionals from Pakistan. Using time series data and multiple regression analysis, the study assessed the impact of GDP growth, unemployment, inflation, FDI, exchange rates, education expenditure, and political instability on brain drain. Findings revealed that economic stability and higher education investment reduce emigration, while unemployment, inflation, and political instability drive brain drain. The study emphasized the need for policy measures to improve economic conditions and retain talent. It also highlighted a research gap in understanding non-economic factors, calling for further studies on cultural and social influences on brain drain.

Popogbe and Adeosun (2020) examined the impact of migration on Nigeria's economic output growth, focusing on migration rates, remittances, population growth, and secondary school enrollment. Using a macro-level approach and the autoregressive distributed lag (ARDL) method to analyze time series data from 1986 to 2018, the study found that net migration negatively affected economic growth, despite high remittance inflows. However, secondary school enrollment had a positive and significant long-term impact on Nigeria's growth rate, highlighting the importance of human capital development for economic progress.

Imafidon (2018) investigated the impact of brain drain on Nigeria's healthcare system by comparing Nigerian medical doctors in the U.S. with those who remained in Nigeria. Using the social ecological model, the study analyzed push factors driving emigration and pull factors attracting doctors to host countries. Through thematic analysis of qualitative data from key-informant interviews with 17 doctors, obtained via convenience and snowball sampling, the study provided insights into the challenges facing Nigeria's healthcare sector due to medical brain drain.

Theoretical Review

The theoretical framework for this study is built on Lucas model. Human capital enters the production function in the Lucas model in the same way that technology does in the Solow model, that is, in a labour-augmenting form (which would seem like a rather natural way to conceptualize things). The economy is made up of identical individuals (or representative agents) who seek to maximize their lifetime utility. The degree of consumption and the

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allocation of time between labour and skill learning are two variables over which agents have influence. The first variable influences an agent's future production, whereas the second affects the accumulation of physical capital. Lucas proposes the following method of production:

$$Yt = AK_t^{\beta} H_t^{\beta} (UthtLt)^{1-\beta h_{at}^{r}} \quad (1)$$

where Y, A, K, and L are output, technology, capital, and labor, respectively, and u is the fraction of an individual's time dedicated to work, h is the representative agent's skill level or human capital, and ha is the economy's average human capital. The technological level, A, is believed to be constant (so that it could in principle be dropped from the expression or subsumed within the capital term). Exogenous population growth is assumed. The most significant assumption of the model involves the law of motion according to which the human capital variable evolves with time, leaving aside the last term on the right-hand side for the time being. Lucas believes that investing in education produces human capital, which is the most important factor in the growth process. He distinguishes between internal impacts of human capital, which raise the productivity of the particular worker undergoing training, and external effects, which increase the productivity of capital and other workers in the economy. Rather than physical capital, investments in human capital have spillover effects that raise the degree of technology.

III.METHODOLOGY

The paper employed secondary data sourced from World Bank Indicators data and National Bureau of Statistics (NBS). It covers the period of 33 years (1990–2023). It adopted the ARDL-ECM approach in order to investigate the impact of brain drain on the non-manufacturing sector output in Nigeria. The first step was to test the stationarity of the series to avoid spurious regression results. Estimation was conducted using the econometric computer software package, E-Views 12.

Model specification

The model used for this investigation is the adaption and modification of the work of Oluwaseyi et al (2020). The model is modified and specified to follow the study objectives and hypotheses. It is therefore stated as follows;

$$NMSO = f(NMR, PCI, UNEMPR) \quad (2)$$

Where; NMSO = Non-manufacturing Sector Output, NMR = Net Migration Rate, PCI = Per Capita Income and UNEMPR = unemployment rate

It is expressed explicitly as

$$NMSO_t = \beta_o + \beta_1 NMR_t + \beta_2 PCI_t + \beta_3 UNEMPR_t + \mu_t \quad (3)$$

Where;

$\beta_{0:}$ Intercept term

β_1—$\beta_{4:}$ Coefficients of the independent variables

μ_t : Error term

The ARDL form of the model is as follows:

$$NMSO = \beta_0 + \sum_{g=1}^{l} \beta_1\, NMSO_{t-1} + \sum_{h=1}^{m} \beta_2\, NMR_{t-i} + \sum_{i=1}^{n} \beta_3\, PCI_{t-i} + \sum_{j=0}^{o} \beta_4\, \mathrm{UNEMPR}_{t-i} + \sum_{g=1}^{l} \beta_5\, \Delta NMSO_{t-1} + \sum_{h=1}^{m} \beta_6\, \Delta NMR_{t-i} + \sum_{i=1}^{n} \beta_7\, \Delta PCI_{t-i} + \sum_{j=0}^{o} \beta_8\, \Delta\mathrm{UNEMPR}_{t-i} + + \varepsilon_t (4)$$

Where;

Δ is the difference operator and

$\beta_{1-}\beta_4$ are the short run dynamics of the independent variables.

The empirical error correction model (ECM) is stated as;

$$\Delta NMSO = \beta_0 + \sum_{g=1}^{l} \beta_1\, \Delta NMSO_{t-1} + \sum_{h=1}^{m} \beta_2\, \Delta NMR_{t-i} + \sum_{i=1}^{n} \beta_3\, \Delta PCI_{t-i} + \sum_{j=0}^{o} \beta_4\, \Delta\mathrm{UNEMPR}_{t-i} + \lambda ECM_{t-1} + \varepsilon_t (5)$$

where the ECM_{t-1} is expected to be negative and shows the speed of adjustment of non-manufacturing sector outputto equilibrium in the long run after a disequilibrium occurs due to change in the explanatory variables.

IV.RESULTS AND DISCUSSION

Descriptive Analysis

This section provided a summary of the descriptive statistics for the four key variables observed in the study: Non-Manufacturing Sector Output (NMSO), Net Migration Rate (NMR), Per Capita Income (PCI), and

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Unemployment Rate (UNEMP). The dataset comprised 33 observations for each variable, enabling a preliminary analysis of their distributional characteristics and statistical properties.

Table 1: Descriptive Analysis

	NMSO	NMR	PCI	UNEMP
Mean	31343.16	-0.276091	295994.8	14.21515
Median	27361.21	-0.288	210456.8	13.70000
Std. Dev.	18355.52	0.077119	297327.3	9.791933
Skewness	0.280030	-0.002536	0.914768	0.524506
Kurtosis	1.502472	1.611106	2.824235	2.498862
Jarque-Bera	3.514855	2.652448	4.644883	1.858400
Probability	0.172488	0.265478	0.098034	0.394870
Observations	33	33	33	33

Source: *Researcher's Computation Using EViews-12 (2025)*

The average value of Non-Manufacturing Sector Output (NMSO) is approximately 31,343.16, with a median of 27,361.21, indicating a right-skewed distribution as further confirmed by the skewness coefficient of 0.280. The standard deviation of 18,355.52 revealed a moderate dispersion around the mean. The kurtosis value of 1.502 suggested a platykurtic distribution, characterized by lighter tails than the normal distribution. The Jarque-Bera statistic of 3.514 with a probability value of 0.172 indicated that the null hypothesis of normality cannot be rejected at the 5% level, implying that the NMSO data is approximately normally distributed.

In contrast, the Net Migration Rate (NMR) has a mean of -0.276 and a median of -0.288, pointing to a slightly negative average migration rate. The standard deviation is relatively low at 0.0771, indicating minimal variation in net migration rates across the observations. Skewness is nearly zero (-0.0025), and kurtosis is 1.6111, signifying a symmetrical and flat distribution. The Jarque-Bera statistic of 2.652 with a probability of 0.265 further supported the normality of the distribution, making NMR a statistically well-behaved variable for subsequent analysis.

The Per Capita Income (PCI) presented a mean of 295,994.8 and a median of 210,456.8, suggesting a significant right skew as confirmed by the skewness coefficient of 0.9148. The variable also displayed a very high standard deviation of 297,327.3, which implied substantial variability in income levels. The kurtosis value of 2.824 is close to the normal threshold, yet the Jarque-Bera statistic of 4.644 with a probability of 0.098 suggested marginal non-normality at the 10% significance level. This indicated potential outliers or high-income earners influencing the distribution, a common feature in income data.The Unemployment Rate (UNEMP) exhibited a mean of 14.215 and a median of 13.700, indicating a distribution that is slightly positively skewed, as reflected in the skewness value of 0.5245. The standard deviation is 9.7919, showing notable variation in unemployment rates. The kurtosis of 2.4989 implied a distribution slightly flatter than normal. However, the Jarque-Bera statistic of 1.858 with a corresponding p-value of 0.3949 suggested that the data conformed well to a normal distribution.

Stationary Tests (Unit Root Tests)

To ascertain the stationarity properties of the variables employed in this study, the Augmented Dickey-Fuller (ADF) test was conducted. Stationarity is a critical precondition in time series econometrics, as the presence of unit roots can lead to spurious regression results, misinterpretation of relationships, and inefficiencies in model estimation. The ADF test helps determine whether a time series is non-stationary and possesses a unit root, or if it is stationary.The results of the ADF tests for all four variable Non-Manufacturing Sector Output (NMSO), Net Migration Rate (NMR), Per Capita Income (PCI), and Unemployment Rate (UNEMP) are summarized in the table. The null hypothesis of the ADF test posited that a unit root is present in the series, whereas the alternative hypothesis suggested stationarity.

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Table 2: Unit Root test

Variable	Augmented Dickey-Fuller (ADF) Test		
	ADF	@ 5%	Status
NMSO	-2.171419	-1.951687	1(0)
NMR	-3.905221	-2.957110	1(1)
PCI	- 2.268773	-1.952910	1(1)
UNEMP	-5.735134	-2.967767	1(1)

Source: *Researcher's Computation Using EViews-12 (2025)*

For NMSO, the ADF test statistic is -2.1714, which exceeded the critical value at the 5% significance level (-1.9517 in absolute terms). Thus, the null hypothesis of a unit root is rejected, indicating that NMSO is stationary after first differencing. This is denoted by its integration order of I(0).Similarly, NMR yielded an ADF statistic of -3.9052, which is more negative than the 5% critical value of -2.9571. Therefore, the null hypothesis is rejected, and NMR is also deemed stationary at first difference, i.e., I(1). This suggested that while the level form of NMR may be non-stationary, its first difference is stable and mean-reverting.

The test statistic for Per Capita Income (PCI) is -2.2688, which again is lower than the corresponding 5% critical value of -1.9529. As with the previous variables, this outcome indicated rejection of the unit root hypothesis at first difference, classifying PCI as an I(1) process. This finding is consistent with the behaviour of macroeconomic aggregates such as income, which often display stochastic trends over time.Lastly, the ADF statistic for UNEMP is -5.7351, far exceeding the critical value of -2.9678. This strongly supported rejection of the null hypothesis, confirming that the Unemployment Rate becomes stationary after first differencing. The I(1) classification for UNEMP is typical of labour market variables, which tend to exhibit persistent trends influenced by structural and cyclical dynamics.

Co-integration of ARDL-Bounds Test

To examine the existence of a long-run equilibrium relationship among the variables in the model, the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration was employed, as developed by Pesaran, Shin, and Smith (2001). This technique is particularly advantageous in situations where the underlying regressors are a mix of stationary at level, I(0), and first difference, I(1), but not I(2), and is therefore well-suited to the present study given the unit root properties of the data.

Table 3: ARDL Cointegration -Bound Testing

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	6.360927	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: *Researcher's Computation Using EViews-12 (2025)*

The results of the F-Bounds test are presented in the table above. The calculated F-statistic is 6.3609, which is compared against the critical bound values at different significance levels (10%, 5%, 2.5%, and 1%) under the assumptions of the lower bound I(0) and upper bound I(1). For a model with k = 3 explanatory variables, the critical value bounds at the 5% level are 2.79 (I(0)) and 3.67 (I(1)).Since the computed F-statistic (6.3609) exceeded the upper critical bound value at the 1% significance level (which is 4.66 for I(1)), we decisively rejected the null hypothesis of no levels relationship. This outcome provided strong statistical evidence of the existence of a long-run cointegrating relationship among the variables in the model.

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ARDL Short Run Long Run and ECM Regression Model Result

The Autoregressive Distributed Lag (ARDL) model was employed to explained long-run equilibrium relationships and short-run dynamics between the dependent variable and key macroeconomic indicators, including Net Migration Rate (NMR), per capita income (PCI), and unemployment (UNEMP). The model incorporated an Error Correction Mechanism (ECM) to quantify the speed of adjustment to long-run equilibrium following short-term shocks. Results are derived from a parsimonious specification with lagged differences to capture dynamic effects, alongside diagnostic tests for robustness. The results are presented in three parts: the short-run, the long-run coefficients, error correction model (ECM), and relevant diagnostic statistics.

Table 4: ARDL Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3702.101	1695.368	2.183657	0.0539
NMSO(-1)*	-1.22675	0.269057	-4.559449	0.001
NMR(-1)	-54749.95	12806.91	-4.275033	0.0016
PCI(-1)	0.085233	0.019563	4.356947	0.0014
UNEMP(-1)	201.9545	66.00372	3.059744	0.012
D(NMR)	9980.626	22699.38	0.439687	0.6695
D(NMR(-1))	13270.88	23900.84	0.555247	0.5909
D(NMR(-2))	-5946.843	23521.91	-0.252821	0.8055
D(NMR(-3))	-69828.37	29150.17	-2.39547	0.0376
D(PCI)	-0.033626	0.028955	-1.161298	0.2725
D(PCI(-1))	-0.097376	0.023367	-4.167299	0.0019
D(PCI(-2))	-0.055037	0.028375	-1.939605	0.0811
D(UNEMP)	20.65533	42.9545	0.480865	0.641
D(UNEMP(-1))	-135.4672	55.99195	-2.419405	0.0361
D(UNEMP(-2))	-74.071	49.96082	-1.482582	0.169
D(UNEMP(-3))	-81.65977	38.82474	-2.103292	0.0617
CointEq(-1)*	-0.22675	0.183843	-6.672817	0.0001
R-squared	0.999176			
Adjusted R-squared	0.997939			
F-statistic	807.924			
Prob(F-statistic)	0.0000			
Durbin-Watson stat	1.746295			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
NMR	-44630.09	6193.479	-7.205981	0.0000
PCI	0.069479	0.002972	23.37676	0.0000
UNEMP	164.6257	54.07667	3.044301	0.0124
C	3017.813	1091.44	2.764984	0.0200

Source: *Researcher's Computation Using EViews-12 (2025)*

The error correction term (CointEq(-1)) is both negative and statistically significant, with a coefficient of -0.2268 and a p-value of 0.0001. This negative sign and high level of significance confirm

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the existence of a stable long-run equilibrium relationship among the variables in the model. The magnitude of the coefficient indicates that approximately 22.7% of the short-run disequilibrium from the previous period is corrected in the current period. In other words, deviations from the long-run equilibrium path are gradually corrected at a moderate speed, suggesting that while short-run fluctuations may occur, the system is inherently stable and converges toward long-run equilibrium over time. This dynamic adjustment mechanism validates the suitability of the ARDL model for analysing both short-run shocks and long-run tendencies within the context of migration determinants.

Furthermore, the model exhibited a strong overall goodness-of-fit, as evidenced by the exceptionally high R-squared value of 0.9992 and an adjusted R-squared of 0.9979. These statistics implied that over 99% of the variation in the dependent variable (Non-Manufacturing Sector Output) is accounted for by the explanatory variables included in the model. The F-statistic of 807.924, accompanied by a p-value of 0.000, further supported the joint significance of the model parameters, affirming that the regressors are collectively relevant in explaining the behaviour of the dependent variable. Additionally, the Durbin-Watson statistic of 1.746 suggested the absence of first-order serial correlation in the residuals, thereby satisfying one of the key diagnostic criteria for model validity. This further enhanced the credibility of the regression estimates and ensures the reliability of inferences drawn from the model.

Post-Estimation Checks (ARDL Diagnostic Test)

To ensure the robustness and reliability of the ARDL model, post-estimation diagnostic tests were conducted to assess the presence of heteroskedasticity and serial correlation in the residuals. These diagnostic checks are crucial to validate the adequacy of the model specification and the reliability of statistical inferences drawn from the estimated coefficients.

Table 5: Post-Estimation Diagnostic Tests

Test type	F-Statistic	Prob
Heteroskedasticity Test	0.453737	0.4478
Breusch-Godfrey Serial Correlation LM	0.820444	0.6468

Source: *Researcher's Computation Using EViews-12 (2025)*

The Breusch-Pagan-Godfrey test for heteroskedasticity was employed to examine whether the variance of the residuals is constant across observations. The test returned an F-statistic of 0.4537 with an associated probability value of 0.4478, which is well above the conventional significance level of 0.05. Consequently, we fail to reject the null hypothesis of homoskedasticity, indicating that the residuals have a constant variance. This result suggests that the model does not suffer from heteroskedasticity, thereby validating the efficiency of the estimators.

To evaluate the presence of autocorrelation in the residuals, the Breusch-Godfrey Serial Correlation LM Test was applied. The result produced an F-statistic of 0.8204 and a corresponding p-value of 0.6468. Since the p-value exceeds the 5% level of significance, the null hypothesis of no serial correlation cannot be rejected. This implies that the residuals are not serially correlated, affirming the model's specification and supporting the validity of the dynamic structure of the ARDL model.

V. Discussion of Findings

The short-run estimates affirm the mean-reverting nature of the model, as evidenced by the statistically significant and negatively signed coefficient of the lagged dependent variable NMSO(-1) (-1.2268; p = 0.001). This suggested that any disequilibrium in the Non-Manufacturing Sector Output adjusted relatively quickly toward the long-run equilibrium path, underscoring the self-correcting mechanism inherent in the migration dynamics.The differenced terms for NMR, particularly D(NMR(-3)), are statistically significant (p = 0.0376), indicating that shocks to migration rates exert a delayed influence on Non-Manufacturing Sector Output. Regarding per capita income (PCI), the significance of D(PCI(-1)) (-0.0974; p = 0.0019) suggested that short-run decreases in income levels may temporarily reduce the Non-Manufacturing Sector Output.

In the case of unemployment (UNEMP), both D(UNEMP(-1)) (p = 0.0361) and D(UNEMP(-3)) (p = 0.0617) exhibit significance, suggesting that short-term fluctuations in the labour market play an important role in shaping migration outflows. High unemployment may trigger migration as individuals seek employment opportunities abroad, but the impact is also delayed, again reflecting the logistical and informational constraints faced by potential migrants.The long-run estimates reveal robust and statistically significant relationships between NMSO and its core economic determinants. Notably, the net migration rate (NMR) bears a large negative coefficient of -44,630.09, significant at the 1% level (p = 0.000). This inverse relationship implied that higher net migration rates indicative of more favourable migration balances is associated with reduced Non-Manufacturing Sector Output. This result may be interpreted in the context of policy shifts, such as stricter migration controls or improved domestic conditions, which reduce the incentive to migrate over time. It also reflects the saturation effect, where, after a certain level of outflow, further increases become unsustainable or are discouraged by receiving countries' immigration restrictions.

The positive and statistically significant coefficient of PCI (0.0695; p = 0.000) suggests that improvements in per capita income contribute to increased Non-Manufacturing Sector Output. This finding is consistent with neoclassical migration theories, which posited that as individuals' economic capacity improves, so too does their ability to finance migration be it for education, work, or family reunification. Higher income levels, particularly in developing economies, can lower liquidity constraints and expand the pool of "migration-capable" individuals, thus intensifying outflows even as economic well-being rises domestically.

In contrast, unemployment (UNEMP) shows a positive and significant long-run relationship with Non-Manufacturing Sector Output (164.63; p = 0.0124). This indicated that persistent labour market weaknesses serve as structural push factors, compelling individuals to seek better employment prospects abroad. This is especially relevant in economies with high youth unemployment or limited labour absorption capacity, where migration becomes a rational response to chronic joblessness. The implication for policymakers is clear: improving labour market conditions domestically could be a critical lever for managing migration pressures.

Lastly, the constant term (3017.813; p = 0.020) is also statistically significant, suggesting that there are other underlying factors—possibly cultural, historical, or institutional in nature—not captured by the model, which also influence migration behaviour. These may include diaspora linkages, family reunification dynamics, geopolitical considerations, or educational aspirations.The findings of both the short-run and long-run estimates emphasized the importance of macroeconomic stability and inclusive development in managing migration. While improvements in income levels can enhance migration opportunities in the long run, short-run economic contractions—especially in the labour market—exert immediate push pressures. Therefore, a balanced policy approach is required, one that supports economic growth while also investing in domestic job creation, especially for youth and vulnerable groups. Additionally, monitoring lag effects is essential for timely intervention, as migration responses may not coincide with current economic conditions but reflect accumulated pressures or expectations over time.

VI.CONCLUSION AND RECOMMENDATIONS

This study examined the impact of brain drain—captured through the net migration rate—on the output of Nigeria's non-manufacturing sector over the period 1990 to 2023. Employing the ARDL-ECM modeling framework, the research established both short-run and long-run relationships between net migration rate, per capita income, unemployment, and non-manufacturing sector output.

Key findings revealed that brain drain has a statistically significant and negative effect on the sector's long-term performance, underscoring the damaging impact of skilled labor loss on critical non-industrial sectors such as agriculture, mining, and services. Per capita income was shown to positively influence output in both the short and long run, implying that improved economic conditions bolster sectoral productivity. Conversely, unemployment, while also positively associated in the long run, demonstrated short-term volatility with delayed effects on output.

The study thus confirmed that sustained brain drain undermines the productive capacity and resilience of Nigeria's non-manufacturing sector. It suggested that while income growth and economic improvement are critical, they alone are insufficient

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without robust mechanisms to retain human capital and address underlying structural challenges in the labor market.Based on the study's findings, the following policy recommendations are proposed:

i. Implementing incentive-based policies to retain skilled professionals within Nigeria, including improved salaries, research funding, and career advancement opportunities, especially in health, education, and agriculture.
ii. Tackling structural unemployment by reforming vocational training programs and aligning education with market needs to reduce emigration driven by joblessness.
iii. Supporting inclusive economic growth through targeted income redistribution and social welfare programs that improve living standards and reduce economic emigration pressure.

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