ASYMMETRIC IMPACT OF FOREIGN DIRECT INVESTMENT ON ECONOMIC COMPLEXITY IN NIGERIA (1992-2022)

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ABSTRACT

This study investigated the asymmetric impact of Foreign Direct Investment (FDI) on economic complexity in Nigeria from 1992 to 2022, with a focus on both linear and nonlinear relationships. The study revealed that, in the short run, FDI positively influences economic complexity, with significant immediate effects. In the long run, the benefits of FDI appear to be contingent on other macroeconomic factors such as trade openness and human capital development. In exploring the nonlinear dynamics, the Non-Linear ARDL model uncovered that positive FDI shocks initially stimulate economic complexity, but these effects are dampened by short-run volatility, leading to significant negative impacts in subsequent periods. Conversely, negative FDI shocks result in an immediate downturn in economic complexity, followed by a recovery and improvement in later periods. This highlights the asymmetric nature of FDI's influence on the economy. The study also examined the role of human capital, and found out that it has a significant negative impact on economic complexity in both the short and long runs. This may be due to a lag in realizing the benefits of human capital investments or misalignment with economic needs. These findings reveal the importance of not only attracting and sustaining FDI but also implementing complementary policies that enhance human capital, promote trade openness, and strengthen governance in order to foster sustainable economic complexity and growth in Nigeria.

***Keywords*:** *Asymmetric impact, Foreign Direct Investment (FDI), Economic Complexity, Nigeria, Non-Linear ARDL, Sustainable Growth*

1. INTRODUCTION

It has long been understood that foreign direct investment (FDI) plays a significant role in economic development, especially for growing nations like Nigeria. It facilitates the growth of new industries, the extension of existing ones, and the formation of competitive export markets by giving access to essential finance, technology, and knowledge. Nonetheless, there are still many facets of relationship between FDI and economic complexity, which is a gauge of a country's capacity to manufacture and export a wide variety of high-end goods and services. Nigeria's economy appears to be less complex, which raises questions about the long-term sustainability of the economy. Despite being the 39th in the world with a nominal GDP of approximately $477.4 billion (World Bank, 2023), a deeper examination shows a worrying truth: Nigeria's standing in the Economic Complexity Index (ECI) has been declining over the past few years, and according to the most recent dataset (The Observatory of Economic Complexity, 2021) it is currently ranked 126th out of 131 countries.

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This indicates that Nigeria's productive capacities are less sophisticated and diverse than the world average, which is a serious setback for a country with enormous potential. This downward trend is further evident when examining the historical data. Back in 2000, Nigeria held a more respectable 102nd position in the ECI rankings (The Atlas of Economic Complexity, 2000). The subsequent two decades, however, witnessed a worrying slippage, reflecting a concerning stagnation in the development of intricate and diverse production capabilities within the Nigerian economy.

Nigeria heavily depends on extractive resources, especially natural gas and crude oil, which is one of the main causes of its low complexity. These goods, which make up more than half of the nation's overall exports (The Observatory of Economic Complexity, 2021), present little chances for advanced production techniques and value addition. This reliance makes the economy more susceptible to fluctuations in the price of commodities globally and prevents it from diversifying into high-value and sophisticated manufactured items.

The undeveloped manufacturing sector in Nigeria, which accounts for a meager 9% of the country's GDP, exacerbates this situation (World Bank, 2023). This narrow industrial base inhibits the growth of critical technological expertise and innovation ecosystems, reinforcing the economy's low level of complexity. Furthermore, widespread infrastructural challenges act as another critical roadblock to enhancing economic complexity. Inefficient production and trade networks impede the smooth flow of goods and services, hindering the potential for intricate production linkages and knowledge transfer.

In addition to improving economic production capabilities to upgrade processes and introduce new ideas while the products' sophistication is enhanced, the presence of multinational entrepreneurs in the economy may bring prosperity and expansion (Antonietti and Franco, 2021; Nguyen et al., 2021). Through technology transfer from foreign subsidiaries operating in the host nation, foreign direct investment (FDI) may increase economic complexity through knowledge spillovers in interactions between multinational and domestic businesses, enhance efficient operations, imitation of ideas, or generation of new ideas (Anand, Mishra, and Spatafora, 2012; Arnold and Javorcik, 2009). On the other hand, FDI may negatively impact economic complexity by enhancing greater competitive exposure to local firms, especially infant firms.

To address these concerns, this study will primarily focus on two research questions**:** Do the effects of FDI on economic complexity exhibit a linear or nonlinear relationship? How does the interaction between human capital and FDI affect economic complexity? Correspondingly, our main objective is to investigate the asymmetric impact of foreign direct investment (FDI) on economic complexity in Nigeria. The specific objectives are: To examine the linear and nonlinear relationship between FDI and economic complexity in Nigeria and to analyze the role of human capital development in the relationship between FDI and economic complexity in Nigeria.

Existing literature offers evidence for both positive and negative impacts of FDI on economic complexity. Studies by Osinubi and Ajide (2022) shows that foreign direct investment positively impacts economic complexity in all the MINT countries (Mexico, Indonesia, Nigeria and Turkey), while, its impact is negative in BRICS countries (Brazil, Russia, India, China and South Africa). Additionally, the study of Hausmann et al. (2007) and Hidalgo and Hausmann (2009) suggest positive impacts through knowledge transfer, technology spillovers, and access to international markets, leading to increased productive diversification, technological advancement, and overall economic competitiveness. Conversely, studies by UNCTAD (2018) and Rodrik (2018) raise concerns about potential negative consequences, such as crowding out domestic firms, exacerbating existing inequalities, and hindering the development of local

innovation capacity. Additionally, the effectiveness of FDI in promoting economic complexity is often dependent on contextual factors like institutional quality, human capital, and infrastructure. However, the position of a single country like Nigeria still remains unknown. This study explores this by investigating the relationship between FDI and ECI in Nigeria.

Foreign direct investment (FDI) is widely recognized as a crucial driver of economic growth and development because of it impacts on the host nation, such as, advancement in technology, managerial skill, employment and production capacity increment and capital inflow. However, the relationship between FDI and economic complexity, a critical indicator of long-term economic competitiveness, has mixed results. While some studies suggest a positive relationship between FDI and economic complexity (Hausmann et al., 2007; Hidalgo and Hausmann, 2009), others highlight the potential for negative consequences and uneven distributional effects (UNCTAD, 2018; Rodrik, 2018).

Meanwhile, existing research on FDI and economic complexity often overlooks the potential for asymmetric impacts, where the relationship between FDI and economic complexity is non-linear and dependent on various contextual factors. This raises crucial questions about the differential effects of positive versus negative FDI shocks, and the role of moderating factors like human capital.

In other words, positive or negative shocks in foreign direct investment may lead to an increase or decrease in economic complexity. This scenario calls for an empirical investigation into the nonlinear relationship between foreign direct investment and economic complexity which has been neglected in the literature. In relation to this, Chen et al., (2020) hints that examining the nonlinear relationship between two economic variables is very essential due to its significant contributions to specific sectorial policy formulation. It has been argued that economic agent's reaction to economic variables could be different in a period of positive shocks and negative shocks of the same magnitudes (Shahbaz et al, 2017; Olanipekun et al, 2019; Hatemi-J, 2019). Economic agents react more to negative shocks when compared to positive shocks (Hatemi-J, 2019). Examining potential existence of nonlinear relationship can also be inferred from the presence of asymmetric information phenomenon in economic complexity. In this case, capturing asymmetries in the economic complexity flow become necessary in Nigeria where there are weak institutions and poor corporate governance in the financial sector.

Therefore, a significant gap exists in our understanding of the asymmetric impact of FDI on economic complexity. This implies that there is the possibility of a non-linear and context-dependent relationship, with different effects based on the magnitude, direction (positive or negative), and composition of FDI inflows. This gap is particularly crucial in the Nigerian context, where FDI plays a significant role but its impact on economic complexity remains unclear and potentially asymmetrical. While some sectors, like manufacturing or technology, that receive FDI with technology transfer, might experience a significant increase in complexity, others, like resource extraction with limited knowledge spillovers, might see a smaller impact. Additionally, weak institutions in Nigeria, like inadequate infrastructure or poor governance, could further limit the positive effects of FDI on overall economic complexity.

The rest of this study is organized as follows: Section 1 is the background of the study; Section 2 presents a review of the literature. In Section 3, we specify the model, the sources of data and the methodology employed. Section 4 discusses the results while Section 5 concludes the study and offers policy recommendations.

2. LITERATURE REVIEW

2.1 Conceptual Clarifications

Economic Complexity

The idea of economic complexity began to be used frequently in the literature with the paper 'The Atlas of Economic Complexity' by Hausmann et al (2011). Economic complexity refers to the range and sophistication of a country's production capacities. It's a gauge of the variety and complexity of products and services an economy can generate, as well as the expertise and abilities ingrained in its manufacturing processes. An economy's degree of complexity is correlated with the variety of practical knowledge it possesses. Put another way, the degree of economic complexity in an economy is dictated by the efficiency with which preexisting knowledge is integrated, and the outcome has an impact on the structure of production (Hausmann et al, 2011). Furthermore, the economic system's capacity and production structure are related to economic complexity. It depicts the nature of knowledge accumulation by economic actors 'exercise in the process of production (Osinubi and Ajide, 2022; Nguyen et al., 2021). It transforms inputs into outputs using domestic expertise, diversifying items for export by the nation.

Foreign direct investment (FDI)

When a lender or investor (often a firm) transfers funds to a foreign company that the investor then owns and controls, this is known as foreign direct investment (FDI), according to Pugel (2009). The Pugel definition holds significance as it clarifies the two methods of implementing foreign direct investment (FDI): either by establishing a new foreign firm or acquiring an existing one. The definition provided by the United Nations Conference on Trade and Development (UNCTAD) is often referenced. Foreign direct investment (FDI) is characterized by a resident entity in one economy having a long-term relationship and a persistent interest and control in an enterprise located in a different economy. According to UNCTAD, the key aspect of FDI is the long-term interest of the direct investor in a company. Therefore, only the capital provided by the direct investor or related firms should be classified as FDI. The components of FDI are divided into three parts: equity capital, reinvestment earnings, and intra-company loans. Equity capital refers to the shares of a company that a direct investor purchases in a foreign nation. On the other hand, reinvested earnings refer to the portion of earnings that direct investors choose to reinvest instead of receiving or remitting back to the investor. Finally, the exchange of money between direct investors (parent business) and affiliates (subsidiaries, branches, and associates) is known as intra-company loans (also called intra-company debt transactions).

Complexity measurement

Hidalgo and Hausmann (2009) developed a technique that looks at the global export pattern to capture the complexity of specific products and countries. The main thesis put out is that complicated items are uncommon (low ubiquity) and are found only in locations that manufacture a large number of other products (highly diversified). Producer complexity index (PCI) is a measure that is computed using the "Method of Reflections" and is obtained from a bipartite network of countries and products. This works by iteratively calculating the average ubiquity of the other products produced by these nations as well as the average variety of the countries producing a given commodity. Accordingly, a product is deemed complicated if it is manufactured by a small number of highly diverse nations that also manufacture uncommon products. The Economic complexity index (ECI) defines a country as complex if it generates a wide variety of goods, particularly those that are relatively uncommon (low ubiquity). The average PCI of a nation's exported goods determines the ultimate value of that nation's ECI, and the average ECI of the nation's exporting a particular good determines the PCI of that good. Both Hausmann et al. (2014) and

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Hidalgo and Hausmann (2009) demonstrated that there is a strong correlation between a country's GDP per capita and its ECI values, particularly when natural resource wealth is taken into account. More significantly, scatterplots of GDP per capita values at any given time and country ECI variations indicate that countries tend to converge to an income level that is dictated by their ECI. These scatter plots also predict future growth.

2.2 Theoretical Framework

This study was based on the Endogenous growth theory to offer theoretical foundations for the link between foreign direct investment (FDI) and Economic complexity (ECI). The endogenous growth theory was put forward by Romar and Lucas in 1990 as a result of the dissatisfaction with the neoclassical theory which had arisen on both theoretical and empirical grounds. Neoclassical growth theory attributes long-run growth to technological progress but leaves unexplained the economic determinants of that technological progress. Empirical dissatisfaction developed over the prediction that economic growth and saving rates should be uncorrelated in the steady state. The data makes it clear that the rate of savings and growth are positively correlated across countries (Dornbusch et al, 1977).

In contrast to the traditional neoclassical economic view that economic growth primarily stemmed from accumulating physical capital and labor, endogenous growth theory (EGT) proposes a radical shift in perspective. This theory emphasizes the role of technological advancement and human capital in economic growth. FDI can contribute to growth by introducing new technologies and fostering knowledge transfer through "spillover effects", which can be in form of human development, sophisticated production techniques, education, market strategy, and etc. This means skills and knowledge from the foreign company can benefit local businesses and workers. Endogenous growth models view technological progress as internal (endogenous) to the system. This paradigm shift, pioneered by seminal works like Paul Romer's (1990) "Endogenous Technological Change," has significantly reshaped our understanding of economic dynamics and policy implications.

The core proposition of EGT lies in the concept of knowledge spillovers. Unlike physical capital, knowledge doesn't diminish with use; it can be infinitely replicated and shared, generating positive externalities for the entire economy. As innovation leads to new technologies, processes, and ideas, these spillovers benefit not just the innovator but also other economic actors. This creates a virtuous cycle: innovation begets further innovation, propelling productivity and economic growth upwards in a self-sustaining manner.

2.3 Empirical Review

In recent years, there has been significant scholarly focus on the relationship between economic complexity and foreign direct investment (FDI). For instance, Osinubi and Ajide (2022) examined the impact of FDI on economic complexity in MINT and BRICS countries. Based on panel co-integration regression analysis, the findings showed that FDI had a beneficial impact on economic complexity in MINT nations but in the BRICS nations, it was negative. The results highlight how crucial it is for governments in developing nations to put policies in place that promote FDI inflows. Investments in highly technical fields should be prioritized in order to increase the economic complexity of the receiving nation. Olusanya (2020) employed non-linear ARDL method to explore the cointegration between foreign direct investment (FDI) and the growth of the manufacturing sector. Utilizing annual data from various sources and integrating error correction specifications, the study revealed that alterations in FDI have both short and long-run

asymmetric effects on the growth of Nigeria's manufacturing sector. Positive foreign direct investment leads to manufacturing sector growth.

Foreign firms in Kenya have played a major role in enhancing economic growth in the agricultural sector, especially in floriculture and horticulture. Over a long period of time, foreign direct investment (FDI) was found to create many externalities in the Kenyan economy in the form of transfer of general knowledge and specific technologies in production and distribution. Hence, Osano and Koine (2016) in their study addressed the role of foreign direct investment on technology transfer and economic growth in Kenya, with a focus on the energy sector in Nairobi between 2001 and 2014. The study adopted a descriptive and inferential survey design. Results indicated that investment in the energy sector led to new technology in the country as technology was transferred to local investors through sharing of knowledge in innovation and production.

FDI and Economic Growth

Sijuwola (2023) investigated the asymmetric impact of Foreign Direct Investment (FDI) on inclusive growth in Nigeria over the period from 1991 to 2021. Non-linear autoregressive distributed lag (NARDL) model was employed. The findings of the study indicated that FDI has an asymmetric effect on inclusive growth in Nigeria. Positive changes in FDI inflows are found to have a significant and increasing impact on inclusive growth in the long run, while negative changes in FDI inflows are associated with a reduction in inclusive growth over time. The relationship between foreign direct investment (FDI) inflows and economic growth in host countries is a heavily debated issue. Although some studies have found evidence of the positive impact of FDI on economic growth, others have revealed the opposite result. Studies that examined the causality between FDI and gross domestic product (GDP) have also found evidence of unidirectional causality and, in some cases, bidirectional causality. Thus, Sarker and Khan (2020) investigated the causal nexus between FDI and GDP in Bangladesh. The augmented ARDL model used found a long-run relationship between FDI and GDP. Granger causality results indicated the presence of a unidirectional causality running from GDP to FDI.

Laura (2003) showed that the benefits of FDI vary greatly across sectors by examining the effect of foreign direct investment on growth in the primary, manufacturing, and services sectors. An empirical analysis using cross-country data for the period 1981-1999 suggested that total FDI exerts an ambiguous effect on growth. Foreign direct investments in the primary sector had a negative effect on growth but positive in the manufacturing sector. Evidence from the service sector is ambiguous.

Li and Liu (2005) examined the effect of FDI on economic growth for a panel of 84 countries using both single equation and simultaneous equation system techniques. A significant endogenous relationship between FDI and economic growth is identified from the mid-1980s onwards. FDI not only directly promotes economic growth by itself but also indirectly does so via its interaction terms. The interaction of FDI with human capital exerts a strong positive effect on economic growth in developing countries, while that of FDI with the technology gap has a significant negative impact.

Human Capital and Economic Complexity

Soyyigit, Eren, and Akis (2019) studied the relationship between the level of economic complexity and human development in developed and developing countries. The primary focus of the study was to determine whether there were differences between these two groups of countries concerning the long-term relationship between economic complexity and human development. The researchers applied the Bai and

Carrion-I-Silvestre cointegration test to G20 country data spanning from 1992 to 2017. The study's findings revealed that, with the exception of the United States, Human Development Index (HDI) had an impact on Economic Complexity Index (ECI). The impact of HDI on ECI was negative in Germany, France, the United Kingdom, Italy, and Japan, while it was positive in other countries. These results indicate that, in developed countries (excluding Canada and Australia), human development has a negative impact on the economic complexity level.

FDI, Human Capital development and Economic Complexity

Dankyi et al. (2022) explored the human capital development, foreign direct investment, and economic growth nexus within the ECOWAS region while controlling for carbon emission, urbanization, and renewable energy. The study suggests that the rate of human capital, foreign direct investment, CO2 emissions and urbanization affect economic growth.

The dynamics of Foreign direct investment (FDI) inflow indicates that its new wave is efficiency-seeking and, thus, the recent literature emphasizes the host countries knowledge role and productive capabilities. Sadeghi et al (2020) used two proxies to measure the country's economic complexity, including economic complexity index (ECI) and economic sophistication (EXPY). The results indicated that economic complexity is one of the main determinants of FDI inflow with statistically and economically robust positive effects on FDI inflows to host countries. Furthermore, their findings explain why countries with equal human capital endowment have different performances in FDI attraction.

3. Methodology

3.1 Model Specification

In line with Ajide and Osinubi (2024), Nguyen et al. (2021), the study adopts their model to capture the asymmetric effect of FDI on economic complexity in Nigeria as stated in the equation below. This study contributes to knowledge by looking into factors that can influence economic complexity in Nigeria.

$ECI_t = f(FDI_t)$ ---------- (1)

Where, ECI and FDI denote economic complexity, and foreign direct investment respectively at time *t*.

Additional factors might have an impact on economic complexity as informed by theories and earlier empirical studies, such as economic growth, human capital, trade openness, remittances and control of corruption.

As noted by Nguyen et al. (2021), one of the key factors influencing economic complexity is economic growth. Economic growth is anticipated to contribute favorably to economic complexity since GDP per capita might affect product quality.

Economic complexity is proven to be highly correlated with human capital, regardless of how it is measured (Anand et al., 2012; Cabral and Veiga, 2010; Chu, 2020; Costinot, 2009; Gao and Zhou, 2018; Hausmann, Hidalgo, and Bustos, 2014; Nguyen et al., 2020). This is predicated on the idea that education boosts people's productivity, knowledge, creativity, and skills, which are relevant for an improved economic complexity. According to Khan et al. (2020), endogenous growth theory strongly emphasizes the role that human capital plays in transforming resources and enhancing productive capabilities.

Trade openness, as argued by some studies (such as Gala et al., 2018; Gao and Zhou, 2018; Ghebrihiwet, 2019; Nguyen et al., 2021), promotes technological advancement, and thus, we expect a positive relationship between trade openness and economic complexity. In other words, Keller (2010) concurs that openness will allow a nation to benefit from the diffusion of technology, which has the potential to increase

economic complexity. In the same vein, Khan et al. (2020) reveals that openness enables firms to be more efficient in allocating scarce resources, thereby increasing their revenues. The increase in revenue due to trade openness, according to Bustos (2011), can make firms upgrade technology and production. The general form of our model is stated below:

$ECI_t = f(FDI_t, GDP_t, LHCI_t, LTOP_t, REMITT, CC_t)$----------(2)

The specific form is written as;

$ECI_t = a_0 + \beta_1 FDI_t + \beta_2 GDP_t + \beta_3 LHCI_t + \beta_4 LTOP_t + \beta_5 REMITT_t + \beta_6 CC_t + \varepsilon_t$------- (3)

Where ECI, FDI, GDP, LHCI, LTOP, REMITT, and CC represent economic complexity, foreign direct investment, economic growth, log of human capital index, log of trade openness, remittances and control of corruption respectively. "t" denotes the study period in years while ε_t is the error/disturbance term. Additionally, the log of human capital index and trade openness was used in order to reduce the impact of extreme values and improve the normality of the data distribution.

In order to meet the third objective of this study, the model is specified as:

$ECI_t = a_0 + \beta_1 FDI_t + \beta_2 GDP_t + \beta_3 LHCI_t + \beta_4 (FDI * LHCI)_t + \beta_5 LTOP_t + \beta_6 REMITT_t + \beta_7 CC_t + \varepsilon_t$ ..... (4)

Where, FDI*LHCI represent the interaction of foreign direct investment and log of human capital.

Estimation Technique

Linear ARDL Model Specification.

The ARDL linear specification for equation 3 is thus:

$\Delta ECI_t = a_0 + \sum_{k=1}^{n} \gamma_k \Delta ECI_{t-k} + \sum_{k=0}^{P} \eta_k \Delta FDI_{t-k} + \sum_{k=0}^{p} \theta_k \Delta GDP_{t-k} + \sum_{k=0}^{p} \lambda_k \Delta LTOP_{t-k} + \sum_{k=0}^{p} \partial_k \Delta REMITT_{t-k} + \sum_{k=0}^{p} \delta_k \Delta CC_{t-k} + a_1 ECI_{t-1} + a_2 FDI_{t-1} + a_3 GDP_{t-1} + a_4 LTOP_{t-1} + a_5 REMITT_{t-1} a_6 CC_{t-1} + \epsilon_t$.....(5)

Non-linear ARDL Model Specification.

Shin et al (2011) advanced a non-linear autoregressive distributed lag (NARDL) cointegration approach as an asymmetric extension to the already existing ARDL model by Pesaran and Shin (1999), to capture both long-run and short run asymmetries in a specified variable of interest. This modeling approach is adopted for this study. FDI $^+$ and FDI $^-$ are the decomposed partial sums of positive and negative changes in FDI.

$FDI_t^+ = \sum_{k=1}^{t} \Delta FDI_t^+ = \sum_{k=1}^{t} \max(\Delta FDI_t^+, 0)$ .....(6)

$FDI_t^- = \sum_{k=1}^{t} \Delta FDI_t^- = \sum_{k=1}^{t} \min(\Delta FDI_t^-, 0)$ .....(7)

The ARDL non-linear specification of equation 3 is:

$\Delta ECI_t = a_0 + \sum_{k=1}^{n} \gamma_k \Delta ECI_{t-k} + \sum_{k=0}^{P} \eta_k \Delta FDI^+_{t-k} + \sum_{k=0}^{P} \pi_k \Delta FDI^-_{t-k} + \sum_{k=0}^{p} \theta_k \Delta GDP_{t-k} + \sum_{k=0}^{p} \theta_k \Delta LHCI_{t-k} + \sum_{k=0}^{p} \lambda_k \Delta LTOP_{t-k} + \sum_{k=0}^{p} \partial_k \Delta REMITT_{t-k} + \sum_{k=0}^{p} \delta_k \Delta CC_{t-k} + a_1 ECI_{t-1} + a_2 FDI^+_{t-1} + a_3 FDI^-_{t-1} + a_4 GDP_{t-1} + a_5 LHCI_{t-1} + a_6 LTOP_{t-1} + a_7 REMITT_{t-1} + a_8 CC_{t-1} + \epsilon_t$.....(8)

Modeling for the role of human capital, we have:

$\Delta ECI_t =$

$a_0 + \sum_{k=1}^{n} \gamma_k \Delta ECI_{t-k} + \sum_{k=0}^{P} \eta_k \Delta (FDI * LHCI)_{t-k} + \sum_{k=0}^{p} \theta_k \Delta GDP_{t-k} + \sum_{k=0}^{p} \theta_k \Delta LHCI_{t-k} +$

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$$\sum_{k=0}^{p} \lambda_k \, \Delta LTOP_{t-k} + \sum_{k=0}^{p} \partial_k \, \Delta REMITT_{t-k} + \sum_{k=0}^{p} \delta_k \, \Delta CC_{t-k} + a_1 ECI_{t-1} + a_2 (FDI * HCI)_{t-1} + a_3 GDP_{t-1} + a_4 LHCI_{t-1} + a_5 LTOP_{t-1} + a_6 REMITT_{t-1} + a_7 CC_{t-1} + \epsilon_t \ldots\ldots (9)$$

To achieve our first objective, which was to identify the kind of relationship between FDI and economic complexity, this study employed the linear ARDL method. To achieve objective two, which was to analyze the nonlinear impact of FDI on economic complexity in Nigeria, the study employed the Non-linear ARDL method. To achieve objective three, which was to examine the moderating role of human capital in promoting economic complexity, we employed a linear ARDL model and interacted FDI and Human capital (FDI*LHCI).

Sources of Data

Based on a time series data analysis, the study analyzes annual secondary data on Nigeria between 1992 and 2022. The data used include economic complexity, foreign direct investment, economic growth, human capital, remittance, control of corruption and trade openness. Except for economic complexity and control of corruption, which is accessible from MIT's Observatory of Economic Complexity (http://atlas.media.mit.edu), and International Country Risk Guide published by The PRS Group respectively, all data on the other variables used were sourced from the World Bank's World Development Indicators Database's online edition.

4. Results and Discussion of Findings

The descriptive statistics for the seven variables ECI, FDI, GDPR, LHCI, LTOP, REMITT and CC provide a comprehensive overview of their central tendencies, dispersion, and range. Table 4.1 presents the result. ECI, FDI, GDP, LHCI, LTOP, REMITT and CC represent economic complexity, foreign direct investment, economic growth, log of human capital index, log of trade openness, remittances and control of corruption respectively.

Table 4.1 Descriptive Statistics

	ECI	FDI	GDPR	LHCI	LTOP	REMITT	CC
Mean	-2.013280	1.330118	4.172906	0.492416	12.54824	3.463573	1.494516
Median	-2.067500	1.523782	4.230061	0.515270	12.59680	3.998536	1.500000
Maximum	-0.677319	2.900249	15.32916	0.680186	12.84596	8.333829	2.000000
Minimum	-2.811023	-0.039522	-2.035119	0.236387	12.21729	0.108433	1.000000
Std. Dev.	0.430925	0.870824	3.783493	0.144296	0.237041	2.382685	0.317698
Observations	31	31	31	31	31	31	31

Source: *Authors' computation, 2024*

Correlation Analysis

Table 4.2 correlation matrix shows that the Economic Complexity Index (ECI) has a weak negative correlation with Foreign Direct Investment (FDI) (-0.22) and Gross Domestic Product Growth Rate (GDPR) (-0.07), suggesting that more complex economies might receive less FDI and experience slower growth. ECI has a weak positive correlation with human capital (LHCI) (0.21) and trade openness (LTOP) (0.28), indicating that higher economic complexity is associated with better human capital and more open trade. Notably, there is virtually no correlation between ECI and Corruption Control (CC) (-0.004). FDI shows a moderate positive correlation with GDPR (0.37) but negative correlations with LHCI, LTOP, and

CC, implying that higher FDI inflows may coincide with less human capital, less trade openness, and weaker control of corruption. The strong negative correlation between GDPR and CC (-0.50) suggests that higher economic growth is associated with lower corruption control. The high correlations between LHCI and LTOP (0.95) and between LHCI and Remittances (REMITT) (0.74) indicate that improvements in human capital is associated with more open economies and higher remittance inflow.

Table 4.2 Correlation matrix

	ECI	FDI	GDPR	LHCI	LTOP	REMITT	CC
ECI	1.000						
FDI	-0.220	1.000					
GDPR	-0.067	0.367	1.000				
LHCI	0.206	-0.257	0.039	1.000			
LTOP	0.277	-0.143	0.059	0.946	1.000		
REMITT	-0.087	0.251	0.119	0.739	0.744	1.000	
CC	-0.004	-0.209	-0.504	-0.275	-0.107	-0.189	1.000

Source: *Authors' computation, 2024*

4.3 Unit root test and Cointegration

Table 4.3 presents the results of the unit root tests carried out to determine the stationarity of the time series and their levels of integration. Employing Augmented Dickey-Fuller and Philips-perron test, the result shows that except for log of human capital that is stationary at level form, all other variables obtained stationarity after first difference. The implications of the mixed order integration are that certain estimation techniques cannot be applied to estimate the specified model. In this case, the most appropriate linear regression estimation is the autoregressive distributed lags (ARDL) test. But first the ARDL bond test for cointegration will be conducted to ascertain if there exists a long run relationship between the variables.

Table 4.3 Augmented Dickey-Fuller and Philips-Perron Unit Root Test Results

VARIABLES	ADF		PP		
	Statistics	Prob.	Statistics	Prob.	Integration
ECI	-4.438279	0.0019	-4.687633	0.0008	I (1)
FDI	-6.798039	0.0000	-6.844763	0.0000	I (1)
GDPR	-7.572496	0.0000	-11.33049	0.0000	I (1)
LHCI	-3.884158	0.0059	-3.091299	0.0380	I (0)
REMITT	-5.515492	0.0001	-6.034618	0.0000	I (1)
LTOP	-2.885123	0.0594	-2.821207	0.0677	I (1)
CC	-7.656379	0.0000	-2.996201	0.0471	I (1)

Source: *Authors' computation, 2024*

The study goes further to investigate if there's a long run relationship between the variables involved using bounds test co-integration. The result is shown in Table 4.4. This table provides evidence that the variables are linked in the long term. Looking at Table 4.4, the F-statistics for the linear ARDL approaches higher

than the upper limits for both 5% and 10% significance levels. This suggests a long-run relationship. The F-statistic for the non-linear ARDL approach is also greater than the critical values at both significance levels, indicating the presence of long-run connection in this case. In simpler terms, the study will now explore how foreign direct investment affects economic complexity in Nigeria, considering both short-term and long-term impacts for the linear model and it will also account for potential non-linear (asymmetric) effects in the short run.

Table 4.4 ARDL Bound Test result

Test Statistic	**Value**	**K**	**ARDL Form**
F-statistic	12.43016	5	Linear ARDL (3, 3, 3, 2, 2, 1)
F-statistic	10.29183	7	Non-linear ARDL (1, 2, 2, 1, 1, 2,1, 2)
F-statistic	6.529183	7	Linear ARDL (1, 2, 2, 1, 0, 2, 2, 2)
		Critical value	
		Linear ARDL	
Significance level	**I(0) bound**	**I(1) bound**	
10%	2.26	3.35	
5%	2.62	3.79	
		Non-linear ARDL	
10%	2.03	3.13	
5%	2.32	3.5	
		Linear ARDL	
Significance level	**I(0) bound**	**I(1) bound**	
10%	2.03	3.13	
5%	2.32	3.5	

Source: *Authors' computation, 2024*

The short-run linear estimates indicated that the Economic Complexity Index (ECI) in Nigeria responds significantly to both its own lags and lags of FDI. The first lag of ECI has a positive and significant impact, suggesting that improvements in economic complexity are likely to persist over time, fostering further complexity in the economy. This finding aligns with Adebayo (2018), who also observed that economic complexity can have immediate and reinforcing effects on economic performance. Conversely, the second lag of ECI exhibits a significant negative impact, which may reflect short-term volatility or structural adjustments within the economy. This result is consistent with Sijuwola (2023), who noted that initial gains in economic complexity might be followed by corrective adjustments, potentially due to the economy's need to adapt to new complexities.

FDI also showed mixed short-run effects. The immediate impact of FDI on economic complexity is positive and significant, underscoring the role of FDI in enhancing economic complexity in the short term. This is in line with the findings of Osinubi and Ajide (2022). However, the first lag of FDI is insignificant, suggesting that the benefits of FDI may not persist immediately. Interestingly, the second lag of FDI reveals a delayed positive effect, indicating that the positive impacts of FDI may accumulate and become more evident over time.

In the long run, the impact of FDI on economic complexity appeared to be more nuanced. FDI showed a negative but insignificant effect on economic complexity, suggesting that while FDI is crucial in the short run, its long-term impact may be contingent on other factors. This finding is consistent with Abamu (2022), who highlighted that the long-term benefits of FDI might depend on the broader macroeconomic environment. Similarly, GDP growth rate also showed a negative and insignificant long-run effect, indicating that GDP growth alone may not be sufficient to drive long-term improvements in economic complexity. This resonates with Li and Liu (2005), who emphasized the need for complementary policies and investments to realize the full potential of economic growth.

Trade openness, however, demonstrated a significant positive impact on economic complexity in the long run. It underscores the importance of integrating into global markets in order to foster economic complexity. This supports the broader literature that suggests that trade openness facilitates knowledge and technology transfer. On the other hand, remittances showed a significant negative long-run effect, suggesting that reliance on remittances may hinder the development of economic complexity by promoting dependency rather than productive investments. The control of corruption emerged as a critical factor in enhancing economic complexity, with significant positive long-run effects. This result is in line with Osano and Koine (2016), who stressed the importance of good governance in maximizing the benefits of FDI and fostering economic development.

The non-Linear ARDL model revealed asymmetric effects of FDI on economic complexity, highlighting the importance of considering both positive and negative FDI shocks separately. Positive changes in FDI initially showed a positive but insignificant impact, with significant negative effects emerging in subsequent periods. This suggests that while positive FDI inflows can stimulate economic complexity in the short term, there may be short-run volatility that dampens these effects over time. Negative FDI shocks, on the other hand, have a significant negative impact on economic complexity in the short run, followed by a significant positive effect in subsequent periods. This pattern reflects the complex dynamics of FDI, where negative shocks may initially disrupt economic complexity but can lead to structural adjustments that restore or even enhance complexity in the longer term. Human capital, measured by the Human Capital Index (HCI), showed a significant negative impact in both the short and long run. This finding is somewhat counterintuitive but could be explained by the potential lag in realizing the benefits of human capital investments or misalignment between human capital development and the needs of the economy. The short and long-run estimates with linear ARDL are presented in Table 4.5 while the short and long-run estimates with non-linear ARDL in Table 4.6. Table 4.7 shows the result of interacting FDI with HCI.

Table 4.5 Result of short and Long run estimates with linear ARDL

Short- and Long-run Estimates with Linear (Symmetric) ARDL (3, 3, 3, 2, 2, 1)

Short Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ECI(-1))	0.381302	0.146659	2.599920	0.0316
D(ECI(-2))	-0.441127	0.166796	-2.644713	0.0295
D(FDI)	0.625319	0.162407	3.850321	0.0049
D(FDI(-1))	0.028117	0.091374	0.307714	0.7662
D(FDI(-2))	0.268541	0.109968	2.441990	0.0404
D(GDPR)	0.476197	0.554638	0.858574	0.4156
D(GDPR(-1))	0.060864	0.018043	3.373192	0.0097

D(GDPR(-2))	-0.238946	0.038559	-6.196840	0.0003
D(LTOP)	-43.214124	59.556055	-0.725604	0.4888
D(LTOP(-1))	192.074189	60.558689	3.171703	0.0132
D(REMITT)	-0.692738	0.102300	-6.771620	0.0001
D(REMITT(-1))	0.164802	0.046946	3.510438	0.0080
D(CC)	1.786370	0.520599	3.431376	0.0089
CointEq(-1)	-0.894736	0.149514	-5.984298	0.0003

Long Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	-0.225565	0.233036	-0.967938	0.3614
GDPR	-1.295052	1.099961	-1.177362	0.2729
LTOP	3.566511	0.821703	4.340390	0.0025
REMITT	-0.595091	0.127519	-4.666682	0.0016
CC	1.307795	0.475336	2.751305	0.0250
C	-43.079702	9.036398	-4.767353	0.0014

Source: *Authors' computation, 2024*

Table 4.6 Result of Short and Long run estimates using non-linear ARDL

Short- and Long-run Estimates with Non-Linear (Asymmetric) ARDL (1, 2, 2, 1, 1, 2, 1, 2)

Short Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI_POS)	0.324268	0.230919	1.404249	0.1979
D(FDI_POS(-1))	-0.618522	0.190827	-3.241269	0.0119
D(FDI_NEG)	-0.499996	0.154096	-3.244717	0.0118
D(FDI_NEG(-1))	0.728366	0.168852	4.313631	0.0026
D(GDPR)	-0.521587	0.563554	-0.925532	0.3818
D(LHCI)	-76.955693	12.272096	-6.270786	0.0002
D(LTOP)	66.265387	61.120619	1.084174	0.3099
D(LTOP(-1))	-222.286003	50.639926	-4.389540	0.0023
D(REMITT)	0.039544	0.071371	0.554069	0.5947
D(CC)	-1.556009	0.418936	-3.714192	0.0059
D(CC(-1))	0.995423	0.458216	2.172390	0.0616
CointEq(-1)	-1.270753	0.190872	-6.657626	0.0002

Long Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI_POS	0.434385	0.188396	2.305701	0.0500
FDI_NEG	-1.454534	0.191641	-7.589872	0.0001
GDPR	1.201660	0.611030	1.966614	0.0848
LHCI	-48.545879	4.673433	-10.387627	0.0000
LTOP	9.480395	1.404864	6.748265	0.0001

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REMITT	0.166416	0.066766	2.492530	0.0374
CC	-2.145243	0.319189	-6.720923	0.0001
C	-104.333629	15.321088	-6.809806	0.0001

Source: *Authors' computation, 2024*

Table 4.7 Result of Short and Long run estimates using linear ARDL with Human capital index included in the model

Short- and Long-run Estimates with Linear (Symmetric) ARDL (1, 2, 2, 1, 0, 2, 2, 2)

Short Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI)	-0.559103	0.317854	-1.758990	0.1124
D(FDI(-1))	0.712096	0.329692	2.159885	0.0591
D(GDPR)	-0.053594	0.026230	-2.043222	0.0714
D(GDPR(-1))	0.088319	0.028459	3.103403	0.0127
D(REMITT)	-0.022257	0.058010	-0.383679	0.7101
D(LTOP)	13.204325	3.343041	3.949794	0.0034
D(CC)	-1.813235	0.676640	-2.679763	0.0252
D(CC(-1))	1.533952	0.631137	2.430456	0.0380
D(LHCI)	-75.653393	13.018923	-5.811033	0.0003
D(LHCI(-1))	-32.325675	11.911918	-2.713725	0.0239
D(FDI*LHCI)	1.003708	0.687232	1.460507	0.1782
D(FDI*LHCI(-1))	-1.483602	0.826446	-1.795159	0.1062
CointEq(-1)	-0.745662	0.208161	-3.582147	0.0059

Long Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	-2.156235	0.767889	-2.808002	0.0204
GDPR	-0.262166	0.081149	-3.230695	0.0103
REMITT	0.149457	0.115942	1.289064	0.2295
LTOP	17.708202	3.578339	4.948721	0.0008
CC	-4.172144	0.970537	-4.298801	0.0020
LHCI	-40.657845	8.934727	-4.550542	0.0014
FDI*LHCI	3.268483	1.747059	1.870848	0.0942
C	-194.728948	39.029176	-4.989317	0.0007

Source: *Authors' computation, 2024*

5. Conclusion and Policy Implications

This study investigated the asymmetric impact of Foreign Direct Investment (FDI) on economic complexity in Nigeria from 1992 to 2022. The objectives of the study were to examine the linear and nonlinear impact of foreign direct investment on economic complexity, and the influence of human capital in the relationship between foreign direct investment and economic complexity in Nigeria. The results highlighted several key findings that emphasize the dynamics between FDI, economic complexity and

other macroeconomic variables. In the short run, FDI positively impacts economic complexity, suggesting that inflows of foreign capital contribute to the diversification and sophistication of Nigeria's economic activities. However, this effect is not linear, as delays and sometimes negative impacts were observed, highlighting the volatility associated with FDI and the need for careful management of foreign investments. The study also emphasized the importance of good governance, particularly the control of corruption, in maximizing the benefits of FDI. Good governance practices strengthen the positive impact of FDI, suggesting that institutional quality plays a critical role in transforming foreign investments into sustainable economic complexity.

In the long run, the relationship between FDI and economic complexity becomes more nuanced, with the benefits of FDI appearing to be contingent on other macroeconomic factors such as trade openness and human capital development. While FDI is essential for driving economic complexity, the study finds that without complementary policies, such as enhancing human capital and ensuring a corruption-free environment, the long-term gains from FDI may not fully materialize. The asymmetric effects of FDI, with both positive and negative shocks influencing economic complexity differently, further underline the need for strategic planning and adaptive policies to harness the full potential of foreign investments. Overall, this study provides crucial insights for policymakers, emphasizing the need for a holistic approach that integrates FDI with broader economic and institutional reforms to foster sustainable economic growth and complexity in Nigeria.

Based on the findings of this study, the following recommendations are made: strengthening governance and institutional quality, enhancing human capital development, managing FDI volatility and promoting long-term stability and promoting complementary policies for FDI integration.

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