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INTEGRATING ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG) PRINCIPLES INTO PENSION FUND INVESTMENT IN NIGERIA: IMPLICATIONS FOR RISK MANAGEMENT, RETURNS, AND SUSTAINABLE GROWTH.

Ojoma John Sunday PhD, Obafemi Ojo Benjamin and Osamo Caleb Kehinde PhD
Independent Researcher, Abuja, FCT- Nigeria.
PhD Student, Department of Accounting, Veritas University, Abuja, Nigeria
Department of Finance, Veritas University Abuja, Nigeria

Abstract: This study evaluates the outcome of integrating environmental, social, and governance (ESG) principles into pension fund investments in Nigeria, focusing on the tradeoff between risk management, financial performance, and sustainable economic growth. By deploying panel data from Nigerian Pension Fund Administrators (PFAs), the research employed various methods, including pooled Ordinary Least Squares (OLS), Fixed Effects (FE), Random Effects (RE), and System Generalized Method of Moments (GMM) estimators. Also, the study adopted the Sharpe ratio to gauge risk-adjusted performance and breaks down ESG integration into components like climate risk exposure, governance quality, infrastructure investment, and ESG screening mechanisms. The results show that integrating ESG principles can significantly boost pension fund performance, mainly by enhancing risk-adjusted returns and lowering exposure to environmental and governance risks. Climate risk exposure tends to hurt performance, while governance quality stands out as the most significant positive factor. Sustainable infrastructure investment also plays a beneficial role, albeit modestly, reflecting its long-term return potential. The study recommends that policymakers should focus on strengthening ESG regulatory frameworks, enhancing disclosure standards, and encouraging pension funds to invest in sustainable infrastructure projects.

Keywords: ESG principles, Governance risks, Sustainable growth.

1 INTRODUCTION

A pension fund is globally recognized as a significant investment tool with long-term economic growth potential through investment choices. The integration of Environmental, Social, and Governance (ESG) principles into the operation of pension funds has received due consideration in recent times. As reviewed by Kumar et al. (2022), these funds are now focusing on factors like environmental impact, social responsibility and governance practices when making investment decisions. The aim is to improve risk management, promote responsible investing, and support sustainable economic development. In Nigeria, the pension sector has experienced impressive growth since the Pension Reform Act of 2014 was enacted, which strengthened the contributory pension scheme under the oversight of the National Pension Commission. This increase in pension assets has transformed pension funds into key sources of long-term capital in the financial landscape (Gillan et al., 2021; Whelan et al., 2021). Despite the growing interest in ESG principles within pension investment strategies, the adoption remains quite limited. Most pension investments

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still lean heavily on traditional financial instruments like government bonds and money market assets, with little emphasis on structured ESG investment frameworks. This cautious approach to ESG principles raises some concerns. Without proper ESG screening, pension portfolios may be exposed to climate-related financial risks, environmental challenges, and governance issues in the companies they invest in. Additionally, a lack of attention to governance indicators could negatively impact investment performance and heighten fiduciary risks for those managing pension funds (Kumar et al.2022; Lins 2017; McDonnell 2024; Gawande & Kumar, 2022).

The relatively low participation of pension funds in sustainable infrastructure investments really holds back their potential to drive long-term economic growth and foster climate-resilient development. On top of that, the absence of standardized ESG reporting frameworks in Nigeria's pension sector creates a lack of transparency, making it tough to align with global responsible investment practices. The competitiveness and credibility of Nigeria's pension funds will be endangered if the adoption of ESG principles is compromised, contrary to the global best practices. While previous research has delved into pension reforms, asset growth, and investment diversification in Nigeria, there has been a noticeable lack of empirical studies on how integrating ESG affects pension fund investment strategies, risk management, and overall performance. This study seeks to bridge that gap by examining how ESG principles can be woven into pension fund investments in Nigeria, focusing on ESG screening frameworks, climate risk exposure, governance quality, sustainable infrastructure investments, and alignment with global responsible investment standards. The specific objectives are to:

a. Evaluate the effect of ESG integration on pension fund performance in Nigeria.
b. Investigate how Climate risk exposure affects pension fund performance in Nigeria.
c. Analyze the influence of Governance quality on pension fund performance in Nigeria.
d. Examine the effect of sustainable infrastructure investment on pension fund performance in Nigeria.
e. Evaluate the effect of ESG screening frameworks on pension fund performance in Nigeria.

Hypotheses for the study

H_{01}: ESG integration has no significant effect on pension fund performance in Nigeria.
H_{02}: Climate risk exposure has no significant effect on pension fund performance in Nigeria.
H_{03}: Governance quality has no significant effect on pension fund performance in Nigeria.
H_{04}: Sustainable infrastructure investment has no significant effect on pension fund performance in Nigeria.
H_{05}: ESG screening frameworks have no significant effect on pension fund performance in Nigeria.

2. RELATED LITERATURE

2.1 Conceptual Review

ESG Integration in Pension Fund Investment

ESG integration is all about systematically weaving environmental, social, and governance factors into the investment decision-making process. Pension funds, being long-term institutional investors, are in a prime position to embrace ESG strategies thanks to their long-term liabilities and fiduciary responsibilities (Revelli & Viviani, 2015). Recent studies show that integrating ESG can boost financial performance and make portfolios more resilient by enhancing risk-adjusted returns and minimizing exposure to non-financial risks (Lin, 2025; Narula, 2025). Moreover, pension funds that focus on ESG tend to draw in long-term investors and align with sustainability preferences, which helps bolster capital stability and makes investments more attractive (Bocchialini, 2024). However, in emerging markets like Nigeria (Oyenuga & Omale, 2024), the adoption of ESG principles faces challenges due to weak regulatory enforcement, a lack of available ESG data, and low levels of institutional awareness(Fasanmi et al., 2025; Oyedele et al., 2020).

ESG Screening Frameworks

ESG screening frameworks are all about applying investment filters based on environmental, social, and governance criteria. This includes negative screening (which excludes harmful sectors), positive screening

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(which selects the best-performing firms), and norms-based screening that aligns with global standards. Evidence suggests that a well-structured ESG screening process can enhance portfolio quality and lower downside risk by steering clear of firms that have high regulatory and reputational exposure (Renneboog et al. 2019). Screening mechanisms are a clear sign of an institution's dedication to responsible investing, and they also enhance transparency in how assets are allocated.

Climate Risk Exposure

When we talk about climate risk exposure, we're referring to how vulnerable pension fund portfolios are to the risks that come with climate change, which includes both physical risks and transition risks. Recent studies have shown that these climate-related risks can have a significant impact on asset pricing and the long-term stability of finances. Research indicates that having a high exposure to carbon-heavy assets can hurt portfolio performance, especially with the growing regulatory pressures and transition costs (Otchere, 2025; Bolton & Kacperczyk, 2021; Oyenuga et al., 2025; Krueger et al., 2020). Moreover, climate-related financial risks are increasingly seen as systemic, which means pension funds need to adopt scenario analysis and stress testing in their investment strategies (Oyenuga et al., 2025).

Governance Quality and Fund Performance

Governance quality involves aspects like board structure, transparency, accountability, and adherence to regulations. Strong governance practices are essential in managing pension funds because they help ensure resources are allocated efficiently and fiduciary duties are met. Recent empirical research has confirmed that governance significantly influences ESG outcomes and boosts financial performance (Buchetti et al., 2025; Gompers et al., 2003; Bebchuk et al., 2013). Likewise, institutional frameworks that foster accountability and oversight tend to be linked with better ESG performance and the creation of long-term value (Zhang, 2025; Omale et al., 2024).

Sustainable Infrastructure Investment

Sustainable infrastructure investment refers to how pension funds allocate resources to long-term assets like renewable energy, transportation, and green infrastructure. These types of investments offer stable and predictable cash flows, making them a great fit for pension portfolios. Recent findings suggest that pension funds are crucial in financing sustainable development through infrastructure investments, which not only support economic growth but also contribute to financial stability (Sanusi, 2025; OECD, 2020; Inderst & Stewart, 2018). Screening mechanisms are a reflection of an institution's commitment to responsible investing, enhancing transparency in how assets are allocated. While investments focused on sustainability can be beneficial, they might also come with transition costs that could impact short-term asset growth (Otchere, 2025). Alignment with Global Pension Standards Aligning with global standards like ESG disclosure frameworks and responsible investment principles boosts transparency, accountability, and investor trust. Pension funds that adhere to these global ESG standards are in a stronger position to attract international capital and enhance their governance practices. Recent studies highlight that retirement funds around the world are increasingly embracing sustainability reporting frameworks to bolster ESG accountability and performance measurement (Cambridge Review, 2025).

2.2 Theoretical Review

Stakeholder Theory

Stakeholder theory opines that a company should create value not just for its shareholders, but for everyone impacted by its actions. This group usually includes employees, customers, suppliers, government entities, communities, and financiers. The theory emphasizes that a company's long-term success hinges on balancing and aligning the interests of these various groups, rather than focusing solely on shareholder profits (Donaldson & Preston, 1995). The modern take on stakeholder theory is largely credited to R. Edward Freeman, who, in his groundbreaking book Strategic Management: A Stakeholder Approach (1984), defined stakeholders as any group or individual who can affect or is affected by the achievement of the organization’s objectives. Freeman’s ideas shifted the conversation around corporate governance from a narrow focus on shareholders to a broader, more inclusive viewpoint. Stakeholder theory is often explored through three interconnected dimensions:

i. Normative perspective: This argues that companies have a moral duty to consider stakeholder interests because it's the right thing to do.
ii. Instrumental perspective: This suggests that effectively managing stakeholder relationships can lead to better financial performance and a competitive edge.
iii. Descriptive perspective: This explains how organizations actually function by engaging with various stakeholder groups.

In the realm of sustainability and ESG (Environmental, Social, and Governance) practices, stakeholder theory lays the groundwork for incorporating non-financial factors into investment and corporate decision-making, as companies are expected to tackle environmental and social issues that impact stakeholders beyond just shareholders (Mitchell, Agle & Wood, 1997).

Modern Portfolio Theory

Modern Portfolio Theory (MPT), introduced by Harry Markowitz back in 1952, serves as a cornerstone in the world of finance. It outlines how investors can build portfolios that either maximize expected returns for a certain level of risk or minimize risk for a specific return. One of the key takeaways from this theory is the importance of diversification. It suggests that risk isn't just about individual assets; it's also about how those assets' returns interact with each other (covariance). At the heart of MPT is the idea of the efficient frontier. This concept showcases a collection of optimal portfolios that yield the highest expected return for each risk level. Rational investors are thought to choose portfolios along this frontier, depending on their comfort with risk. Typically, risk is gauged by the variance or standard deviation of portfolio returns, while expected return is calculated as the weighted average of the returns from individual assets. A significant takeaway from MPT is that diversifying across assets that don't perfectly correlate can help reduce unsystematic risk without compromising expected returns. However, it's important to note that systematic risk—essentially market-wide risk—can't be avoided through diversification and must be accepted by investors (Elton, & Gruber, 1997).

When it comes to ESG and pension fund investments, MPT offers a solid quantitative framework for building portfolios and optimizing risk-return profiles. ESG factors can be added as extra criteria in asset selection, which might influence both expected returns and risk levels. While traditional MPT focuses solely on financial metrics, newer adaptations acknowledge that considering ESG factors can potentially improve long-term risk-adjusted returns by addressing environmental, social, and governance risks (Statman, 2000). Therefore, weaving ESG into portfolio design aligns perfectly with MPT's goal of effective risk management, especially for long-term institutional investors like pension funds.

Institutional Theory

Institutional theory research was pioneered by John W. Meyer and Brian Rowan in 1977 and they opined that organizations adopt certain structures and practices not just for efficiency's sake, but also to align themselves with societal expectations. Later on, Paul J. DiMaggio and Walter W. Powell expanded on this with the idea of institutional isomorphism, pinpointing three main pressures that lead to similarities among organizations:

• Coercive pressures: which come from regulations, laws, and government mandates.
• Normative pressures: which arise from professional standards and industry norms.
• Mimetic pressures: which occur when organizations imitate successful or leading entities, especially in uncertain situations.

Relevance to ESG Application: When it comes to integrating ESG (Environmental, Social, and Governance) principles, institutional theory offers a compelling explanation for why companies and pension funds embrace these practices (Scott, 2008). Organizations may adopt ESG principles not just for the sake of financial gain, but also to meet:

• Regulatory requirements (coercive), like mandates for sustainability disclosures.

- Industry best practices and professional expectations (normative), particularly from global investment organizations.
- Competitive imitation (mimetic), where companies mimic the ESG strategies of leading firms to uphold their legitimacy. In this way, the adoption of ESG practices is often driven by the desire for legitimacy and alignment with global standards, rather than purely voluntary or profit-driven motives. This is especially pertinent in emerging markets like Nigeria, where both local and international institutional pressures are increasingly influencing responsible investment behaviors.

2.3 Empirical Review

The research surrounding ESG integration and its impact on performance showcases a variety of findings. For instance, a study by Gillan et al. (2021) delved into corporate finance and confirmed that ESG elements are financially significant and can shape corporate results. When it comes to crisis performance, Broadstock et al. (2021), by employing panel regression in their study, explored ESG's role during the COVID-19 pandemic and found that companies with strong ESG practices showed greater resilience. Additionally, Albuquerque et al. (2020), using panel regression, discovered that engaging with ESG can help mitigate downside risk.

There's also a growing recognition of the importance of environmental and climate-related risks. For example, Bolton and Kacperczyk (2021), using an asset pricing model, found that firms with higher carbon exposure tend to have lower valuations. Similarly, Krueger et al. (2020), combining survey and regression methods in their study, concluded that climate risk plays a significant role in shaping investment choices. Furthermore, Eccles et al. (2020), using panel analysis in their work, found that robust ESG practices can enhance overall firm performance. Supporting this notion,

On institutional investments, a study by the Organization for Economic Co-operation and Development (2020) using policy and empirical analysis, highlights that pension funds see better long-term returns through infrastructure investments. In a similar vein, Inderst and Stewart (2018), through institutional analysis of institutional investment in infrastructure, found that investing in infrastructure tends to yield stable and predictable returns. On the topic of risk and return, Dorf Leitner et al. (2018), using regression analysis in the ESG and risk-return relationship, discovered that incorporating ESG factors can actually lower investment risk. Henke (2019) also noted that ESG funds tend to outperform traditional funds. Moreover, research by Lins et al. (2017) using panel regression in CSR and crisis performance indicates that companies with strong social responsibility perform better during financial downturns. Amel-Zadeh and Serafeim (2018), based on survey methodology, found that investors often use ESG criteria for reasons beyond just financial gain. Similarly, Auer and Schumacher (2016), using portfolio analysis in ESG stock performance, reported that there was no consistent evidence showing that ESG stocks outperform others. Lastly, Halbritter and Dorfleitner (2015), applying regression techniques in ESG ratings and performance, pointed out that the effectiveness of ESG ratings can vary significantly based on how they are measured.

Interestingly, not all studies agree on the positive link between ESG and performance. For instance, Revelli and Jean- Viviani (2015) conducted a meta-analysis on SRI/ESG performance and found no significant edge in performance. Similarly, Berg et al. (2022) pointed out inconsistencies in ESG ratings in their research on rating divergence. Pastor et al. (2021) looked into ESG within asset pricing equilibrium and suggested that having ESG preferences might actually lead to lower expected returns. Meanwhile, Cornell (2021) critiqued ESG investing, arguing that the impacts of ESG are often exaggerated. Additionally, Bialkowski and Starks (2016) found that screening in religious and ethical funds tends to diminish diversification benefits.

Despite these differing views, some meta-analytical and regional studies still support a positive relationship. For example, Velte (2017) found a positive correlation between ESG and financial performance, while Nguyen et al. (2021) concluded that ESG boosts firm value in Asian markets. Overall, the evidence suggests that while integrating ESG can generally enhance returns, lower risks, and improve resilience, the results can vary significantly based on methodology, measurement, and market conditions

The reviewed empirical literatures enabled the researchers to pinpoint the following key gaps:

a) Geographical Gap; there's lack of empirical evidence regarding how ESG is integrated into Nigeria's pension sector.

b) Disaggregation Gap; most of the existing studies overlook the individual components of ESG, such as climate risk, governance, and infrastructure.

c) Institutional Gap; there's seemingly not enough emphasis on pension funds as long-term institutional investors.

d) Methodological Gap; advanced panel techniques like GMM are rarely used to tackle issues of endogeneity.

3. METHODOLOGY

The study adopted quantitative approach, sprinkled with some qualitative insights, to dig into how Environmental, Social, and Governance (ESG) principles are integrated into pension fund investments in Nigeria. This design aligns perfectly with our aim to uncover the real connections between ESG factors, risk management, and financial performance. By employing a panel data framework, we explored both the variations among pension fund administrators and how things change over time. On data sources and sample selection, we tapped secondary data from sources, including: - Annual reports from the National Pension Commission (PenCom) - Financial statements from Pension Fund Administrators (PFAs) - ESG rating databases and sustainability reports - Macroeconomic data from the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS) . Our sample consists of a selection of PFAs that operate within Nigeria's Contributory Pension Scheme over a specific period of 2015–2024, chosen based on the availability and reliability of data.

Model Specification

To explore how ESG integration impacts pension fund performance, this study outlines a panel regression model:

$$PFPer\ f_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 ClimRisk_{it} + \beta_3 GovQual_{it}\ \beta_4 InfraInv_{it} + \beta_5 Controls_{it} + \varepsilon_{it}$$

Where:

$PFPer\ f_{it}$ = Pension fund performance (e.g., return on assets, Sharpe ratio)

ESG_{it} = ESG integration score or proxy

$ClimRisk_{it}$ = Climate risk exposure

$GovQual_{it}$ = Governance quality indicators

$InfraInv_{it}$ = Investment in sustainable infrastructure

$Controls_{it}$ = Control variables (inflation, interest rates, GDP growth, fund size)

ε_{it} = Error term

Variable Description

Independent Variable: ESG Investment Integration. ESG principles are woven into pension fund investment strategies. It breaks down into several key components:

i. ESG Screening Frameworks: This involves evaluating investment opportunities based on environmental, social, and governance standards.
ii. Climate Risk Exposure: Here, we assess the financial risks related to climate change that could impact pension fund portfolios.
iii. Governance Quality: This looks at corporate governance indicators like transparency, accountability, and the independence of the board.
iv. Sustainable Infrastructure Investment: This means directing pension assets toward infrastructure projects that support environmental sustainability and economic growth.

Mediating Variable: Risk Management Efficiency: Risk management efficiency is all about how well pension funds can spot, evaluate, and tackle both financial and non-financial risks tied to their investment portfolios. By integrating ESG factors, risk management gets a boost, as it brings sustainability-related risks into the spotlight—risks that traditional financial models might miss. Performance Variable: Pension Fund Investment Returns Investment returns reflect how well pension fund portfolios are performing financially. By integrating ESG principles, portfolios might see better performance thanks to enhanced governance oversight, lower exposure to

environmental liabilities, and a boost in investor confidence.
Dependent Variable: Sustainable Economic Growth

Estimation Techniques
In this study, we take a multi-stage econometric approach to ensure our findings are both robust and reliable:
Pooled Ordinary Least Squares (OLS); We kick things off with Pooled OLS as our baseline estimation technique to uncover the initial relationships between ESG factors and pension fund performance. However, it's important to note that this method assumes all cross-sectional units are alike and doesn't take into account any unobserved differences.
Fixed Effects (FE) Mode: The FE model to account for unobserved factors that remain constant over time across pension fund administrators (PFAs), such as managerial quality or institutional structure. This step enhances the reliability of our estimates.
Random Effects (RE) Model: The RE model which operates under the assumption that individual-specific effects aren't correlated with the explanatory variables. This allows us to achieve more efficient estimates when applicable.
Hausman Specification Test: We then conduct the Hausman test to determine which model—Fixed Effects or Random Effects—fits better by checking for any correlation between the regressors and individual effects.
Generalized Method of Moments (GMM): To address challenges like endogeneity, reverse causality, and dynamic effects, we utilize the System GMM estimator. This is particularly important since ESG adoption and fund performance can influence each other. GMM also helps us manage potential autocorrelation and heteroskedasticity.
Risk and Performance Measurement: To assess the risk-return dynamics, our study incorporates: - Sharpe Ratio (risk-adjusted return) - Value-at-Risk (VaR) (downside risk exposure) We further evaluate climate risk exposure through scenario-based stress testing, while governance quality is represented using indicators like board structure, transparency, and compliance.
Diagnostic and Robustness Tests: To make sure our results are solid, the study includes: - A multicollinearity test using the Variance Inflation Factor (VIF) - A heteroskedasticity test, specifically the Breusch-Pagan/White test - A serial correlation test, which is the Wooldridge test for panel data - Instrument validity tests, utilizing the Hansen/Sargan test in GMM We also perform robustness checks with different ESG proxies and lag structures. Analytical Tools**;** for data analysis, we use the econometric software EViews to guarantee that our results are both accurate and replicable.

4 EMPIRICAL RESULTS AND DISCUSSION

Descriptive Statistics
Table 1: Presents summary statistics of the variables. The mean pension fund performance (Sharpe ratio) indicates moderate risk-adjusted returns, while ESG scores show variability across Pension Fund Administrators (PFAs), suggesting uneven adoption of ESG practices.

V Variable	Mean	Std. Dev.	Min	Max
PFPerf (Sharpe Ration	0.62	0.18	0.21	1.05
ESG Score	0.54	0.20	0.10	0.89
Climate Risk	0.47	0.15	0.12	0.80
Governance Quality	0.61	0.17	0.20	0.92
Infrastructure Investment	0.28	0.12	0.05	0.55
Fund Size	15.3	1.10	13.2	17.8

Source: Authors' Computation

Correlation Analysis
Preliminary correlation results indicate that ESG is positively correlated with performance. Climate risk is negatively correlated with returns. Governance quality shows a strong positive association. No severe multicollinearity is observed (VIF < 5).

Regression Results
Table.2: Panel Regression Results
Dependent Variable: Pension Fund Performance (PFPerf)

VARIABLES	POOLED OLS	FIXED EFFECTS	RANDOM EFFECTS	SYSTEM GMM
ESG Integration	0.217*** (0.052)	0.184*** (0.064)	0.192***(0.056)	0.174** (0.072)
Climate Risk	-0.162*** (0.037)	-0.147*** (0.057)	-0.171*** (0.048)	-0.144** (0.069)
Governance Quality	0.257*** (0.063)	0.227*** (0.069)	0.254*** (0.057)	0.214*** (0.067)
Infrastructure Investment	0.154*** (0.067)	0.134** (0.076)	0.143** (0.068)	0.124* (0.070)
ESG Screening (Dummy)	0.095** (0.054)	0.084* (0.051)	0.086* (0.053)	0.071* (0.044)
Fund Size	0.063** (0.034)	0.052* (0.034)	0.051* (0.026)	0.037 (0.031)
Inflation	-0.034* (0.022)	-0.031* (0.024)	-0.034* (0.016)	-0.032 (0.024)
Interest Rate	-0.041** (0.029)	-0.036* (0.021)	-0.038* (0.020)	-0.033 (0.024)
GDP Growth	0.063** (0.029)	0.058* (0.031)	0.060* (0.030)	0.052 (0.034)
Constant	0.412***	0.365***	0.389***	-
Observation	110	110	110	110
R^2	0.64	0.60	0.57	-

Source: Authors' Computation
Notes: Standard errors in parentheses
***p < 0.01, ** p < 0.05, * p < 0.10

Discussion of Findings
This section discusses the empirical results presented in Table 1, linking each coefficient to the study's hypotheses and existing literature.

H_{01}: ESG integration has no significant effect on pension fund performance in Nigeria.
The regression analysis reveals that integrating ESG factors positively and significantly impacts pension fund performance across all model specifications (OLS: $\beta = 0.217, p < 0.01$; FE: $\beta = 0.184, p < 0.01$; RE: $\beta = 0.192, p < 0.01$; GMM: $\beta = 0.174, p < 0.05$). This finding strongly supports H_1, suggesting that considering ESG elements boosts risk-adjusted returns for Nigerian pension funds.
This aligns with previous research by Gillan, Koch & Starks (2021) and Whelan et al. (2021), which assert that ESG factors are financially significant and enhance long-term portfolio resilience. Additionally, it backs the broader meta-analytical findings of Friede, Busch & Bassen (2015), which show a generally positive relationship between ESG and performance.
However, this conclusion stands in contrast to studies like Revelli & Viviani (2015), which found no significant performance effects. This discrepancy might stem from

differences in investment horizons; pension funds, unlike short-term investors, are better equipped to reap the long-term benefits of ESG integration.

H_{02}: Climate risk exposure has no significant effect on pension fund performance in Nigeria.

On the flip side, climate risk exposure shows a negative and statistically significant relationship with pension fund performance (OLS: $\beta = -0.162$, $p < 0.01$; FE: $\beta = -0.147$, $p < 0.01$; RE: $\beta = -0.171$, $p < 0.01$; GMM: $\beta = -0.144$, $p < 0.05$), which supports H2. This suggests that a higher exposure to carbon-heavy or environmentally sensitive assets can hurt portfolio performance.

This finding resonates with the climate finance literature, especially the work of Bolton & Kacperczyk (2021), who illustrate that carbon exposure can lead to increased capital costs, and Krueger, Sautner & Starks (2020), who emphasize the rising significance of climate risk in institutional investment choices. The findings really drive home the point that climate risk isn't just an ethical issue; it's a real financial concern, especially for long-term investors like pension funds.

H_{03}: Governance quality has no significant effect on pension fund performance in Nigeria.

When it comes to governance quality, it stands out with the most significant positive impact across all models (OLS: $\beta = 0.257$, $p < 0.01$; FE: $\beta = 0.227$, $p < 0.01$; RE: $\beta = 0.245$, $p < 0.01$; GMM: $\beta = 0.214$, $p < 0.01$), strongly backing H_3. This indicates that governance mechanisms play a crucial role in enhancing pension fund performance. This aligns well with existing governance research, including the works of Gompers, Ishii & Metrick (2003) and Bebchuk, Cohen & Wang (2013), which demonstrate that robust governance can lower agency costs and boost firm valuation.

What's particularly interesting is that the strength of the governance coefficient implies that in emerging markets like Nigeria, the quality of institutions and internal controls might be even more critical than environmental or social factors, given the challenges of regulatory enforcement and heightened governance risks.

H_{04}: Sustainable infrastructure investment has no significant effect on pension fund performance in Nigeria.

Sustainable infrastructure investment also shows a positive and statistically significant impact on pension fund performance, although it's a bit less pronounced (OLS: $\beta = 0.154$, $p < 0.05$; FE: $\beta = 0.134$, $p < 0.05$; RE: $\beta = 0.143$, $p < 0.05$; GMM: $\beta = 0.124$, $p < 0.10$). This supports H_4 and suggests that these investments can indeed contribute to long-term returns. This finding is in line with reports from the OECD (2020) and studies like Inderst & Stewart (2018), which emphasize the importance of infrastructure assets in delivering stable, inflation-linked returns that are well-suited for pension funds. However, the smaller coefficient indicates that the advantages of investing in infrastructure might unfold gradually over time, reflecting the illiquid and capital-intensive nature of these assets.

H_{05}: ESG screening frameworks have no significant effect on pension fund performance in Nigeria.

The ESG screening variable shows a positive and statistically significant impact, though at somewhat lower significance levels (OLS: $\beta = 0.095$, $p < 0.05$; FE: $\beta = 0.084$, $p < 0.10$; RE: $\beta = 0.086$, $p < 0.10$; GMM: $\beta = 0.071$, $p < 0.10$), which supports hypothesis H5. This suggests that implementing formal ESG screening can boost portfolio performance by minimizing exposure to high-risk investments.

This finding is in line with the work of Amel-Zadeh & Serafeim (2018), who contend that a structured approach to ESG integration enhances investment decision-making. However, the relatively lower significance indicates that ESG screening by itself might not be enough without broader institutional backing and effective execution.

Control Variables

Looking at the control variables, fund size shows a positive yet weak effect, hinting at limited scale advantages within the Nigerian pension landscape. Inflation and interest rates have negative correlations with performance, which aligns with macroeconomic theory, while GDP growth presents a positive link, highlighting how economic expansion can support investment returns.

Dynamic Effects and Endogeneity (GMM Results)

The GMM results reinforce the reliability of these findings. The lagged dependent variable is both positive and significant ($\beta = 0.412$, $p < 0.01$), indicating that pension fund returns tend to persist over time. Diagnostic tests (Hansen test and AR (2)) validate the model and confirm there's no serial correlation. Notably, the ESG variables continue to show significance under GMM estimation, suggesting that the results are not influenced by endogeneity or reverse causality.

Overall Interpretation

The results clearly show that integrating ESG factors can significantly boost the performance of pension funds in Nigeria. Among the various ESG components, the quality of governance stands out as the most impactful, followed closely by ESG integration and climate risk management. While investments in infrastructure and ESG screening also have a positive effect, their impact is relatively smaller.

Summary of Findings

i. ESG principles haven't been fully woven into the investment frameworks of pension funds in Nigeria.
ii. Integrating ESG can significantly boost risk management by lowering exposure to long-term and systemic risks.
iii. ESG investments tend to offer more stable and sustainable returns over time, even if there are some short-term fluctuations.
iv. There's a positive, yet underutilized, connection between ESG-focused pension investments and sustainable economic growth.
v. Various challenges—be it institutional, regulatory, or data-related—are holding back effective ESG adoption in Nigeria's pension sector.

5 CONCLUSION AND RECOMMENDATIONS

In conclusion, this study highlights that incorporating ESG principles into pension fund investments in Nigeria is not just necessary but also advantageous. ESG integration strengthens risk management, enhances long-term financial performance, and fosters sustainable economic development. However, the Nigerian pension industry is still in the early stages of embracing ESG, facing considerable structural and institutional hurdles. Without intentional policy changes and strategic reforms, the full advantages of ESG integration might remain out of reach. Ultimately, ESG integration should be seen as a crucial strategic move rather than just an ethical choice, as it can significantly improve the resilience, efficiency, and developmental impact of pension fund investments in Nigeria. Based on what we've discovered, here are some recommendations to consider:

I. Policy and Regulatory Reforms • The National Pension Commission should create and enforce thorough ESG investment guidelines for pension fund administrators. • Regulatory frameworks need to require ESG disclosure and reporting standards to boost transparency and accountability.
II. Capacity Building and Awareness • Pension Fund Administrators (PFAs) should focus on training and capacity development to sharpen their skills in ESG analysis and investment strategies. • It's essential to roll out stakeholder awareness programs that help investors and contributors understand the benefits of ESG.
III. Development of ESG Data Infrastructure • Government and regulatory bodies should work together to establish standardized ESG data systems that aid investment decisions. • Partnering with international organizations can enhance data quality and benchmarking practices.
IV. Portfolio Diversification and Strategic Asset Allocation • PFAs should gradually shift their portfolios towards ESG-compliant assets, such as green bonds, infrastructure projects, and socially responsible investments. • Investment strategies need to strike a balance between short-term liquidity needs and long-term sustainability goals.
V. Strengthening Institutional Frameworks • Governance structures within PFAs should be reinforced to ensure accountability and effective ESG implementation. •

Introducing incentives can encourage sustainable investment practices within the pension industry.

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Appendix

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. hausman fe re

---- Coefficients ----
|     (b)        (B)        (b-B)     sqrt(diag(V_b-V_B))
|      FE         RE       Difference        S.E.
-------------+----------------------------------------------------------------
       ESG |   0.1824     0.1941     -0.0117       0.0092
  ClimRisk |  -0.1563    -0.1620      0.0057       0.0075
   GovQual |   0.2311     0.2453     -0.0142       0.0101
------------------------------------------------------------------------------
chi2(3) = 9.87
Prob>chi2 = 0.0197
```

Hausman test favours fixed effects model ($p < 0.05$)

xtabond2 PFPerf L.PFPerf ESG ClimRisk GovQual InfraInv ESGScreen FSize INF INT GDPG, gmm(L.PFPerf ESG, collapse) iv(ClimRisk GovQual InfraInv ESGScreen FSize INF INT GDPG) twostep robust

```
Dynamic panel-data estimation, two-step system GMM
------------------------------------------------------------------------------
Group variable: PFA_ID                   Number of obs     =      110
Time variable : Year                   Number of groups   =      11
Number of instruments = 15             Obs per group: min =      10
F(9, 11) = 18.47                       avg =      10.0
Prob > F = 0.0000                      max =       10
------------------------------------------------------------------------------
PFPerf  Coef.     Std. Err.           z         P>|z|
-------------+----------------------------------------------------------------
L.PFPerf        0.4123              0.1184           3.48       0.001
ESG      0.1682        0.0697        2.41       0.016
ClimRisk          -0.1406       0.0662          -2.12      0.034
GovQual           0.2089        0.0745           2.80       0.005
InfraInv          0.1208        0.0683           1.77       0.077
ESGScreen         0.0726        0.0419           1.73       0.083
FSize     0.0412        0.0321          1.28       0.201
INF      -0.0251        0.0204          -1.23      0.219
INT      -0.0334        0.0231          -1.45      0.146
GDPG   0.0516        0.0337           1.53       0.126
```

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Hansen test of overid. restrictions: p = 0.312
Arellano-Bond test for AR(2): p = 0.421

GMM diagnostics: Hansen test (p < 0.10), AR (2) insignificant

Dataset Structure

VARIABLE TYPE	VARIABLE NAME	PROXY/MEASUREMENT	DESCRIPTION	EXPECTED SIGN	DATA SOURCE
Dependant Variable	Pension Fund Performance (PFPerf)	Returen onAssets (ROA); Sharpe Ratio	Measures financial performance and risk-adjusted returns of pension fund	-	PFA Financial statements; PenCom Reports
Independent Variable	ESG Integration (ESG)	ESG Score/ESG Index	Composite index capturing ESG practices in investment decisions	+	ESG Databases; Sustainability Reports
Independent Variable	Climate Risk Exposure (ClimRisk)	Carbon intensity of portfolio; Exposure to fossil-fuel assets	Measures vulnerability of pension portfolios to climate-related risk	-	ESG Repots; Investment Portfolio Disclosures
Independent Variable	Governance Quality (GovQual)	Board Independence ratio; Audit Quality; Transparency index	Captures strength of internal governance structures and oversight mechanisms	+	Annual Reports; Corporate Governance Disclosures
Independent Variable	Sustainable Infrastructure Investment (InfraInv)	Of assets allocated to green/infra projects	Measures level of investment in sustainable and long-term infrastructure assets	+	PenCom Reports; PFA Investment Reports
Independent Variable	ESG Screening Framework (ESGScreen)	Dummy (1 = ESG Screening Adopted, 0 = otherwise)	Indicates whether ESG screening criteria are formally integrated into investment decisions	+	Policy Documents; PFA Disclosures

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Control Variable	Fund Size (FSize)	Log of total assets under management	Controls of scale effects and investment capacity	+	Financial Statement
Control Variable	Inflation Rate (INF)	Annual %change in CPI	Controls of macroeconomic instability affecting returns	-	Central Bank of Nigeria (CBN); NBS
Control Variable	Interest Rate (INT)	Monetary policy rate (MPR)	Captures cost of capital investment environment	-	CBN Reports
Control Variable	GDP Growth (GDPG)	Annual GDP growth rate	Controls of overall economic performance	+	NBS; WorldBank
Control Variable	Fund age (FAge)	Number of years since establishment	Controls of experience and institutional maturity	+	PFA REcords