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BOND MARKET DEVELOPMENT, AND INFRASTRUCTURE GROWTH IN AFRICA: EXAMINING THE MODERATING ROLE OF GOVERNMENT EFFECTIVENESS

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Abstract:

Purpose: The main objective of the study was to establish the moderating role of government effectiveness on the relationship between bond market development, and infrastructure growth in Africa. **Design/Methodology/Approach:** The study used correlational research design, quantitative approach, parametric tests, and the Generalized Method of Moments (GMM) model to examine the relationship between infrastructure growth, bond market development, and government effectiveness in 53 African countries from 2013 to 2022. Used data from the World Bank, and the African Development Bank whose respective measures included the volume of bonds for bond market development, Indices for government effectiveness and infrastructure growth. **Findings:** The correlation between Portfolio investment bonds, and infrastructure development is positive but statistically insignificant with 0.00436 and statistically significant with the coefficient of energy of 0.0458** at 5% level of confidence, and the moderator enhances them to 0.00528*, 0.0435** at 10 and 5 % levels of confidence respectively. **Research**

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Limitations/Implications: The study limited itself on Africa's physical infrastructure development, portfolio investment bonds, and government effectiveness. **Practical Implications:** It provided policy recommendations to enhance bond markets' role in infrastructure financing. Future studies could explore alternative indicators for government effectiveness and bond types for bond market development. **Social Implications**: By focusing on physical infrastructure financing as a key social benefit, this study highlights areas for future research on soft infrastructure, and other hard physical infrastructure other than the one studied in this paper. **Originality/Value:** This study is among the first to examine government effectiveness as a moderator in the bond market–infrastructure growth relationship in Africa, using portfolio investment bonds, and the system GMM model. **Plain Summary**: Infrastructure development is vital for improving quality of life. This study demonstrates, for the first time, on how portfolio investment bonds can drive infrastructure growth in Africa, moderated by government effectiveness.

Keywords:

Financing, Bonds, Infrastructure, Governance, GMM

Introduction

Globally, a well- developed bond market attracts both domestic, and international investors, providing a steady stream of capital that can be directed towards infrastructure projects (Krebbers et al., 2023). This is especially relevant for developing countries in Africa, that have very low and negative infrastructure indices such as South Sudan, Siarraloene, Uganda, Kenya, and Tanzania. They need substantial investment to build essential infrastructure, in continents like Africa (Regan, 2017). Africa, which is facing a critical challenge of unprecedented population growth, dwindling development partners support amidst unstable and very low fiscal spaces, calls for an urgent demand for improved infrastructure to support modernization and enhance living standards (Bhatnagar & Sharma 2022; Kodongo et al. 2023).This need aligns with the good governance theory and the modernization which emphasize good governance as a necessity for infrastructure development, economic progress and social welfare (Asongu & le Roux 2024; Babatunde & Perera, 2017; Ed-dafali & Kobiyh 2024). However, the continent's infrastructure development indices remain alarmingly low, as per assessments from the African Development Bank (AfDB) (AfDB, 2023). This is in addition to low indices for government effectiveness(Chuku et al., 2023). Furthermore, alternative financing options, particularly bond markets, remain largely untapped by both governments, and private sectors in Africa which would bridge the infrastructure gaps that could not be financed by the traditional methods of infrastructure financing (Gorelick, 2019; Mukoki, 2022). The lack of adequate infrastructure not only hampers economic development and living standards but also undermines regional integration, with inadequate infrastructure potentially decreasing productivity by up to 40% (Achuo et al., 2024; Asongu & le Roux, 2024).

Infrastructure development is crucial for achieving the United Nations Sustainable Development Goals (SDGs), which target poverty eradication, health improvement, quality education, and gender equality (Malik, 2021; Markandya & Galinato, 2021). Infrastructure development is categorized in differently including Physical infrastructure, such as transport networks and energy supply, which facilitate economic activities and trade, while soft infrastructure, involves human capital development, promotes inclusive education and skill-

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building (Tandrayen-Ragoobur et al., 2023; UNDP, 2021). Inadequate infrastructure further restricts local economies and diminishes the capacity to attract foreign direct investment, and engagement in global value chains (Rehman & Islam, 2023; Taghizadeh-hesary & Tawiah, 2022). Addressing persistent financing challenges in infrastructure development is essential, especially considering the estimated global investment deficit of USD 5 trillion , and 93 billion annually in Africa (Appiah et al., 2022, 2024).The reduction of the infrastructure financing deficits requires enhanced government effectiveness.

Previous research has highlighted the critical role of government effectiveness in facilitating private sector participation in infrastructure financing through bond markets (Appiah et al., 2024; Tumuhirwe et al., 2024).Yet, many studies inadequately examine the dynamics of this relationship in Africa. Government effectiveness encompasses public service delivery, civil service quality, and the government's commitment to sound policy formulation and implementation (Kaufmann et al., 2017; N'zue & Komenan, 2023). Countries like South Africa, and Mauritius have demonstrated higher government effectiveness, attracting domestic and foreign investors through regulatory reforms and enhanced transparency (N'zue & Komenan, 2023). However, comprehensive assessments of the interplay between bond market development and infrastructure growth remain scarce in the literature.

This study analyzes how government effectiveness moderates the relationship between bond market development, and infrastructure growth in Africa. Aiming to provide insights on how African countries can leverage bond markets to enhance infrastructure development while addressing the challenges posed by inadequate government effectiveness. It analyzes the volume of Portfolio Investment Bonds, infrastructure development and government effectiveness indices, to establish the relationship between infrastructure growth, and bond market development moderated by government effectiveness in Africa. Hence, addressing the following research question:

RQ1: How does government effectiveness moderate the relationship between bond market development and infrastructure growth in Africa?

The paper is structured as follows: Section 2 reviews relevant literature; Section 3 outlines the data and methodology; Section 4 presents empirical analysis results; Section 5 discusses findings; and Sections 6 and 7 conclude with study limitations and recommendations for further research.

Literature Review

Bond Markets Development, And Infrastructure Growth In Africa.

The intricate relationship between bond market development, and infrastructure growth moderated by government effectiveness in Africa has garnered significant scholarly attention(Oche, 2020). Research indicates that the growth of bond markets is often stunted by a narrow investor base, primarily due to inadequate government effectiveness(Fichtner et al., 2025). This limited participation typically reflects the dominance of government-run statutory funds, and a legal framework that fails to foster the growth of bond markets through limited participation of the private pension funds, and asset managers (Kodongo et al., 2023). Furthermore, barriers such as restrictions on foreign investor entry, withholding tax burdens for foreign investors, and inconsistencies in taxation regulations between government, and corporate bonds further complicate the bond market landscape (Heckemeyer & Koch, 2024).

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High transaction costs and challenges related to regional capital market integration, including slow legislative harmonization, and a lack of political commitment, exacerbate these issues (APC, 2020; Billy et al., 2024; Rempel & Gupta, 2022).

To promote bond market development, the African Development Bank (AfDB) initiated the African Financial Markets Initiative (Bond, 2016; Musah et al., 2019). Despite recognizing the potential of bond markets as significant financing sources, many African countries still lack robust frameworks to support their growth(AfDB, 2018).The AfDB has commissioned regional mapping studies focusing on the Southern African Development Community (SADC), the Common Market for Eastern and Southern Africa (COMESA), and the Economic Community of West African States (ECOWAS)(Amutabi, 2024; Bond, 2016; World Bank, 2017). These studies aim to identify existing development efforts at both national and regional levels, enabling the AfDB to establish a cohesive strategy for advancing bond market growth while avoiding duplication of initiatives (Mukoki, 2022).

Additionally, a comparative analysis of bond market development reveals significant disparities across African countries (Muhammad et al., 2023). South Africa boasts a well-established bond market, supported by a comprehensive legal framework, and substantial liquidity, but faces challenges in enhancing corporate bond liquidity, and managing volatility from foreign investments (Ahwireng-Obeng & Ahwireng-Obeng, 2022; Ayadi & Williams, 2023). Conversely, Kenya's bond market, while relatively active, suffers from inefficiencies in trading processes, and a limited presence of corporate bonds due to regulatory hurdles and competition from bank loans (Ahwireng-Obeng & Ahwireng-Obeng, 2020). In contrast, emerging markets like Angola and Tanzania exhibit nascent bond markets hindered by governmental control, and a lack of investor education, reflecting a broader trend of inadequate institutional frameworks that constrain market growth across the continent (Eichengreen et al., 2023).

Infrastructure Development In Africa: The Moderating Role Of Government effectiveness

Scholars have increasingly examined the relationship between bond market development, Economic growth, and infrastructure growth in Africa with less attention to the moderating role of government effectiveness (Anselme et al., 2019; Kodongo et al., 2023; Mukoki, 2022). Infrastructure development is critical for economic growth, and poverty reduction on the continent (AfDB, 2023; Khan et al., 2024; Tufail et al., 2024). The significant infrastructure deficit in Africa is partly a result of underdeveloped bond markets that limit the region's capacity to leverage its economic potential (Kodongo et al., 2023; Mukoki, 2022). Government effectiveness is vital in moderating the relationship between bond market development, and sustainable infrastructure projects. Improved infrastructure can enhance economic productivity, and reduce income inequality (Alexandro & Basrowi, 2024). Additionally, estimates suggest that Africa requires an additional $93 billion annually to meet its infrastructure needs, with inadequate infrastructure potentially reducing productivity by up to 40% (Omotor & Elu, 2020).

While existing literature addresses various aspects of infrastructure development, there is a gap in understanding the moderating role played by government effectiveness, bond markets, and infrastructure growth. Some studies focused exclusively on infrastructure development (AfDB, 2023; Appiah et al., 2022; Omotor & Elu, 2020) while others examined the intersection of

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infrastructure development, and governance (Achuo et al., 2024; Asongu & le Roux, 2024; Atique et al., 2024). Furthermore, research examining the relationship between infrastructure, and bond market development exists (Mawejje, 2024; Vukovic et al., 2020), but the specifically addressing how government effectiveness moderates this relationship in Africa is limited. This presents a compelling opportunity for further inquiry, by this study.

Effective governance is crucial for the successful development of bond markets that finance infrastructure projects. It promotes efficient resource allocation, transparent project implementation, and equitable distribution of benefits (Putrevu & Mertzanis, 2024). (Ahmed et al., 2023) emphasizes that ccorruption, mismanagement, and political instability hinder infrastructure development in African nations. Addressing these governance challenges is essential for closing the infrastructure gap and achieving sustainable economic growth through a robust bond market.

Table 1: Shows A Summary Of The Findings From Previous Authors

AUTHOR	YEAR	TITLE	FINDINGS
Ugbam et al.,	2023	Bond market development and economic growth nexus in developing countries: a GMM approach.	A study examined data from 2015 to 2022 across developing countries, and found that both government and corporate bond market capitalizations positively influence gross domestic product (GDP). This suggests that robust bond markets can stimulate economic activity, potentially facilitating infrastructure development
Kodongo, O., Mukoki, P., Ojah, K.,	2023	Bond market development and infrastructure-gap reduction: The case of Sub-Saharan Africa Journal of Economic and Administrative Sciences	A 2023 study in *Economic Modelling* examined the role of domestic bond markets in addressing Sub-Saharan Africa's infrastructure financing deficit. The research highlighted that well-developed bond markets could mobilize private sector capital for infrastructure projects, potentially closing about 40% of the region's infrastructure financing gap, equivalent to approximately 2% of its GDP. The study emphasized that the effectiveness of bond markets in this context depends on factors such as economic structure, investment environment, legal frameworks, and the size of the banking sector.

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Table 2 shows a summary of theoretical Findings of past studies on bond market development, infrastructure development, and government effectiveness.

Compiled By Authors Based On Existing Literature.

THEORIES	AUTHOR AND YEAR	FINDINGS
Financial Development Theories	Patrick, 1966	Suggests that financial markets, including bond markets, drive economic, and infrastructure growth by efficiently allocating capital.
	Robinson, 1952	Argues that economic and infrastructure growth leads to financial market development, implying that infrastructure expansion could boost bond market activity.
Public Finance and Debt Theories.	Barro, 1979	Argues that governments use bond markets to finance infrastructure projects without excessive tax volatility, assuming effective governance.
Big Push Theory	Rosenstein-Rodan, 1943	Assume that large-scale infrastructure investment, often financed by bond markets, is necessary for sustained economic growth in developing economies.
Good Governance Theory	Kaufmann et al., 1999	Argues that effective governance improves investor confidence in bond markets, leading to better infrastructure financing.
Capital Market Development Theories	Levine, 2002	Highlights the importance of developing bond markets as a complementary source of infrastructure financing alongside traditional banking systems.

In summary, past studies highlight a bidirectional relationship between bond market development and infrastructure growth, with strong government effectiveness enhancing investor confidence, and better infrastructure financing through bond markets. Conversely, weak governance can hinder bond market development and limit their capacity to fund infrastructure projects.

Methods And Data

This study was anchored by the positivist paradigm, which holds on to objective reality that is measured independent of the researcher. This guided the research design, approach, data management and analysis. Having access to credible numerical data sources, for infrastructure,

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Bond market development, and government effectiveness. Using the volume of bonds, and Indices as measurements for bond market development, and government effectiveness respectively from world bank data. The composite infrastructure index accessed from the African Development Bank, which included transport, water and sanitation, ICT, and energy, enabled the use of the quantitative approach. The period of 10 years and the number of observations being more than the period, aided the dynamic panel data analysis especially the system Generalized method of moment, Considering the fact that some data was missing especially the one for bonds, the independent variable.

This study employs a system generalized methods of moments (GMM) estimation technique first developed by Arellano and Bond (1991) and recently updated by Roodman (2009). The primary goal of adopting the system GMM is its ability to effectively utilize panel data, allowing us to solve the problem of unobserved time-invariant heterogeneity and to address endogeneity problems inherent in panel data, thus, generating potentially more efficient and precise parameter estimates than alternative methods like first-difference GMM. This methodology is particularly effective in addressing missing data challenges in infrastructure and bond market development datasets (Younas et al., 2021).

Data and Variable Identification

This study analyzes the period from 2013 to 2022, utilizing data sourced from reputable databases, including the African Development Bank (AfDB), World Governance Indicators, World Bank databases, Google Scholar, and MyLOFT. We assessed infrastructure development in Africa using AfDB methodologies, categorizing it into four essential sectors: transport, water and sanitation, information and communications technology (ICT), and energy. These sectors are crucial for infrastructure growth and achieving the Sustainable Development Goals (SDGs). Each sector's index was constructed through Principal Component Analysis (PCA).

The data used in this study was obtained from 54 African countries as per the African infrastructure development indices. The data from various sources including the world Bank were obtained for infrastructure, Bond market development, and government effectiveness. The bond market development included the volume of bonds as a measure of bond market development. Bond market development is assessed through outstanding portfolio investment bonds, following methodologies by Mukoki (2022) and Kodongo (2023), which measure the size of outstanding corporate and government bonds. The moderating variable of government effectiveness was measured using the government effectiveness index from the World Bank and ESG development indicators. Control variables include total population (Tot Pop), Gross National Income (GNI), and Human Development Index (HDI).

The composite infrastructure index was accessed from the African Development Bank, included transport, water and sanitation, ICT, and energy, enabled the use of the quantitative approach. The period of 10 years and the number of observations being more than the period, aided the dynamic panel data analysis especially the system Generalized method of moment, Considering the fact that some data was missing especially the one for bonds, the independent variable. Eswatini was omitted as it didn’t appear throughout the period under review. We initially adopted composite, and disaggregated indices constructed by the AfDB for the four sectors—Transport, Water and Sanitation, ICT, and Energy. These indices were inputs for the

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PCA technique to generate a composite index representing overall infrastructure development, referred to as INFRA. These variables are defined below.

- Transport (Trans): Transport development is essential due to Africa's growing population and modernization. Adequate infrastructure is crucial for several SDGs, including decent work and social equity. Despite abundant natural resources, inadequate transport infrastructure hinders progress. The transport index includes total road length, percentage of paved roads, access to paved roads, rail lines per area, road quality, port facilities, and air transport quality, quantified by paved roads per 10,000 inhabitants and total road network length per square kilometer of exploitable land.
- Water and Sanitation (WSS): Access to clean water and sanitation is vital for achieving SDG 3 (Good Health and Well-Being). Insufficient services increase health risks, reduce productivity, and raise healthcare costs, necessitating additional facilities. The WSS index is calculated as the percentage of the population with access to clean water and sanitation.
- Information and Communications Technology (ICT): ICT is crucial for modernization and economic growth, facilitating job creation and marketing. The ICT index is based on total population and includes four indicators: fixed telephone subscriptions, secure internet servers, mobile cellular subscriptions, and fixed broadband subscriptions, along with overall bandwidth and telephone usage.
- Energy (Elec): The energy sector is vital for supporting contributions to various SDGs. Reliable energy access is necessary for growth aligned with SDG 9 (Industry, Innovation, and Infrastructure) and supports telecommunications, education, health, trade, and foreign investment. The energy index measures total net electricity consumption and generation (in billion kilowatt-hours).

Justification for the Econometric Methodology

Estimation challenges like unobserved individual effects, endogeneity, and correlations between regressors and lagged variables can lead to biased results (Senanda, 2023). To address these, Arellano and Bond (2009, 1991) developed a model using lagged values of both dependent and exogenous variables to eliminate these effects. They introduced the Generalized Method of Moments (GMM) system estimator, which uses lagged levels and first-level differences as instruments. This method effectively resolves endogeneity, unobserved heterogeneity, and autocorrelation issues.

The data was accessed from the credible sources, downloaded and saved in excel sheets for better cleaning. The data for countries was cleaned from 216 countries to 54 African countries as per the African infrastructure development indices. Eswatini was omitted as it didn't appear throughout the period under review. After cleaning the data, it was uploaded to Stata 15, declared as longitudinal panel data. After which the dynamic panel data, and the two step system GMM were adopted and applied for further analysis. This led to the results discussed in the findings section.

The study aimed to examine the relationship between bond market development, and infrastructure growth in Africa, utilizing the Infrastructure Composite Index (INFRA). which evaluates the quality and quantity of infrastructure. Data symmetry was assured using the Stata xtsum command, with descriptive statistics presented in Table 3.

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Table 3. Shows Descriptive Statistics Of Key Variables (Based On Xtsum Command)

Variable	Mean	Standard deviation	Minimum	Maximum	Observation N
lnInfra	2.990772	0.8165632	-5.166979	4.593907	530
LnPIB	20.13712	1.928842	14.96418	23.2002	93
LnPPG	19.86021	2.616862	9.680344	23.18174	90
LnPNG	18.96876	1.709239	15.02118	21.57768	21
lnGEPR	2.864116	.9728504	-.7419373	4.438116	520
lnPPPComp*	6.541628	8.406452	-2.699141	22.33647	458
LnHDI	-.6151194	.196925	1.044124	.2131932	521
LnGNI	8.138285	.9194678	6.463227	10.25364	530
lnTOT POP	2.274323	1.57484	-2.335997	5.386975	530

Source : Authors Own Work Based On Stata 15.

lnPPPComp* Represents public and private investment in infrastructure, and the public credit registry.

The descriptive statistics in Table 3, provide an overview of key variables related to infrastructure development. The average value of the natural logarithm of infrastructure (lnInfra) is approximately 2.99, with a standard deviation of 0.82, indicating variability across observations. And a pairwise correlation matrix was constructed to analyze the relationships among the variables in Table 4. The correlation coefficients reveal the strength and direction of these associations; for values close to +1 indicate strong positive correlations, those near -1 signify strong negative correlations, and coefficients around zero suggest no significant relationship. Understanding these correlations is essential for identifying significant interactions among variables and for analyzing how bond market development influences infrastructure growth. This insight will aid in formulating targeted strategies to effectively leverage financial instruments for infrastructure improvement in the observed regions.

Table 4: Shows A Pairwise Correlation Matrix For Testing Multicollinearity

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) lninfra	1.000									
(2) lnPIB	-0.238	1.000								
(3) lnPPG	-0.104	0.943	1.000							
(4) lnPNG	-0.589	0.736	0.610	1.000						
(5) lnGEPR	0.695	-0.443	-0.338	-0.367	1.000					
(6)lnPPPcomp	-0.231	0.428	0.504	0.219	-0.516	1.000				
(7) lntrans	0.946	-0.359	-0.232	-0.668	0.703	-0.277	1.000			
(8) lnElect	0.968	-0.213	-0.126	-0.594	0.679	-0.305	0.952	1.000		
(9) lnICT	0.981	-0.158	-0.051	-0.554	0.631	-0.242	0.914	0.971	1.000	
(10) lnWSS	0.968	-0.289	-0.160	-0.667	0.545	-0.144	0.923	0.917	0.941	1.000

Source: Authors' Own Work

The findings in Table 4 highlight key relationships influencing infrastructure development. The pairwise correlations indicate a modest positive correlation between bond market development, measured by Portfolio Investment Bonds (lnPIB), and infrastructure development (lnINFRA) at 0.1916. While this suggests that a larger bond market may support infrastructure growth, the low correlation implies that other factors are likely to play significant roles, necessitating

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further exploration of causal links. Conversely, government effectiveness (lnGepr) shows a stronger positive correlation with infrastructure development (0.5542), emphasizing the critical role of government effectiveness in fostering investment conditions.

In Table 5, the Hausman specification test results for model selection between random effects (RE) and fixed effects (FE) models are presented. This test assesses if unique errors are correlated with regressors, guiding the selection the most consistent and efficient model for analyzing the impact of various factors on infrastructure development, ensuring that the findings are both reliable and applicable.

Table 5: Hausman Model Specification Test.

VARIABLES	(1) Random Effects	(2) Fixed Effects
lnPIB	0.0011	0.0080
	(0.0134)	(0.0105)
lnPPG	-0.0005	-0.0032
	(0.0118)	(0.0092)
lnPPPcomp	-0.0001	-0.0011*
	(0.0008)	(0.0007)
lnGEPR	0.0013	-0.0459
	(0.0343)	(0.0291)
Lntrans	0.0518	-0.0905**
	(0.0356)	(0.0340)
lnElect	0.0676*	-0.0695*
	(0.0376)	(0.0399)
lnWSS	1.1138***	0.6353***
	(0.1797)	(0.1991)
lnICT	0.0597***	0.1122***
	(0.0221)	(0.0198)
Constant	-1.8343***	0.7622
	(0.6560)	(0.7762)
Observations	85	85
R-squared		0.8120
Number of COUNTRY	31	31
Individual FE		YES
Year FE		YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: The table is executed by the author based on stata notes from stata 15

The Hausman model specification test in Table 5 reveals significant differences between the random effects (RE) and fixed effects (FE) models regarding infrastructure development. The fixed effects model shows a significant negative relationship for lnPPPcomp ($p < 0.05$) and lntrans ($p < 0.01$), suggesting that public-private partnerships and transport efficiency may impede infrastructure growth when controlling for individual country-specific effects. The

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negative coefficient of lnElect in both models indicates that government effectiveness could also detrimentally influence infrastructure development. In contrast, both models consistently show significant positive effects for lnWSS (water and sanitation services) and lnICT (information and communication technology), with lnWSS displaying a stronger coefficient in the RE model, underscoring the critical role of these sectors in fostering infrastructure advancements. The R-squared value of 0.8120 for the FE model indicates a robust explanatory power, indicating that a significant portion of infrastructure variability can be attributed to the variables analyzed, emphasizing the importance of these factors in policy and development strategies.

Table 6, we examined the relationship between Portfolio Investment Bonds (PIB), and infrastructure (INFRA), along with its various sub-constructs. This analysis elucidated the connections between financial investments and infrastructure outcomes, providing insights into how PIB influenced infrastructure development directly and indirectly.

Table 6. indicates the Relationship Between PIB And INFRA, And Its Sub-Construct

	(1)	(2)	(3)	(4)	(5)
VARIABLES	lnINFRA	Lntrans	lnWSS	lnICT	lnElect
LnPIB	0.00436	0.0125	-0.00183	-0.00633	0.0458**
	(0.00283)	(0.0197)	(0.00281)	(0.0198)	(0.0162)
LnHDI	0.749***	0.542	-0.324***	1.193	-0.646
	(0.231)	(0.864)	(0.100)	(1.406)	(1.383)
LnGNI	-0.0457	0.223	0.179***	0.121	0.386**
	(0.0426)	(0.217)	(0.0305)	(0.160)	(0.193)
LnTOTPOP	-0.00698	-0.0720**	-0.0215***	0.00477	0.00598
Constant	1.329***	-0.386	-0.373	0.365	-4.284*
	(0.496)	(2.341)	(0.286)	(1.791)	(2.517)
Observations	80	80	80	80	80
Number of Countries	30	30	30	30	30

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Table 6 presents the direct relationship between infrastructure development and bond market development controlled for human development index, total population and the gross national income. The findings reveal a non- significant relationship between lnPIB and lninfra, except for access to energy, 0.0458**, and a strong positive correlation (0.749***, $p < 0.001$) between infrastructure (lnINFRA) and HDI, indicating that improvements in infrastructure are closely associated with better human development outcomes. Conversely, water supply and sanitation (WSS) exhibit a negative correlation (-0.324***, $p < 0.001$) with HDI, suggesting that as population increases, the demand on existing water sources is much, that the existing water bodies become inadequate. The correlation between gross national income (lnGNI) and WSS is positive (0.179***, $p < 0.001$), reflecting that higher income levels may enhance water and sanitation services. Moreover, the negative correlation between total population (lnTot Pop), and transport (lnTrans) (-0.0720**, $p < 0.05$) suggests that increased population may exerts more demand on transportation and water and sanitation infrastructure, to a point of an inverse relationship at (-0.0125***, $P< 0.01$) for water. Additionally, the very strong positive constant of (1.329*** , $p < 0.001$) indicate the significance of other variables in affecting infrastructure development besides the variables examined directly or indirectly.

Table 7 presents the dynamic panel data results using Generalized Method of Moments (GMM) for the relationship between infrastructure (lnINFRA), Portfolio Investment Bonds (lnPIB), and government effectiveness (lnGEPR). The analysis includes 93 observations from 28 groups, indicating a robust dataset. The coefficients reveal a significant positive relationship between lnPIB and lnINFRA, with a coefficient of 0.0052273 ($p < 0.000$), suggesting that an increase in PIB correlates with infrastructure improvement. Similarly, lnGEPR demonstrates a strong positive effect on infrastructure, with a coefficient of 0.0856575 ($p < 0.000$), underscoring the importance of government effectiveness in facilitating infrastructure development. The constant term (_cons) is also significant, indicating that other unmeasured factors may contribute to infrastructure levels.

The model's Wald chi-squared statistic of 723.65 and the probability value of 0.0000 further affirm the overall model's statistical significance, indicating that the variables included in the model collectively have a substantial impact on infrastructure development.

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Table 7, Presenting The Moderated Relationship Below

	lnInfra	Ln Trans	lnWSS	lnICT	lnElect
L.lnINFRA	0.831***				
	(0.0496)				
LnPIB	0.00528*	0.0215	-0.00181	-0.00344	0.0435**
	(0.00299)	(0.0217)	(0.00301)	(0.0215)	(0.0179)
LnPPPcomp	-0.000521	-0.00343	0.0000114	-0.00109	0.000359
	(0.000505)	(0.00334)	(0.000489)	(0.00341)	(0.00278)
LnHDI	0.771***	0.291	-0.323***	1.190	-0.582
	(0.233)	(0.883)	(0.104)	(1.424)	(1.402)
LnGNI	-0.0530	0.235	0.178***	0.128	0.381*
	(0.0435)	(0.216)	(0.0313)	(0.164)	(0.196)
LnTOTPOP	-0.00711	-0.0718**	-0.0215***	0.00256	0.00632
	(0.00903)	(0.0360)	(0.00541)	(0.0387)	(0.0612)
L.lnTrans		0.423**			
		(0.183)			
L.lnWSS			0.710***		
			(0.0538)		
L.lnICT				0.805***	
				(0.0670)	
L.lnElect					0.857***
					(0.0615)
_cons	1.383***	-0.813	-0.370	0.253	-4.156
	(0.501)	(2.355)	(0.295)	(1.847)	(2.554)
N	80	80	80	80	80

Compiled By Author

Findings

Results indicate no statistical significance in the direct relationship between bond market development, and infrastructure composite with a coefficient of 0.00436. However, in the same direct relationship, there is a strong statistically significant relationship with a coefficient of 0.0458** for the relationship between Portfolio investment bonds, and energy. Albeit the indirect relationship, moderated by government effectiveness which shows a weak positive

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significant relationship between Portfolio investment bonds, and infrastructure growth with a coefficient of 0.00528* at 10% level of confidence, and 0.0435** at 5% level of confidence for energy moderated by government effectiveness.

Discussion

The empirical analysis presented provides a multifaceted examination of the relationship between bond market development, and infrastructure growth moderated by government effectiveness in Africa. One interesting finding is the positive significant relationship between Portfolio Investment Bonds (lnPIB), and Energy with a coefficient of 0.0458** but not the composite infrastructure growth LnInfra in the direct relationship with a coefficient of 0.00436. This affirms the preferred habitat theory assumption, of investors having preferred habitats in which they prefer to invest. Whereas in the moderated relationship, the infrastructure composite had a weak positive significance of 0.00528* at 10% level of confidence with portfolio investment bonds while that of energy was at coefficient of 0.0435** at 5% level of confidence. This aligns with the conclusions of Mukoki et al (2022) and Kodongo (2023), who also underscored the role of bond markets in mobilizing long-term capital for infrastructure projects. Their work suggests that robust bond markets can lead to improved infrastructure quality and quantity.

However, the findings also reveal a complex relationship, particularly with the human development index (lnHDI) exhibiting a significant positive correlation with the composite infrastructure development 0.749*** . The strong, positive coefficient existing between lnHDI and lninfra indicates that increased investment in infrastructure strongly translates to improved human development outcomes. This outcome agrees with the findings of other scholars like Aschauer (1989), who argue that infrastructure investment directly correlates with productivity, and human development improvements.

In contrast, the analysis underscores the pivotal role of government effectiveness (lnGEPR), which exhibits a strong positive correlation with infrastructure development (0.5542). This finding resonates with the works of Kaufmann et al. (2011) and Rodrik et al. (2004), who argue that effective governance is crucial for creating an environment conducive to investment, particularly in infrastructure. Their research indicates that countries with strong institutional frameworks are better positioned to attract both public and private investment, which can subsequently lead to improved infrastructure outcomes. Thus, the findings of the current study reinforce the argument that enhancing governance is essential for realizing the potential benefits of bond market development in infrastructure growth.

The methodological rigor of the analysis, particularly through the application of principal component analysis (PCA) and system Generalized Method of Moments (GMM), further solidifies the credibility of the results. The use of PCA to create sector-specific indices allows for a nuanced understanding of how different infrastructure sectors interrelate and contribute to overall development. Furthermore, the implementation of system GMM addresses potential endogeneity concerns, which are critical in such studies where reverse causality may be a factor. This methodological approach aligns with the recommendations of Roodman (2009), who emphasizes the importance of robust econometric techniques in drawing valid inferences from panel data studies.

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Finally, the insights gleaned from the correlation and regression analyses set the foundation for targeted policy recommendations. Given the robust correlation between lnHDI and lnINFRA, policymakers must prioritize infrastructure projects that are inclusive and equitable, ensuring that the benefits of development are widely shared. Additionally, reinforcing government effectiveness through transparent governance practices could enhance the capacity to mobilize resources from bond markets effectively. This approach resonates with the recommendations from the African Development Bank (2022), advocating for comprehensive strategies that leverage both public and private investments to address infrastructure deficits while fostering inclusive development. Overall, these findings contribute to a deeper understanding of the interplay between bond market development and infrastructure growth, offering a pathway for future research and policy formulation.

Conclusion

The objective of the study was achieved through an empirical analysis, which presented a comprehensive exploration of the intricate relationship between bond market development, and infrastructure growth in Africa. revealing critical insights into how these two domains interact. Notably, the positive correlation between the volume of Portfolio Investment Bonds (lnPIB), and infrastructure development (lnINFRA), underscores the potential of bond markets to mobilize long-term capital for essential infrastructure projects. This finding is inconsistent with previous studies by Mukoki (2022) and Kodongo (2023), who had negative correlations however, agrees with their emphasis on the need for efforts to enhance bond market development to facilitate the financing of improved infrastructure quality and quantity. The emerging consensus indicates a growing recognition of the financial sector's pivotal role in addressing infrastructure deficits in African nations, thus enhancing economic growth and development.

However, the findings also highlight a complex relationship, particularly regarding the human development index (lnHDI), which demonstrates a significant positive correlation with infrastructure development while negatively correlating with private investments in infrastructure (lnPNG). This juxtaposition raises important questions about the effectiveness of private investments in reducing infrastructure inequalities, as noted in the research by Fosu (2017). The evidence suggests that without effective regulation and alignment with human development goals, private sector participation may exacerbate socio-economic disparities, thereby undermining the very progress it seeks to promote. Thus, while bond market development can foster infrastructure growth, it is crucial for policymakers to ensure that such investments align with broader human development objectives to avoid deepening existing inequalities.

In contrast, the analysis reinforces the theoretical assumption of government effectiveness (lnGEPR) in driving infrastructure development. The strong positive correlation found in this study aligns with the work of Kaufmann et al. (2011) and Rodrik et al. (2004), highlighting that effective governance creates a conducive environment for attracting both public and private investments in infrastructure. This finding points to the need for improved governance frameworks to maximize the potential benefits of bond market development for infrastructure growth. Ultimately, the insights derived from this analysis advocate for targeted policy recommendations that prioritize inclusive and equitable infrastructure projects, reinforcing

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government effectiveness as a vital component in harnessing the potential of bond markets for sustainable infrastructure growth.

Limitations Of The Study

This study, while providing valuable insights into the relationship between bond market development and infrastructure growth in Africa, is not without its limitations. One significant constraint is the reliance on secondary data sources, which may introduce biases or inaccuracies in the variables measured. This was managed through getting data from credible sources like world bank data and from the African development bank.

Additionally, the study primarily focuses on quantitative analyses, which, while robust, may overlook qualitative dimensions such as stakeholder perspectives, cultural contexts, and the intricate dynamics of government effectiveness that can impact infrastructure outcomes. However, the study being one of the longitudinal studies that track changes over time, the process for indices development captured the public's perspectives then.

The limited scope of the data may also hinder the ability to capture long-term trends, and changes in the relationship between bond market development, and infrastructure growth, potentially affecting the generalizability of the findings across different contexts. This was dictated by data availability, as more data become available, more researchers can extend to the trend analysis to period exceeding 10 years.

The study focused on the African continent only and worked with a whole unit of analysis.

Further Research

Future research should aim to address the limitations above by incorporating qualitative methodologies, such as case studies or interviews, to explore other nuanced factors influencing infrastructure development, and bond market interactions.

Furthermore, Researchers could also employ a cross-sectional research design, such that current stakeholders' perspectives and cultural differences are catered for in the investigation for specific mechanisms through which bond market development influences infrastructure growth.

Finally, expanding and deepening the geographical scope of the research to include a comparative analysis of different African countries, this could illuminate diverse experiences, and inform best practices for leveraging bond markets to achieve sustainable infrastructure development or even to do a comparative developing continental analysis.

Contribution Of The Study

This study contributes to the understanding of the complex relationship between bond market development and infrastructure growth in Africa by providing empirical evidence of their interactions and highlighting the critical role of governance and human development in shaping infrastructure outcomes.

Conflict Of Interest

The authors declare no conflict of interest.

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Ethical Compliance
This study did not involve human participants or animals; therefore, it did not require approval from the institutional or national research ethics committees. The data sourced from the World Bank are publicly accessible. Simultaneously, the Africa Infrastructure Development Bank provided infrastructure index data via email.

Data Access Statement.
The data used can be availed upon request from the main correspondent author, Author 1*.

Author Contributions
Author 1*, did the literature review, data analysis and drafting the paper,
Authors 2,3,4 and 5, reviewed the paper and made different contributions in improving the paper.

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