sustainability

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Environmental Change and Inclusive Finance: Does Governance Quality Matter for African Countries?

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Abstract: This paper examines the effect of environmental change on inclusive finance in African countries during the period 1996–2020. It also investigates the moderating role of government quality on the association between environmental change and inclusive finance. We collected five-year average data from various sources such as the World Development Indicators, the World Governance Indicators, and the International Monetary Fund. Government quality is measured by six dimensions: political stability, voice and accountability, government effectiveness, regulation quality, the rule of law, and corruption control. Environmental change is measured by CO_2 emissions. Inclusive finance is measured by the financial development index through depth, access, and efficiency ratios. These variables represent the most used in prior studies as they are published by international organizations such as the World Bank and the International Monetary Fund, which represent a reputable source of timely information related to the business environment in which business executives operate in several countries. The results show a significant impact of environmental change on inclusive finance. Including economic governance induces a significant and positive effect on financial inclusion in all instances. Our results also show that the coefficients of the interaction between environmental change and governance dimensions are positive and significant. The moderator role of governance is improved when taking into account political, institutional, and economic governance. Our findings offer more motivation for regulators and governments to develop environmental policies that integrate inclusive finance to meet sustainable development goals. Our results are important as they can help regulators, investors, and policymakers to assess and better understand the potential moderation role of governance quality in the relationship between inclusive finance and environmental change.

Keywords: government quality; environmental change; inclusive finance; sustainability; sustainable development goals

Citation: Borgi, H.; Mabrouk, F.; Bousrih, J.; Mekni, M.M. Environmental Change and Inclusive Finance: Does Governance Quality Matter for African Countries? *Sustainability* **2023**, *15*, 3533. https://doi.org/10.3390/su15043533

Academic Editors: John Asafu-Adjaye, Abebe Shimeles and Théophile Azomahou

Received: 20 November 2022
Revised: 17 January 2023
Accepted: 27 January 2023
Published: 14 February 2023
Corrected: 30 June 2023

1. Introduction

Throughout the past decade, developing, less developed, and even developed countries have taken steps to improve their inclusive finance [1] as inclusion in finance is broadly linked to sustainable development [2,3]. In fact, the 2030 Sustainable Development Goals (SDGs) include inclusive finance as a target, emphasizing its role as a promoter of some SDGs (https://www.uncdf.org/financial-inclusion-and-the-sdgs, last accessed 10 September 2022), such as SDG 1, related to eradicating poverty; SDG 5 is concerned with ensuring gender equality and economic empowerment of women [4]. SDG 8 is concerned with supporting economic growth and job creation; SDG 9 is concerned with stimulating industry, innovation, and infrastructure; and SDG 10 is concerned with reducing inequality. Therefore, inclusive finance plays an important role in financial and sustainable development by contributing to the optimization and upgrading of the financial system [5].

Government intervention plays an important role in achieving a high degree of financial inclusion, and its main challenge remains financial sustainability. Major adjustments to current governance processes and practices are necessary if societal growth paths are to be oriented more toward sustainable patterns. Sound governance is essential to dealing with energy and environmental crises. However, the existing literature suggests that a lack of political will has been garnered to effectively manage energy and environmental challenges [6].

Numerous studies have looked into the drivers of inclusive finance [5,7]. Mhlanga [7] focus on the drivers of inclusive finance in rural Zimbabwe. Their results show that inclusive finance is driven by off-farm income, education level, distance to the nearest financial institution, financial literacy, and the age of the household. However, none of these publications provide particular attention to the potential effect of environmental change on inclusive finance and the potential moderating role of governance in this relationship in Africa. This study will shed light on the consequent repercussions and contribute to the field with the unique findings therein, given the regional difference in the institutional arrangement and the recent relative stability of political regimes in African countries and its impact on environmental sustainability.

Africa is a particular and interesting context. In fact, the economic growth of many African countries is increasing rapidly [8]. As a result, Africa is becoming the second fastest-growing region in the world. However, the continent suffers from weak governance [9] and climate change [10]. These revelations have led regulators and policymakers to recognize that some African countries have been able to foster economic growth with development strategies, visions, and processes but not with inclusive growth as well [8]. Furthermore, climate change is expected to increase risks in Africa and, therefore, can really impede the future development of the continent. The interplay between environmental issues and inclusive growth, and more particularly inclusive finance, requires further analysis in order to better understand how policymakers can develop and implement adequate policies that can contribute to effectively addressing these issues. All the mentioned revelations make Africa a unique context worthy of consideration. Borgi and Mnif [9] and Tawiah and Boolaky [11] also invite researchers to conduct empirical studies on the African setting because of its typical socioeconomic, cultural, and business setups.

The current study aims to boost debates on how environmental change can affect inclusive finance in African countries and how governance can moderate the nexus between environmental change and inclusive finance in Africa.

Hence, this paper aims to investigate the effect of environmental change on inclusive finance in African countries. It also examines the moderator effect on the association between environmental change and inclusive finance in Africa.

We use public interest theory and the Environmental Kuznets Curve hypothesis as a theoretical background to develop our hypotheses. In fact, Borgi and Mnif [9] suggest that future studies should consider public interest theory as one of the regulation theories to explain the role of regulation and government at the country level. In line with [9], we argue that these theories provide a useful framework to better understand how regulators and governments respond to market forces. Hence, we expect that environmental change will affect inclusive finance in Africa. We also expect that governance classified as political, economic, and institutional governance would moderate the association between environmental change and inclusive finance in Africa.

We collected five-year average data (1996–2020) from various sources, such as the World Development Indicators, the World Governance Indicators, and the International Monetary Fund. The selected period is explained by the availability of Governance data, which started only after 1996. Therefore, our time period begins in 1996 and ends in 2020. These years are selected as it takes into consideration the most recent data at the time of conducting the empirical analysis. Government quality is measured by six dimensions: political stability, voice and accountability, government effectiveness, regulation quality, the rule of law, and corruption control. Environmental change is measured by CO_2 emissions.

Inclusive finance is measured by the financial development index through depth, access, and efficiency ratios. These variables represent the most used in prior studies as they are published by international organizations such as the World Bank and the International Monetary Fund, which represent a reputable source of timely information related to the business environment in which business executives operate in several countries.

The results show a positive and significant impact of environmental change on the development of financial inclusion. This means that the increase in CO_2 emissions will promote financial inclusion in African countries. In all instances, economic governance has a significant and positive effect on financial inclusion. Our results show that the coefficients of the interaction between environmental change and the dimensions of governance are positive and significant. This suggests that there is a complementary effect between environmental change and governance on financial inclusion in Africa. The moderator role of governance is improved when taking into account political, institutional, and economic governance. However, when we consider the individual effects of each dimension of governance separately, the results show that only economic governance is positive and significant.

The current study contributes by addressing the discussed concern of inclusive finance by assessing the effect of environmental change and governance indicators on inclusive finance in African countries and how governance is important to moderate the effect of environmental change on inclusive finance. Our research complements the study of [6], which addresses the impact of CO_2 emissions on human development inclusiveness in sub-Saharan Africa and examines the moderator role of governance on the relationship between inclusive human development and CO_2 emissions. Our study stands apart from their findings by investigating the effect of CO_2 emissions on financial inclusiveness, considered the main target that promotes sustainable development goals. Furthermore, as achieving sustainable development represents the main concern for all African countries, as stated by Avom et al. [12] and Olubusoye and Musa [13], our paper includes a large sample of African countries rather than a limited number of countries that may not represent the continent as a whole.

Our findings offer more motivation for regulators and governments to develop environmental policies that integrate inclusive finance to meet sustainable development goals. Findings are important as they can help policymakers, investors, and regulators evaluate and better comprehend the possible moderating impact of governance quality in the relationship between inclusive finance and environmental change.

The rest of the paper is organized as follows: African facts are stylized and displayed in Section 2. Section 3 presents the literature review and hypotheses. We describe our data and methodology in Section 4. Section 5 presents the empirical findings. In Section 6, the paper reaches its conclusion.

2. Stylized Facts in Africa

The primary tool of the governance structure is the African Union Constitutive Act. It outlines the African Union's institutional policies, organizational structure, goals, and guiding ideals. It outlines the universal standards, values, and norms related to human rights, national autonomy, international cooperation, peace and security, and good governance. The African Union Constitutive Act also supports the promotion of sustainable development on an economic, social, and cultural level, as well as the integration of African economies.

The African Union Constitutive Act seeks to achieve greater unity and solidarity among African nations and peoples; to defend the sovereignty, territorial integrity, and independence of its Member States; to accelerate the political and socioeconomic integration of the continent; to promote and defend African common positions on issues of concern to the continent and its peoples; to encourage international cooperation; to raise democratic values, institutions, public participation, and good governance; to protect human and peoples' rights in accordance with the African Charter on Human and Peoples' Rights and

other relevant human rights instruments; and to stimulate peace, security, and stability on the continent (Article 3 of the Constitutive Act).

Over the past three decades, African countries have experienced a variety of problems, including population growth, wars, high levels of national debt, natural disasters, diseases, and environmental change. Climate change, the uncontrolled growth of cities, and pollution from transport and industry are likely to exacerbate poverty, the deterioration of the environment, and the general state of health of the populace over the course of the next 30 years.

Africa has had some of the world's fastest economic growth since the 1990s, which has been accompanied by the expansion of financial services, particularly the availability of commercial bank deposit services. However, this development has not been sufficiently significant to ensure growth sustainability. In several countries, the financial sector and financial instruments are still insufficient, and financial inclusion the extent to which the majority of the population has access to financial products and services remains low. Worldwide Governance Indicators Database presents the six dimensions of government quality (e.g., the rule of law, regulatory quality, political stability and absence of violence/terrorism, government effectiveness, voice and accountability, and control for corruption) developed by Kaufmann et al. [14] in the Middle East and North Africa (MENA) and sub-Saharan Africa.

3. Literature Review

Financial inclusion is defined as all equality and fairness in the provision of affordable formal financial services to all individuals and businesses [15]. According to financial inclusion theories, inequality, and economic growth are significantly associated with financial inclusion [16,17]. Recently, when developing policies, several governments have given the relationship between financial inclusion and economic considerations a high priority [18–20].

Research outlines how financial development supports economic growth through the contributions of Schumpeter, Shaw, and Mckinnon [21–23], who provide a solid theoretical framework for understanding the connection between financial development and economic growth. The underlying concept is that the financial sector is one of the cornerstones in evaluating trends in economic growth. It is crucial in the allocation of an economy's limited resources since it offers accessible financial services and promotes economic growth [24,25]. The positive effect of financial inclusion on economic growth is seen in the relationship between individuals and businesses on the one side and banks and other financial organizations on the other, as described by Kablana and Chhikara [26] and Azali et al. [27]. For people, it is a crucial way to obtain the funds needed to assess fundamental services, including healthcare, education, and consumer goods [28]. As more individuals enter the financial industry, it will become more stable due to the development of new credit facilities and other commercial activities, allowing for the launch of a variety of financial products and services as financial organizations seek steady income growth [29].

The development of a healthy economy is impacted by climate change and environmental change, which affect both financial and non-financial institutions [16,30–33]. The climate risk, which has a severe effect on individual incomes and well-being, reveals the perceived adverse impact of climate change on economic growth. Zhang et al. [34] state that the greenhouse effect is mostly generated by carbon emissions, which have grown to be one of the biggest and most important environmental issues of our time. The release of carbon dioxide (CO_2) has severe economic and societal effects in addition to causing major ecological harm. Since greenhouse gas emissions have led to issues with the global climate, researchers have started to investigate the link between financial inclusion and environmental change.

Some countries are starting to adopt reform plans to avoid the negative impact of environmental change. Ahmad and Satrovic [35] urge inclusive finance to improve the

economic agents' access to and affordability of financial services for green investment and consumption initiatives in order to achieve environmental sustainability.

Moreover, Sinha and Shahbaz; Arifin and Syahruddin [36,37] argue that by 2025, a 5% portion of Indonesia's electricity will be produced by geothermal sources, 5% by wind, biomass, hydro, and solar, and 5% by biofuel. The country launched the low-carbon development initiative (LCDI), which is expected to transform the economy with scalable and actionable policies. As a result of these interventions, by 2024 and 2045, the economy will grow consistently at 5.6% and 6.0%, respectively.

3.1. Environmental Change

Prior literature shows that inclusive finance is an important driving force for economic growth [38,39]. Moreover, environmental regulation plays the role of an important assurance for promoting sustainable and healthy economic development [38]. Theoretically, the Environmental Kuznets Curve (EKC) hypothesis shows that in the early stage of economic prosperity, economic growth is correlated with environmental change, but in the later stage, contributes to later environmental well-being when economic growth exceeds a threshold level [40,41]. However, over time, research shows that the interaction between economic growth and environmental degradation is by no means exogenous, as economic policies/variables, structural adjustment, and other activities all affect the relationship [42,43].

Regulators should devote a deeper focus to climate change and step up their efforts to mitigate it since it creates a structural threat to the financial sector. Systemic risks in the financial system are concerning and could severely harm the real economy. The empirical evidence on the potential threats of climate change on the planet is so obvious that the world needs to be conscious enough to act immediately and avert tragic effects, [44]. Both the private and public sectors worldwide recognize an urgent need to design and implement policies and procedures to fight the different risks caused by climate change and environmental change. This will contribute to reaping the economic benefits (e.g., inclusive finance, among other things) that result from providing solutions to those risks [44,45].

The association between environmental change and inclusive finance has been a crucial topic, therefore, to investigate whether the growing level of CO_2 emissions has any impact on inclusive finance or none at all. The existing literature shows that empirical studies on the impact of environmental change on inclusive finance in the context of African countries are yet scanty. According to Sadorsky [46] and Zhang [47], financial development facilitates the process for customers to get credit, encouraging them to buy energy-intensive goods like cars and driving up carbon emissions. Zhang et al. [34] use the Granger causality test, variance decomposition, and cointegration study to investigate how financial development affects carbon emissions. The analysis argues that China's financial development is one major factor influencing the rise in carbon emissions. And among other things, the size of financial intermediaries has the most influence on carbon emissions. According to Mahalik et al. [48], increased financial development facilitates the ability for businesses to obtain funds, and higher production encourages carbon emissions. Le et al. [49] further showed a positive association between financial development and CO_2 emissions.

The paper stands apart from the existing literature by bringing further investigation into the relationship between financial inclusion and environmental change by focusing on the impact of CO_2 emissions on the development of the financial sector in African countries.

Due to climate change, Africa's development will face additional obstacles and dangers in the twenty-first century. Risks to economic, and financial development will increase if the effects of climate change are not addressed in planning and management.

We expect that carbon will affect inclusive finance in Africa. However, as academics have not reached a unified conclusion in the debate on the association between inclusive finance and CO_2 emissions [50], so we cannot precise an expected sign for this relationship. Therefore, we formulate the following hypothesis:

Hypothesis 1. *Environmental change is associated with inclusive finance.*

3.2. Governance Quality

The public interest theoretical model assumes that regulation serves the "public interest" in response to public demands to correct ineffective practices and perceives regulation as a way to improve social well-being [9]. Proponents of the public interest theory argue that the enforcement of accounting rules can be improved through legal intervention. They argue that the ultimate power rests solely with governments. Public interest theory argues that markets are fragile and unlikely to function effectively. Therefore, government intervention is necessary to control and monitor markets [9,51].

The relationship between financial development and governance, particularly the quality of institutions and legal systems, is being explored in an expanding number of studies. Indeed, research has demonstrated that a legal and regulatory framework that ensures the protection of property rights and the execution of contracts is essential for financial development.

Understanding how government policies increase financial inclusion has received limited research [52]. Governments may, in fact, play a crucial role in the process of inclusion, but the connections between the two have not yet been clearly outlined. Only some recent studies, such as Muhammad et al. [53], offer preliminary analytical evidence that improved government performance improves financial inclusion while optimizing particular governmental indicators.

On the other side, it is widely acknowledged that restrictive regulatory frameworks can reduce financial inclusion by limiting the frequency of individuals engaging in financial transactions [53].

Anarfo et al. [54] find that strong conservative restrictions could have a negative influence on the goals of financial inclusion for the sub-Saharan Africa region. By analyzing the ecosystems of 43 nations, Kabakova and Plaksenkov [55] underline the significance of effective regulation and political assistance for the improvement of financial inclusion, along with other critical aspects like well-being and economic prospects. The nonlinear link between bank concentration and financial inclusion, according to Avom et al. [12], is dependent on several variables, including the degree to which property rights are safeguarded, corruption is under control, the quality of the regulatory system, and others.

Previous studies show that government intervention is fundamental, especially in African countries where governance and control are weak, to ensure the reliability of financial reporting and financial systems among other things [9,56]. These studies consider government quality in terms of the rule of law, regulatory quality, political stability and absence of violence/terrorism, government effectiveness, voice and accountability, and control for corruption based on governance dimensions developed by Kaufmann et al. [14].

Empirically, Asongu and Odhiambo [6] examine the potential moderation role of government quality in the association between environmental degradation and inclusive human development in sub-Saharan African countries during the 2000-2012 period. The authors measure environmental degradation through CO_2 emissions and government quality by the six dimensions of Kaufmann et al. [14] mentioned above. Then, the authors classify government quality into three categories: political, economic, and institutional governance. Their results show institutional governance (that includes control of corruption and the rule of law) moderates environmental degradation and inclusive human development. The corresponding interactive effect is positive, suggesting that good governance is needed to reach positive net effects. They show that institutional governance obviously reduces the adverse effects of CO_2 emissions on inclusive human development at a certain policy threshold. At the individual effect, they also show that regulation quality moderates environmental degradation to wield a negative effect on inclusive human development. Based on the arguments mentioned above, we formulate the following hypotheses:

Hypothesis 2a. *Political governance moderates the association between environmental change and inclusive finance.*

Hypothesis 2b. *Economic governance moderates the association between environmental change and inclusive finance.*

Hypothesis 2c. *Institutional governance moderates the association between environmental change and inclusive finance.*

3.3. Knowledge Gap

According to the above-mentioned literature review, there is still some debate on the theoretical and empirical implications of CO_2 emissions on the development of the financial system, and the findings are still not clear. Further, only a few recent investigations of the connection between financial inclusion and climate change are presented in the literature, such as Asongu and Odhiambo [6], and Avom et al. [12]. These studies contribute to the literature and provide helpful insights, although the results on the relationship between financial inclusion and carbon emissions are conflicting. There are primarily two gaps in the literature on this subject. Firstly, most of the research is conducted to investigate the effect of financial inclusion on CO_2 emissions, which is the inverse relationship that we are trying to investigate in this paper. Secondly, few empirical studies such as Olubusoye and Musa [13], have so far focused on Africa, the region most vulnerable to climate change. However, they ignored the potential effect of governance on the association between CO_2 emissions and economic growth.

4. Data and Methodology

4.1. Sample Data

Our study exploits a balanced panel data set for 49 selected African economies (see Table 1) from the period 1996 to 2020 to examine the effect of environmental change and governance on inclusive finance. The data was collected from World Development Indicators and International Monetary Funds. African countries excluded (4 countries: Gambia; Liberia; Somalia; Zimbabwe) is due to the non-availability of continuous country information, we lost countries without data or continuous missing data for at least 5 years. The list of countries is presented in Table 1 below.

Table 1. List of countries.

Algeria	Congo, Dem. Rep	Kenya	Nigeria
Angola	Côte d'Ivoire	Lesotho	Rwanda
Benin	Djibouti	Libya	Sao Tome and Principe
Botswana	Egypt Arab Rep	Madagascar	Senegal
Burkina Faso	Equatorial Guinea	Malawi	Seychelles
Burundi	Eritrea	Mali	Sierra Leone
Cameroon	Ethiopia	Mauritania	South Africa
Cabo Verde	Eswatini	Mauritius	Sudan
Central African Republic	Gabon	Morocco	Tanzania
Chad	Ghana	Mozambique	Togo
Comoros	Guinea	Namibia	Tunisia
Congo, Rep	Guinea-Bissau	Niger	Uganda
			Zambia

We explore a large volume of data for our analyses, allowing us to build a dynamic panel for the Generalized Method of Moments, a 2-step dynamic panel, including equations in levels and asymptotic standard errors. In comparison to the conventional fixed effect model estimate method, the Generalized Method of Moments, a 2-step dynamic panel, including equations in levels estimation is more efficient. This approach more effectively solves the endogeneity issue by using internal instruments for endogenous indicators. The equation is evaluated simultaneously in the first difference and levels in the first difference using lagged levels of the essential and independent dimensions, and in levels using the first differences of the regression equations. Furthermore, this method of analysis is

applicable for short-term time periods with a large number of cross-sectional units, which was true of the sample in this study, with the sample for this study meeting this requirement with T = 5-year periods and N = 49 (N > T).

4.2. Modeling and Equation

The study has employed panel analytical methods. The model was estimated by the Generalized Method of Moments, a 2-step dynamic panel, including equations in levels and asymptotic standard errors. This method allows for obtaining robust results and correcting the problem of endogeneity caused by measurement errors and the simultaneity of certain repressors. The model is as below:

$$FDI_{it} = \alpha + \delta_1 FDI_{it-1} + \delta_2 Gov_{it} + \delta_3 Carb_{i,t} + \delta_{4it} Mod_{i,t} + \delta_5 W_{it} + \varepsilon_{it} \quad (1)$$

where FDI_{it} represents the financial development index for country i in period t; Gov_{it} entails governance (political, economic, and institutional) for country i in period t, $Carb_{i,t}$ represents CO_2 emissions for country i in period t, Mod_{it} represents the moderator variable ("political governance*CO_2 emissions", "economic governance*CO_2 emissions" and "institutional governance*CO_2 emissions), W_{it} represents the vector of the control variables (infrastructure and technology) for country i in period t, and ε_{it} is the associated error. The study uses an econometric analysis and introduces all governance dimensions, financial development, infrastructure, technology, and environmental change. The variables' definitions are presented in Table 2 below:

Table 2. Definitions of variables and sources.

Variables	Definition	Sources
	Dependent Variable	
Financial Development Index	Financial Development Index summarizes how developed financial institutions and financial markets in terms of their depth (size and liquidity) access (ability of individuals and companies to access financial services and efficiency) (ability of institution to provide financial services at low cost and with sustainable revenue and the level of activity of capital markets).	International Monetary Fund
	Independent Variables	
Environmental Change	Environmental Change is measured by CO_2 emissions (metric tons per capita).	World Development Indicators
	Political Governance	
Voice and Accountability	Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	World Development Indicators
Political Stability and Absence of Violence/Terrorism	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism.	World Development Indicators

Table 2. *Cont.*

Variables	Definition	Sources
	Economic Governance	
Government Effectiveness	Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Development Indicators
Regulatory Quality	Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Development Indicators
	Institutional Governance	
Rule of Law	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	World Development Indicators
Control of Corruption	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	World Development Indicators
	Control Variables	
Infrastructure	Infrastructure is captured by fixed telephone subscriptions (per 100 people).	World Development Indicators
Technology	Technology is provided by individuals using the Internet (% of population).	World Development Indicators

4.2.1. Augmented Dickey–Fuller Test (ADF)

Table 3 results show that all the variables used in the model are stationary at level.

Table 3. Augmented Dickey–Fuller test.

	ADF Statistic at Level
FDI	−5.618 ***
Environmental change	−5.965 ***
Infrastructure	−5.134 ***
Technology	−8.164 ***
Political governance	−5.848 ***
Economic governance	−5.637 ***
Institutional governance	−5.745 ***

Source: The author's estimation. Note: The outcomes are reported based on augmented Dickey–Fuller tests. *** indicates significance at 1%.

4.2.2. Cross-Sectional Dependency (CD) Test

We employ Pesaran's CD test to determine whether cross-sectional dependence exists in panels with many cross-sectional units and few time-series observations [57].

Due to interconnections across countries in the same economic–social network, geographic considerations, and other unobserved variables, cross-sectional dependence is

possible in panel data regression [58]. In fact, independence or uncorrelatedness is not necessary for GMM consistency, and dynamic panel GMM estimators remain consistent [59]. Results of the Pesaran CD test in Table 4, for cross-sectional dependence, show that all $p > 5\%$, and we can accept that there is no cross-sectional dependence in the 4 models.

Table 4. Cross-sectional dependency test.

	Model 1	Model 2	Model 3	Model 4
Pesaran CD test statistic	−0.772	−0.856	−0.698	−0.447
p-value	0.440	0.392	0.485	0.655

5. Empirical Results

The purpose of the current study is to boost debates on how environmental change and governance can affect inclusive finance in African countries and how governance can moderate the nexus between environmental change and inclusive finance in Africa.

Table 5 reports the empirical results of our models.

Table 5. Models (1–4) of the dependent variable: financial development index (FDI).

		Model 1	Model 2	Model 3	Model 4
Constant		0.0133 ***	0.0193 ***	0.0193 ***	0.0204 ***
		(0.0047)	(0.0052)	(0.0057)	(0.0058)
FDI (−1)		0.9630 ***	0.9406 ***	0.9395 ***	0.9355 ***
		(0.0192)	(0.0224)	(0.0225)	(0.0230)
Environmental change		−0.0004	0.0039 **	0.0041 **	0.0047 **
		(0.0011)	(0.0016)	(0.0018)	(0.0019)
Infrastructure		0.0024 **	0.0026 **	0.0017	0.0018
		(0.0011)	(0.0010)	(0.0010)	(0.0011)
Technology		0.0009 *	0.0004	0.0013 **	0.0006
		(0.0004)	(0.0005)	(0.0005)	(0.0005)
Governance	Political governance	−0.0017	0.0014	−0.0014	−0.0017
		(0.0015)	(0.0016)	(0.0015)	(0.0015)
	Economic governance	0.0075 ***	0.0097 ***	0.0092 ***	0.0080 ***
		(0.0022)	(0.0022)	(0.0024)	(0.0022)
	Institutional governance	0.0011	−0.0013	0.0009	0.0030
		(0.0026)	(0.0027)	(0.0025)	(0.0027)
Environmental change*Political governance			0.0027 ***		
			(0.0006)		
Environmental change*Economic governance				0.0023 ***	
				(0.0006)	
Environmental change*Institutional governance					0.0027 ***
					(0.0006)
Time effects		YES	YES	YES	YES
Number of instruments		19	20	20	20
Test for AR (1)		−2.7490	−2.6890	−2.7489	−2.7317
		[0.0060]	[0.0072]	[0.0060]	[0.0063]
Test for AR (2)		−1.0156	−0.98136	−0.97367	−0.95735
		[0.3098]	[0.3264]	[0.3302]	[0.3384]
Sargan overidentification		11.4812	11.3831	12.3497	12.4607
		[0.1759]	[0.1809]	[0.1363]	[0.1318]
Wald (joint) test		11465.8	7981.41	8840.5	8461.39
		[0.0000]	[0.0000]	[0.0000]	[0.0000]
Wald (time dummies)		20.3004	20.0216	19.8503	23.0909
		[0.0001]	[0.0002]	[0.0002]	[0.0000]
Number of countries		49	49	49	49

Notes: Generalized method of moments. Two-step dynamic panel. The values in (.) are the Robust Std. Err. The values in [.] are the *p*-value. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Source: Authors' calculations.

The results show a positive and significant impact of environmental change on the development of financial inclusion in all models except for Model 1. Therefore, Hypothesis 1 stated above: "Hypothesis 1: Environmental change is associated with inclusive finance" is confirmed for Models 2, 3, and 4. This means that the increase in CO_2 emissions will favor financial inclusion in African countries. This finding is aligned with the results of Chirambo [8] and Olubusoye and Musa [13]. Our findings in Table 5 are aligned with the EKC hypothesis in the early stage of financial prosperity as inclusive finance is positively correlated with environmental change. The results imply that most African countries have not achieved the threshold yet. This can be explained by the fact that the high reliance on natural resources for African countries is a major cornerstone for economic and financial expansion. Compared to China, the USA, and other developed countries where there is a high level of manufacturing and industrialization activities, the latter sector in African countries remains underdeveloped. Therefore, Africa depends on natural resource extraction such as gold, oil, coal, phosphate, and copper to generate income through exportations.

African countries as a whole emit very little carbon compared to the industrialized countries that are largely responsible. However, due to the lack of resilience and poor appropriate measures of the continent, Africa will be particularly affected by the severe effects of climate change. An economy based primarily on fossil fuels and dominated by industrialized countries is the cause of unequal resource allocation. In fact, the high energy requirements for extracting natural resources and the careless disposal of chemical waste into the environment's water, land, and air can cause environmental change.

Including economic governance induces a significant and positive effect on financial inclusion in all instances. When it comes to governance indicators, African nations suffer greatly. This basically indicates the poor state of African institutional infrastructure. Therefore, an improvement in government management through good government effectiveness and regulatory quality will favor the formal institutional structures required for the expansion of the financial sector to support economic growth [60]. This finding is aligned with Ambarkhane [61], who finds that African countries struggle with poor governance, excessive political manipulation, incompetent management, poor credit quality, and an inability to manage risk afflict cooperative banks. Improving these barriers by implying good governance will promote sustainable social and financial inclusive growth.

The main motivation for examining the interaction effect between environmental change and governance on financial inclusion is due to the fact that African countries suffer from two main weaknesses: high environmental change, Olubusoye and Musa [13], and poor governance [9]. Hence, investigating the interaction effect allows us to better understand whether governance has the potential moderator role in the association between environmental change and financial inclusion in Africa. Our results show that the coefficients of the interaction between environmental change and the dimensions of governance are positive and significant at the level of 1%. Therefore, our findings confirm the Hypothesis 2 stated above.

Hypothesis 2a. *Political governance moderates the association between environmental change and inclusive finance.*

Hypothesis 2b. *Economic governance moderates the association between environmental change and inclusive finance.*

Hypothesis 2c. *Institutional governance moderates the association between environmental change and inclusive finance.*

This demonstrates that the effects of governance and environmental change on financial inclusion in Africa are linked. Integrating political, institutional, and economic governance enhances the moderator role of governance. However, the results indicate that only economic governance is positive and significant when we look at each aspect of governance separately.

Africa is viewed to be the continent most fragile and least prepared to deal with climate change. The region's limited adaptation capability due to issues and problems in national economies in education, health, infrastructures, and governance systems is what mostly drives the region's vulnerability. This explains the impact of environmental change and governance on Africa's economic growth in general and financial inclusion in particular. The moderator role of governance is strengthened when political, institutional, and economic governance are all integrated. Additionally, both in rural and urban areas of Africa, the environment is getting worse, which is causing poverty to rise and delaying growth and expansion in the financial system.

6. Conclusions and Recommendations

Financial inclusion is one of the main pillars of the expansive concept of inclusive growth. Giving low-income and other vulnerable households access to affordable, appropriate financing can assist developing nations, such as African countries, to unlock the potential of those individuals and entities that are currently completely cut out of the formal financial system and empower communities to manage the risks associated with their livelihoods [62]. Therefore, African nations should make clear political and policy signals that financial inclusion is a top priority since doing so can expand the reach of microfinance institutions, which in turn supports successful climate change management and inclusive growth.

As financial inclusion picks up, it is crucial for African countries to implement the proper strategies and techniques to bring about a turning point in carbon emissions. As economic and financial development is crucial for Africa, our research has expanded debates on the effect of environmental change and governance on inclusive finance as well as the role of governance in moderating the relationship between environmental change and inclusive finance.

The findings of the paper show that on one hand, the expansion of CO_2 emissions will support financial inclusion in African nations as they are highly reliant on the extraction of natural resources to achieve high economic growth and so far, great financial inclusion, Chirambo [8] and Olubusoye and Musa [13]. On the other hand, the results indicate that an improvement in only economic governance through good government effectiveness and regulatory quality will favorite the formal institutional structures required for the expansion of the financial sector but taking into account the moderator effect of the three dimensions of the governance (political, economic and institutional) will have a better impact on the development of financial inclusion [6].

Several significant policy consequences stem from our findings. First, governments should provide low-interest loans and tax deductions for buying and installing renewable energy sources in order to encourage the development of renewable energy as a substitute for traditional sources of energy. A local renewable energy deployment strategy that defines the government's main goals in this area can be adopted by each nation as well. In addition, governments may decide to introduce laws mandating some limitations on the energy used. Incentives for bioenergy or hydropower producers may be used. It becomes critical to implement laws that support the spread of renewable energy technologies across sectors.

Our findings offer more motivation for regulators and governments to develop environmental policies that integrate inclusive finance to meet sustainable development goals. Our results are important as they can help regulators, investors, and policymakers to assess and better understand the potential moderation role of governance quality in the relationship between inclusive finance and environmental change. A national recovery strategy that clearly defines the responsibilities of the African governments should include inclusive finance. In a hostile, unstable, and violent atmosphere, a financial system would not survive. Governments frequently find themselves unable to take the lead during the transition period when fragility is high because of their poor capacity to develop and implement national recovery policies. If there is sufficient coordination, harmonization,

and sequencing of activities, including the graduating leadership of governments as they gain more capability, international support can help a country out of fragility.

We acknowledge certain limitations of our study. While we focus on an understudied and worthy context, the results of this study may not be generalized for other jurisdictions as Africa could be considered a unique context. Future research could complement our study. In fact, future studies may consider other contexts such as Middle East and North African countries or Gulf Cooperation Countries as they may document different results.

Author Contributions: Conceptualization, H.B., F.M. and J.B.; methodology and software, F.M. and M.M.M.; validation, H.B., F.M. and J.B.; formal analysis and investigation, H.B., F.M. and J.B.; data curation, M.M.M. and F.M.; writing original draft preparation, H.B., F.M. and J.B.; writing—review and editing, H.B., F.M., M.M.M. and J.B.; visualization, BH., F.M., M.M.M. and J.B.; funding acquisition, F.M. All authors have read and agreed to the published version of the manuscript.

Funding: Princess Nourah bint Abdulrahman University Researchers Supporting Project number (PNURSP2023R260), Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available on reasonable request.

Acknowledgments: All authors acknowledge funding support given by Princess Nourah bint Abdulrahman University Researchers Supporting Project number (PNURSP2023R260), Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia.

Conflicts of Interest: The authors declare no conflict of interest.

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