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Corporate Finance, Industrial Performance and Environment in Africa: Lessons for Policy

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Abstract

This study employs the Pool Mean Group framework to investigate the impact of corporate finance and industrial performance on pollution in Africa between 1990 and 2020. The study, which focuses on 36 African nations, found that corporate financing insignificantly enhances environmental quality in the short run, while it significantly worsens the environment in the long run. Also, the result shows that industrial performance exerts a negative but insignificant impact on pollution in both the short- and long-run periods. Lastly, the interaction term between corporate finance and industrial performance has a negative and significant impact on pollution in both periods. With this striking result, the study recommends that efforts should be made to promote the growth of environmentally sound production plants in the continent through the removal of credit facilitation bottlenecks.

Keywords: Corporate Finance, Industrial Performance, Pollution, Africa.
JEL Codes: G3, L25, O14, Q53

1. Introduction

The nexus between industrialisation and pollution control is topical mostly in empirical studies in developed countries due to the need to curb the global warming impacts of industrial production (see Fu et al., 2017; Wu et al., 2021; Khan et al., 2021a; Ajide & Mesagan, 2022).On the contrary, the fact that the level of industrial effluents is low in developing nations, especially in Africa makes the subject matter largely untapped. However, the efforts by African nations towards boosting their industrial capacity to produce a sustained level of economic progress means that industrialisation and pollution discourse cannot be overlooked. Else, the region can become a safe haven for industrial pollution thereby offsetting the pollution reduction gains in industrialised regions by validating the pollution haven theory. In addition to examining the nexus between industrial production and pollution, the augmenting role of corporate financing in this relationship is crucial in this study. This is hinged on the fact that the role of financial institutions in directing credits to various production outlets can shape the possible impact of the industrial sector on pollution. Thus, as firms are often faced with the questions of guaranteeing environmental sustainability through their production activities, such rhetorical questions can be better answered through an efficient corporate financing channel.

Considering this vital medium, scholars now challenge the credit providing institutions to play an active role in pollution reduction by channelling financial resources to only environmentally friendly firms. Firms must carefully choose their products and financial inputs to overcome this problem. They must also decide on the sources of financing their projects in terms of either approaching the stock exchange market, setting up a partnership, or even borrowing from creditors (Alenoghena et al., 2014; Ogbuji et al., 2020). Another paramount decision revolves around how efficiently they are to utilise such credits to promote environmental sustainability (see Kwakwa & Adusah-Poku, 2020; Tachega et al., 2021; Mesagan, 2021a). All of these, therefore, necessitates discussing the link between corporate financing and the environment.Corporate financing deals with the sources of funding corporations, businesses and industries. It also entails sourcing and increasing the volume of credits necessary for conducting their daily transactions. Thus, the transfer of funds from the commercial banks or the stock exchange markets falls in the purview of corporate financing (Levine et al., 2018). The reason is that the stock market can provide the needed boost for a company to raise cheap funds, which can help the firm to lower operating costs and increase its profit margin (Yusuf et al., 2020). Thus, the working capital or banks' credits made available to the industrial sector, to a large extent, provide support for the industrial progress in a country. Also, the level of industrial activities can provide access to cheaper sources of finance to boost economic advancement through industrial expansion.

Furthermore, when the industrial sector grows consistently, it can help to bring about the needed structural changes in the economy in terms of output growth and employment (Mesagan & Bello, 2018). The resulting output growth can increase aggregate income, boosts investment, and consequently necessitates industrial expansion. Moreover, the increase in income and investment, caused by industrial expansion, has implications for the environment in several ways. Firstly, the income effect can help to increase aggregate spending on consumption goods, which have implications for the scale effect of emissions (see Saud et al., 2019; Mesagan, 2021b). Secondly, the industrial expansion itself can make the country to become specialist in producing and emitting the 'dirty goods', thereby deepening the composition effect of emissions (see Copeland & Taylor, 2004; Ertugrul et al., 2016). Thirdly, the investment expansion generated can boost the emissions of green-house-gases (GHGs) that the people are exposed to, thereby further intensifying environmental pollution in the country (see Al-Ayouty et al., 2016; Mesagan et al., 2018). However, whatever is the situation, the nature and usage of finances by firms to boost industrial output have implications for pollution.

Moreover, this is consequent that industrial expansion, occasioned by the level of financing, can contribute immensely to the volume of emissions and increase environmental degradation. For instance, financially constrained companies may try to skimp capital by rationing their available credits for competing projects. Such cost-cutting tactics can make the firms engage in harmful practices to the environment. Several studies, like Sims et al. (2003), Tang and Tan (2015), Mesagan and Nwachukwu (2018), Levine et al. (2018), support the notion that the financial capacity of firms is an essential determinant of environmental pollution. This brings to the fore the connection between corporate finance, industrial development and environmental pollution. Moreover, pollution control in the African region is recently attracting scholarly and governmental attention in the quest to reduce global warming below 2^0C, as suggested by the Paris agreement. This is the motivation for the present study. To this end, the question then arises as to what impact corporate finance has on environmental pollution in Africa? Conversely, does industrial development strongly influence Africa's pollution? Also, how can the interaction between corporate finance and industrial performance be used to neutralise the threat of environmental pollution in the African region? These and other essential issues take the central stage in this scientific enquiry.

Our contribution is in two folds. First, the study's analysis of industrial sector contribution to Africa's pollution is innovative. Second, the study's interaction of corporate finance with industrial performance to determine how the interplay between firms' credits and their productivity can improve pollution is also innovative. Our study can also help to stimulate further research in this realm, especially for developing nations with low industrial production capacity. This is crucial because industrial pollution across the world is an issue that should be treated with seriousness if the quest to sustain global environmental sustainability and reduce global warming below 2^0C is to be realised. It is inadequate for environmental studies to neglect low industrial development regions and beam searchlight only on heavily industrialised regions because there could be a carbon emission convergence over time since pollution has transboundary impacts. After this section, section 2 examines the opinions of previous related studies, section 3 presents the methodology, section 4 displays the findings, while section 5 concludes the study and recommends appropriate policies.

2. Brief Literature Review

In this segment, we review relevant literature in the parlance of financing, industrial performance and environmental pollution. The review is considered along three strands. The first stand focuses on financing and environmental pollution, the second strand covers industrial performance and the environment studies, while the third strand entails the finance channels for lowering pollution. On the first strand, Tamazian et al (2009) focused on the period between 1992 and 2004 in BRICS and found that income and financial development strongly and negatively influenced pollution in BRICS economies. Shahbaz et al (2016) utilized quarterly series from 1981Q1 to 2014Q2 to examine the situation in Pakistan and found that stock market financing increased environmental pollution. Also, Nasreen et al (2017) found a unidirectional causal relationship flowing from financial stability to environmental pollution in South Asian countries from 1981 to 2012. This is also alluded to by Mesagan and Nwachukwu (2018), which revealed that financing sources strongly influenced Nigeria's pollution. Furthermore, while focusing on corporate financing and pollution in the US, Levine et al. (2018) revealed that when analysed through credit supply, corporate financing worsened the level of corporate pollution. Asongu and Odhiambo (2020) used GMM and Quintile Regressions technique to analyze the situation of 39 sub-Saharan African (SSA) countries from 2004 to 2014. The study confirmed that financial development reduced pollution in the SSA region through the channel of renewable energy use. Kwakwa and Adusah-Poku (2020) found that domestic credit lowered long-run pollution in South Africa from 1975 to 2014. Similarly, Zhou et al (2020) focused on green financing, growth and environment in 30 Chinese provinces. The study found that green financing improved the Chinese environmental quality but this effect varied with the level of development across the various provinces between 2010 to 2017. The study also revealed that the relationship between development and pollution can be further significantly enhanced by green finance. This is also corroborated by Khan, Riaz, Ahmed and Saeed (2021), which analysed ecological footprints and green finance in 26 Asian economies. The study observed that green finance is environmentally favourable by contributing to the reduction in the level of ecological footprints.

On the second strand, Nascimento (2001) found that manufacturing sector improved environmental quality in South Brazil. In a similar fashion, Al-Ayouty et al (2016) observed that clean manufacturing activities through technology negatively affected carbon emissions from 1990 to 2013. Mesagan et al (2019) examined the role of investment in the energy and environment nexus in BRICS. It was observed that industrial electricity consumed significantly worsened the environment while capital investment across these selected countries substantially improved their quality of environment. Also, Kwakwa and Adusah-Poku (2020) found that manufacturing performance increased long-term pollution in South Africa from 1975 to 2014. The study then suggested that the changing technical features of the country’s manufacturing activities determined the short-run pollution levels. Alhassan (2021) then related agricultural productivity to pollution in 38 Sub-Saharan African countries and found a U-shaped linkage between productivity in agro-allied firms and environmental deterioration. Also, Khan, Hou, Le, and Ali (2021) investigated the situation of top ten manufacturing countries which include the United States, China, Germany, Japan, France, the United Kingdom, India, Italy, South Korea and Mexico from 1970 to 2016.The study found that manufacturing value added positively influenced ecological footprint.

On the third strand of literature, Mol (2012) showed how the financial market mitigate carbon flow. The study revealed that financial market is significant in mitigating climate change problem. Riti et al (2017) found financial development mitigated carbon emissions through the energy use channel for 90 countries between the periods of 1980 to 2014. Recently, Yang et al (2021) focused on BRICS countries within 1990 to 2016 and found that the financial sector exerted an increased impact on environmental pollution. Also, Godil et al. (2021) considered urbanization, transportation and financial development as a mitigating factor of climate change and found financial development negatively impacted ecological footprint in Pakistan. Moreover, Wu et al (2021) focused on GDP growth and environmental quality through the mitigating role of financial development for the G7 and E7 countries. The study which analysed the period between 2010 and 2018 found that GDP growth worsened the environment but green financing mitigated the negative environmental impact emanating from income growth. In this respect, this study has now been properly situated in the literature. The reason is because while a number of empirical studies such as Nasreen et al (2017), Mesagan and Nwachukwu (2018), Zhou et al (2020), Asongu and Odhiambo (2020) and Khan et al. (2021b) have focused on the link between finance and pollution, the role of the industrial sector is largely omitted in their models. Filling this noticeable gap is central to the conduct of this study.

Regarding the theoretical channel, the environmental economics literature has predominantly been built on the tenets of the Environmental Kuznets Curve (EKC), which posits an inverted U-shaped nexus between pollution and income growth. This proposition has either been validated or refuted by scholars in different regions. For instance, Dasguta et al. (2002) opined that depending on the approach employed by a nation in regulating pollution, the diffusion of clean technology for production, and economic liberalisation, the curve might be flattening than U-shape. While considering the financial regulation channel, Mesagan & Nwachukwu (2018) invalidated the EKC in Nigeria for the CO2 emissions model. However, Boutabba (2014) analysed a similar problem regarding the role of financial development and validated the EKC in India. This is also supported by Charfeddine et al. (2018), which found the EKC proposition plausible in Qatar. Similarly, Moghadam & Dehbashi (2018) focused on the financial channel in the pollution abatement model in Iran, but the study refuted the tenets of the EKC. Therefore, as presented in studies by Andreoni & Levinson (2001), Dasgupta et al. (2002), Yang et al. (2021), and Mesagan et al. (2022), the EKC model has pollution per person as a function of GDP per person while the squared GDP per person describes the inverted U-shaped nexus between pollution and income. Thus, owing to the fact that the study entails the impact of industrial production on pollution, we capture the environment with the industrial activities part of CO_2 emissions. The theoretical channel is that corporate financing is expected to boost the level of industrial development, which would, in turn, drive the level of income in the country. With income being identified as the primary driver of pollution, as affirmed in environmental studies, the EKC provides the theoretical backing for this study.

Moreover, since it is important to have mediating channels for lowering pollution, several empirical studies were done through several channels. For instance, empirical studies such as Mol (2012), Riti et al (2017), Wu et al (2021), Yang et al (2021) and Godil et al (2021) beamed searchlight on channels like urbanization, transportation and energy use for reducing the pollution levels. However, none of these studies considered the interaction between corporate financing and industrial performance. This is the main contribution that our study brings to the environmental economics literature. In the same vein, considering the heterogeneous nature of the selected African countries in this analysis, the study employs the PMG technique, which is robust for accommodating dynamic heterogenous panels. We believe that the framework can help to produce more consistent results.

3. Methodology

With respect to the objectives of the study, we build the empirical models following the proposition of the Environmental Kuznets Curve (EKC) proposed by Kuznets (1955). The EKC posits that environmental pollution worsens at the initial stage of growth, but improves at the latter stage. This is represented as:

$$ENV_{it} = \delta_0 + \delta_1 Y_{it} + \delta_2 Y_{it}^2 + \varepsilon_{it} \quad (1)$$

In equation (1),environment (ENV) represents pollution, which is captured by industrial emissions per person, income per capita (*Y*) and its quadratic value (Y^2) are used to capture the inverted *U*-shaped nexus between pollution and growth. Since it is a panel model, i and t represent the countries and series respectively. Then, following the empirical models used in some recent finance-pollution studies such as Levin et al (2018), Saud et al (2019), Zhou et al. (2020), Mesagan et al (2021), and Yang et al. (2021), we present corporate finance and pollution equation as:

$$ENV_{it} = \delta_0 + \delta_1 Y_{it} + \delta_2 Y_{it}^2 + \delta_3 CF_{it} + \delta_4 EC_{it} + \delta_5 FDI_{it} + \delta_6 TO_{it} + \delta_7 GFCF_{it} + \varepsilon_{it} \quad (2)$$

The regressors in equation (2) includes, corporate finance (CF) proxied with the credit of banks to private sector, while the other regressors like foreign direct investment (FDI), energy consumption per capita (EC), trade openness (TO), and gross fixed capital formation (GFCF) are used for control purpose. Hence, $\delta_0, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5$ δ_6 and δ_7 are the slope coefficients of the regressors, ε_{it} is the disturbance term, while the other variables remain as earlier explained.

Based on the need to analyse the link between industrial performance and pollution, equation (1) is then extended to accommodate industrial output as follows:

$$ENV_{it} = \delta_0 + \delta_1 Y_{it} + \delta_2 Y_{it}^2 + \delta_3 IND_{it} + \delta_4 EC_{it} + \delta_5 FDI_{it} + \delta_6 TO_{it} + \delta_7 GFCF_{it} + \varepsilon_{it} \quad (3)$$

In equation (3), industrial performance (IND) is proxied with the manufacturing value added as ratio of the GDP, while the other variables remain as earlier explained. Since the main contribution of this study lies in the interplay between industrial performance and corporate finance, equation (4) is presented as:

$$ENV_{it} = \delta_0 + \delta_1 Y_{it} + \delta_2 Y_{it}^2 + \delta_3 CFIND_{it} + \delta_4 EC_{it} + \delta_5 FDI_{it} + \delta_6 TO_{it} + \delta_7 GFCF_{it} + \varepsilon_{it} \quad (4)$$

In equation (4), the study controls for the interaction between corporate finance and industrial performance as represent it with, *CFIND*. This interaction signifies the possible pollution impact of the effective sourcing and management of finance for producing industrial output. The full identification and data description is presented in Table 1.

Table 1: Variable Identification and Data Source

Variable	Identification	Description	Source
Y	Income per capita	It is captured with GDP per capita	WDI 2021
ENV	Environmental Quality	It is captured with CO_2 emissions from industrial activities measured as % of total fuel used	WDI 2021
CF	Corporate Finance	It is captured with credit to private sector in % to GDP	WDI 2021
IND	Industrial Performance	It is captured with manufacturing value added as % to GDP	WDI 2021
CFIND	Corporate Finance-Industrial Performance Interaction	It is captured with corporate financing and industrial performance	Computed
EC	Energy Consumption	It is captured with fossil fuel energy consumed per capita	WDI, 2021
FDI	Foreign Direct Investment	It is captured with foreign direct investment net inflows in % of GDP	WDI, 2021
TO	Openness to Trade	It is captured with trade in % of GDP	WDI, 2021
GFCF	Gross Fixed Capital Formation	It is captured with gross fixed capital formation in % of GDP	WDI, 2021

Source: Authors' Compilation

As presented in Table 1, the dependent variable,environment, is captured with is captured with industrial activities part of CO_2 emissions, while income per capita (Y) and its squared value (Y2) are important in the EKC model as earlier explained. Following recent study on finance and pollution by Levin et al (2018), corporate finance (CF) is proxied with the banks credit to private sector, industrial performance (IND) is proxied with the manufacturing value added as ratio of the GDP, while foreign direct investment (FDI), energy consumption per capita (EC), trade openness (TO), and gross fixed capital formation (GFCF) are used as moderating regressors. Lastly, CFIND is a derived variable representing the interplay between corporate finance and industrial performance. To conduct the analysis, the study employs the Pool Mean Group (PMG), the Mean Group (MG) and panel Dynamic Fixed effect (DFE) estimation techniques, which are the dynamic heterogeneous panel regression methods. This approach is preferable in this study because it is dynamic and overcomes the system of Generalised Method of Moments' (GMM) cross-section (N) and time (T) restriction. Also, since 36 African countries[1] are selected for analysis and these countries are not entirely homogenous, the dynamic heterogenous panel is more appropriate in this study. The method is partitioned into short run and long run impacts where the short run error correction term (ECT) captures the model's ability to return towards the long run after the short run adjustment (Pesaran et al. (1999; Eregha & Mesagan, 2020; Mesagan & Olunkwa, 2022). Hence, the ECT term of the PMG framework helps to confirm the existence of long run relationship among the regressors and their convergence to the long run. After conducting the PMG, MG, and DFE, we then use the Hausman test to choose appropriate regression to interpret. As presented in Tables 5-7, the Hausman tests are insignificant alluding to the preference for the PMG estimations. Lastly, the thirty-six African countries used in this study is based on the complete availability of data for all regressors from the World Bank covering the period of 1990 to 2020.

4. Empirical Results

Table 2 presents the panel unit root result for both homogeneous and heterogeneous panel. The essence of the test is to check the stationarity status of the panel series because nonstationary series will generate inconsistent and bias estimates leading to misleading conclusion. For the homogeneous condition, we adopt Breitung (2001) and Levin et al (2002) criteria, while both Im et al (2003) and ADF-Fisher are used for the heterogeneous condition. Evidence from both homogeneous and heterogenous processes at level, i.e. I(0), shows that

[1]Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo DR, Congo Republic, Côte d'Ivoire, Egypt, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Mali, Mauritania, Mauritius, Morocco, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Zimbabwe.

both *FDI* and trade openness are stationary at 1% using the homogeneous criteria, while *FDI, TO, ENV, GFCF, IND,* the interaction term and corporate finance are stationary at 1% and 5% levels with the heterogeneous criteria. However, income per capita, *ENV, CF, IND, EC, GFCF* and the interaction term are I(1) regressors using the homogeneous criteria while income per capita and energy consumption are I(1) regressors with the heterogeneous processes. After confirming stationarity of the variables, we present the panel cointegration in Table 3 using the KAO test.

Table 2: Tests for Panel Unit Root

Variables	**Homogeneous Criteria**				**Heterogeneous Criteria**			
	I(0)		**I(1)**		**I(0)**		**I(1)**	
	Breitung (2001)	**Levin et al. (2002)**	**Breitung (2001)**	**Levin *et al.* (2002)**	**ADF–Fisher**	**Im *et al.* (2003)**	**ADF–Fisher**	**Im *et al.* (2003)**
Y	0.2448	-1.0921	-9.9016***	-9.0629***	-1.3108	0.8004	29.486***	-8.0160***
ENV	-0.9770	-3.0652***	-10.032***	-10.280***	2.1523***	-1.8459**	28.904***	-8.0062***
CF	-1.5636**	-0.0183	-2.6953***	-4.0385***	15.817***	-4.1083***	52.485***	-9.1250***
IND	-0.4515	-2.1161***	-8.8557***	-7.3480***	2.5365***	-1.8156**	37.662***	-8.5370***
EC	-1.9183	-2.1069***	-9.8157***	-9.6311***	1.4090	-1.7359**	33.905***	-8.3602***
FDI	-5.4101***	-3.6306***	-10.600***	-9.1646***	11.521***	-5.1122***	68.238***	-9.9459***
TO	-2.1908***	-3.3531***	-10.816***	-8.7857***	4.2431***	-3.1666***	48.322***	-9.3380***
GFCF	-0.9727	-2.4756***	-6.3679***	-7.4986***	2.5903***	-2.3005***	34.648***	-8.3184***
INDCF	-2.2304***	-0.6257	-3.6393***	-5.3474***	14.077***	-3.7711***	52.933***	-9.3773***

Key: ** = $p < 0.05$ and *** = $p < 0.01$. Source: Authors' Computation

The panel co-integration estimates presented in Table 3 is done in three segments. The first shows the panel co-integration for the corporate finance and environmental pollution model. The second and third segments are for the industrial performance and environmental pollution and that for the interaction term and environmental pollution respectively. Since Table 3 reveals that the various Kao residual tests are significant at 5% and 1% significance levels, the study finds the existence of long run relationship among the regressors. Next to this is the correlation result, which is presented in Table 4.

Table 3: Kao Residual panel co-integration result

H_0: There is no co-integration	CF-ENV Model	
	t-Stat	**Prob**
ADF	-3.7677	0.0001***
Residual Variance	211.06	
HAC Variance	99.479	

H_0: There is no co-integration	IND-ENV Model	
	t-Statistic	**Probability**
ADF	-2.3603	0.0269**
Residual Variance	142712.9	
HAC Variance	94688.2	

H_0: There is no co-integration	INDCF-ENV Model	
	t-Statistic	**Probability**
ADF	-2.7281	0.0120**
Residual Variance	138690.1	
HAC Variance	94777.3	

Key: ** = $p < 0.05$ and *** = $p < 0.01$.Source: Authors' Computation

The panel correlation analysis is presented in Table 4 among the panel series to ascertain their degree of association. As shown in the Table 4, the correlation coefficients presented indicate that none of the coefficient exceeds 0.646, which is far below the benchmark of 0.80 for serious multicollinearity. This means that the level of correlation among the series reflects the absence of multicollinearity problem in the empirical model. Hence, the study goes further to present the result of the scientific enquiry in Tables 5 - 7.

Table 4: Bivariate Correlation Result

	ENV	Y	EC	IND	CF	FDI	GFCF	TO	Y2
ENV	1.000								
Y	0.642	1.000							
EC	0.515	0.354	1.000						
IND	0.223	0.277	0.122	1.000					
CF	0.646	0.520	0.561	0.116	1.000				
FDI	-0.119	-0.212	-0.049	-0.084	-0.060	1.000			
GFCF	-0.016	0.177	-0.028	0.288	-0.076	-0.064	1.000		
TO	-0.201	0.157	-0.037	0.011	0.092	0.445	0.146	1.000	
Y2	0.492	0.797	0.300	0.327	0.514	-0.129	0.345	0.267	1.000

Source: Authors' Compilation

In Tables 5 – 7, we present the panel regressions using the PMG, MG and DFE frameworks. In Table 5, we provide the result for the effect of corporate finance on environmental pollution. In Table 6, the result of industrial performance and environmental pollution is presented, while Table 7 displays that of the interaction term and environmental pollution. Regarding the Hausman (*H*) test results presented in Tables 5 - 7, we find that the probability values of the Hausman test statistics are insignificant across all the models. Specifically, it is 34.1% and 97.7% in Table 5, 1.00% and 87.2% in Table 6 and 22.6% and 81.6%in Table 7. Therefore, since the p-values of the respective *H* -Statistics exceed the 5% levels of significance, it denotes the rejection of the null hypothesis that the parameters of regression are not systematically difference. Hence, the study alludes to the pooled mean group's appropriateness. This implies that we proceed to interpret and discuss the PMG estimates in Tables 5 - 7.

Table 5: Corporate Finance and Environment in Africa

Explanatory Variables	Explained: ΔENV	ARDL (1,1,1,1,1,1)	
	PMG	**MG**	**DFE**
Long Run			
Y	-0.0002***	0.0001	0.0001
	(0.0001	(0.0005)	(0.0031)
Y2	0.1225	-1.7351	0.0163*
	(0.1127)	(1.4511)	(0.0109)
CF	0.0577***	-0.0155	0.0330***
	(0.0105)	(0.0430)	(0.0084)
EC	-0.1009	-1.7381	0.0654
	(0.0990)	(0.5093)	(0.0954)
FDI	0.0073	0.1752**	0.0050
	(0.0155)	(0.0812)	(0.0300)
TO	0.0020	0.0059	0.0007
	(0.0027)	(0.0260)	(0.0062)
GFCF	-0.0066	0.0388	-0.0007
	(0.0075)	(0.0594)	(0.0134)
Short Run			
ECT	-0.2700***	-0.6762***	-0.5629***
	(0.1021)	(0.0903)	(0.0604)
Y	0.0001	0.0002	-0.0001*
	(0.0003)	(0.0006)	(0.0001)
Y2	-0.3367	-2.1368	0.0403
	(1.3960)	(2.8744)	(0.1523)
CF	-0.0142	-0.0035	-0.0031
	(0.0096)	(0.0074)	(0.0033)
EC	0.5328**	0.6946***	0.1713***
	(0.2388)	(0.2915)	(0.0672)
FDI	-0.0472**	-0.1526	-0.0042
	(0.0255)	(0.0956)	(0.0143)
TO	0.0147***	0.0066	-0.0001
	(0.0096)	(0.0193)	(0.0036)
GFCF	-0.0739	-0.0678	-0.0129
	(0.0500)	(0.0465)	(0.0091)
Constant	0.4556	13.544	1.6407***
	(0.3293)	(8.6452)	(0.4648)
Hausman Stat.		2.25	1.19
[prob]		[0.3411]	(0.9774)

Key: * = p < 0.1, ** = p < 0.05 and *** = p < 0.01; Source: Authors' Computation

Table 5 presents the result for corporate finance and environmental pollution in Africa in the short- and long-run periods. The coefficient of corporate finance (CF) is -0.0142 in the short run, meaning that it has a negative impact on pollution. However, the long run coefficient of 0.0577 implies that corporate finance positively affects pollution in the long run. Also, the result indicates that the long run impact of corporate finance is significant while the short run impact is not. The implication is that a unit increase in corporate financing causes short term pollution to fall insignificantly by about 0.014 unit but increases long term pollution significantly by about 0.057 unit. Also, another implication is that the long run increase in

Africa's pollution exceeds the short run gain in its pollution reduction potentials considering the coefficients and the significance of the probability values. Moreover, the result in Table 6 covers industrial performance and pollution for both periods. The coefficient of industrial performance (IND) is -0.0021 and -0.0027 respectively in the short- and long-run, meaning that it negatively impacts pollution in both periods. This is an interesting result as it shows that industrial output in Africa does not fuel the level of pollution. However, the insignificant impact of industrial performance at both short- and long-run periods is revealing. First, the interpretation is that a unit increase in industrial performance insignificantly reduces short- and long-term pollution by about 0.002 and 0.003 units respectively. This means that industrial performance has the potential to lower pollution in the continent.

Table 6: Industrial Performance and Environment in Africa

Explanatory Variables	Explained: ΔENV		ARDL (1,1,1,1,1,1)
	PMG	MG	DFE
		Long Run	
Y	0.0002**	0.0001	0.0001
	(0.0001)	(0.0006)	(0.0001)
Y2	-0.0765	-2.4117	-0.0114
	(0.0977)	(2.4109)	(0.1779)
IND	-0.0027	0.1183	0.0108
	(0.0052)	(0.0863)	(0.0136)
EC	0.4317***	-0.4957	0.0929
	(0.1522)	(0.3831)	(0.1032)
FDI	-0.0011	0.2472	0.0191
	(0.0133)	(0.1617)	(0.0321)
TO	0.0023	0.0301***	0.0006
	(0.0022)	(0.0121)	(0.0067)
GFCF	0.0033	0.0313	0.0016
	(0.0068)	(0.0781)	(0.0144)
		Short Run	
ECT	-0.2221**	-0.6457***	-0.5487***
	(0.1073)	(0.6457)	(0.0613)
Y	0.0003**	0.0002	0.0002*
	(0.0001)	(0.0004)	(0.0001)
Y2	-0.6436*	-0.1474	-0.0072
	(0.3943)	(1.4609)	(0.1606)
IND	-0.0021	-0.0729	0.0231**
	(0.0396)	(0.0742)	(0.0115)
EC	0.0396**	0.6897***	0.1794***
	(0.2309)	(0.2812)	(0.0700)
FDI	-0.0674**	-0.1411	-0.0055
	(0.0320)	(0.1085)	(0.0148)
TO	0.0082	-0.0007	-0.0009
	(0.0088)	(0.0063)	(0.0038)
GFCF	-0.0210	-0.0508	-0.0084
	(0.0198)	(0.0361)	(0.0095)
Constant	0.4786**	14.034	1.9487***
	(0.2291)	(10.138)	(0.5117)
Hausman Stat		12.05	4.30
[prob]		[1.000]	[0.872]

Key: * = p < 0.1, ** = p < 0.05 and *** = p < 0.01; Source: Authors' Computation

Furthermore, the pollution impact of the interaction between corporate finance and industrial performance presented in Table 7 for both periods is revealing. The PMG coefficient of the interaction term (INDCF) is negative in both short- and long-run periods at -0.4508 and -3.4234 respectively. However, while the short-run impact of this interplay is insignificant, the long-run impact is significant at 1% critical level. This implies that the interaction between corporate finance and industrial performance can help to lower Africa's pollution in both the short-run and long-run. Interestingly, the result suggests that the long-term impact of this interplay in lowering the continent's pollution is crucially more substantial than that of the short-run, implying that if well harnessed, corporate finance and industrial development can be important in promoting long-run environmental sustainability in Africa. Regarding the suitability of the various models in Tables 5, 7 and 7, the ECT estimates for the models are -0.2700, -0.2221 and -0.1478 respectively. Therefore, since all the ECM coefficients exhibit negative signs and are all significant at 1% significance level, it shows that the models are rightly specified and the speed of adjustment from the short-run to the long-run is 27.0%, 22.2% and 14.7% respectively.Also, regarding the EKC, the results in Table 5-7 validates the existence of the EKC in Africa, except for the long-run result in Table 5.

Table 7: Interacting role of Corporate Finance and Industrial Performance on Pollution

Explanatory Variables	**Explained: ΔENV**		**ARDL (1,1,1,1,1,1)**
	PMG	**MG**	**DFE**
		Long Run	
Y	0.0002**	0.0005	0.0001
	(0.0001)	(0.0008)	(0.0001)
Y2	-0.2495	-1.7113	-0.0679
	(0.3744)	(1.26103)	(0.1734)
INDCF	-3.4234***	-0.0764	0.5811***
	(0.4975)	(0.6863)	(0.1796)
EC	-0.2262**	-1.2408	0.0979
	(0.1122)	(-1.2408)	(0.0992)
FDI	0.0894**	0.16297**	-0.0015
	(0.0416)	(0.0874)	(0.0316)
TO	-0.0300***	0.0121	-0.0005
	(0.0083)	(0.0128)	(0.0065)
GFCF	-0.0174	0.0325	-0.0067
	(0.0215)	(0.0480)	(0.0140)

Short Run			
ECT	-0.1478***	-0.6447***	-0.5554***
	(0.0976)	(0.0909)	(0.0620)
Y	0.0001	0.0001	-0.0002*
	(0.0003)	(0.0005)	(0.0001)
Y2	-0.2639	-1.0464	0.0272
	(1.1269)	(2.0386)	(0.1572)
INDCF	-0.4508	-0.1482	-0.0024
	(0.3628)	(0.1251)	(0.0931)
EC	0.4747**	0.6516**	0.1688***
	(0.2341)	(0.3310)	(0.0689)
FDI	0.0065	-0.1223	-0.0012
	(0.0210)	(0.0864)	(0.0146)
TO	0.0214	0.0098	-0.0009
	(0 .0131)	(0.0152)	(0.0037)
GFCF	-0.0669	-0.0925	-0.0072
	(0.0465)	(0.0614)	(0.0093)
Constant	-0.7208	11.148**	1.8086***
	(0.6179)	(6.0816)	(0.5063)
Hausman Stat.		5.58	8.35
[prob]		[0.226]	[0.816]

Key: * = p < 0.1, ** = p < 0.05 and *** = p < 0.01; Source: Authors' Computation

Moreover, since panel data can be characterized by a certain level of cross-sectional dependence (CD) that can introduce policy biasedness, we present the CD test in Table 8. Thus, we adopt the Pesaran CD test, Frees test, Freidman test and Breitung-Pagan LM test. For the three models, the Pesaran CD test, Frees' test, and Friedman test for cross-sectional dependence show that there is no CD problem in the panel since the p-values are not statistically significant at 5%. Despite that, only the Breitung-Pagan LM test reveals otherwise; it is not enough to confirm the existence of CD among the panel. Therefore, we conclude that there is strong evidence to refute the presence of cross-sectional dependence in the study. This means that the study's usage of the first generation panel unit root, and the PMG, is in order.

Table 8: Cross Sectional Dependence Result

H_0: There exist a cross-sectional dependence

Test	CF-ENV Model		IND-ENV Model		INDCF-ENV Model	
	Stat	P-value	Stat	P-value	Stat	p-value
Pesaran CD test	5.787	0.306	8.066	0.352	4.817	0.299
Frees test	0.762	0.111	1.011	0.159	0.591	0.111
Friedman test	57.54	0.102	89.27	0.101	62.75	0.102
BP LM test	139.73	0.0000***	170.33	0.0000***	134.38	0.0000***

Key:** *** signifies 1% significance level.* ***Source: *Authors Computation*

In Table 9, we present the diagnostic test for all the estimated models using the various specified criteria. The Cusum and Cusum sum of square tests are all greater than the 5% critical levels (i.e., p > 0.05), it implies that panels I-III are stable and lie within the critical bounds at 5%. Also, since the Chi-Square probability of the Breusch-Godfrey LM test for the three models are greater than 0.05, it means that no evidence of serial correlation is found in the panel models. Again, the linearity tests given by the Ramsey RESET suggest that the models are linear because they exceed 5% significance levels, and the models are rightly specified. Lastly, the Jarque-Bera tests' probability values exceed the 5% critical levels, implying that the residual terms are normally distributed. Therefore, the panel models I-III are not spurious.

Table 9: Diagnostic Tests of Corporate Finance, Industrialisation and Environment

Criteria	Tests	Dependent Variable: Environmental Quality		
		CF-ENV Model	**IND-ENV Model**	**INDCF-ENV Model**
Cusum	Stability	Within Bounds	Within Bounds	Within Bounds
Cusum Sq.	Stability	Within Bounds	Within Bounds	Within Bounds
Ramsey RESET	Linearity	1.304 (0.197)	1.273 (0.205)	1.226 (0.217)
Jarque-Bera	Normality	0.826 (0.671)	1.462 (0.458)	1.247 (0.516)
Breusch-Godfrey LM	Serial Correlation	3.654 (0.161)	2.443 (0.522)	3.112 (0.132)

NOTE: The probability values (prob) of every test criterion is presented in the parenthesis, while the statistic values of each test is presented before the prob values. The Obs R-squared value of the Breusch-Godfrey LM, the Ramsey RESET, cumulative sum (Cusum), and cumulative sum of squares (Cusum sq.) are validated at 5% levels of significance. **Source:** Authors' compilation.

Discussion of Findings

The intuition from these empirical findings regarding pollution impact of the interplay between corporate finance and industrial performance are presented next. Firstly, we find that corporate finance exerts a negative and insignificant effect on pollution in the short run, while that of the long run is positively significant. The short-run impact is at variance with theoretical expectation because corporate financing is expected to boost economic productivity and consequently raise short-run pollution. However, the long-run sign conforms to expectation significantly expand pollution. This means that the long-term impact of corporate financing is substantial and that its short-term beneficial impact in lowering the continent's pollution is not sustainable. This is indicative of the fact that the financial resources provided by Africa's financial institutions cannot guarantee long-term pollution reduction. Although, there is potential for corporate finance to reduce short run pollution, it significantly increases pollution in the long run. The short-run potential pollution reduction impact of corporate financing is in consonance with Zhou et al (2020) which revealed that green financing improved the Chinese environmental quality but this effect varied with the level of development across the 30 Chinese provinces between 2010 to 2017. Furthermore, the long-run result is at variance with the results of Kwakwa and Adusah-Poku (2020) and Khan et al. (2021b). For instance, Kwakwa and Adusah-Poku (2020) found that domestic credit lowered long-run pollution in South Africa between 1975 to 2014, while Khan et al. (2021b) observed that green finance is environmentally favourable by contributing to the reduction in the level of ecological footprints. However, the long-run result is in agreement with those of Shahbaz et al (2016) and Levine et al. (2018). This is because Shahbaz et al (2016) utilized quarterly series from 1981Q1 to 2014Q2 to examine the situation in Pakistan and found that stock market financing increased environmental pollution, while Levine et al. (2018) revealed that credit supply to firms worsened the level of pollution from corporate firms in the US.

Moreover, the fact that industrial performance negatively and insignificantly impacts pollution for both periods is interesting since it indicates that industrial output in Africa does not increase pollution. This result does not conform with theoretical expectation because industrial performance is expected to boost economic productivity and consequently raise pollution. Albeit, the probable justification is because it is only industrial pollution that is used as the dependent variable rather than the overall pollution. This result implies that industrial productivity has the potential to lower industrial pollution in the continent.

However, its insignificant impact on pollution is expected owing to the low level of industrial productivity in Africa, as revealed by the low contribution of industrial output to the GDP. It also reveals that although the potential to lower both short- and long-term pollution exists, industrial output is not the major contributor to Africa's pollution. This result is in tune with those of Mesagan and Olunkwa (2020) and Mesagan, Ajide and Vo (2020), which revealed that capital invested in the African region can provide the crucial means to reduce pollution. Also, it aligns with Nascimento (2001) and Al-Ayouty et al. (2016), which both observed that manufacturing output lowered the level of pollution in Brazil and Egypt, respectively. It is, however, at variance with those of Kwakwa and Adusah-Poku (2020) and Khan et al. (2021a). Kwakwa and Adusah-Poku (2020) revealed that manufacturing performance increased long-term pollution in South Africa, while Khan et al. (2021a) observed that manufacturing value-added positively influenced ecological footprint among the top ten manufacturing nations.

Lastly, the interaction impact for both periods is revealing because it implies that green financing is operational in Africa. It also implies that if green financing is given serious attention, the interactive impact of corporate financing and industrialisation can help to lower both short- and long-term emissions. This is because after the short-term adjustment, the long-run impact of the interaction term is negative and significant. This is a major contribution to the literature because it means that the finance-industry performance interaction can help to lower Africa's pollution in both periods. Interestingly, the result suggests that the long-term impact of this interplay in lowering the continent's pollution is more substantial than that of the short-term. Implying that if well harnessed, corporate finance and industrial development can be huge in promoting long-run environmental sustainability in Africa. The economic intuition is that corporate financial institutions such as banks and stock exchanges in Africa often mobilise financial resources towards environmentally friendly industrial activities. For instance, the recent green bond being floated by several African nations such as Nigeria, Egypt, South Africa, and the likes is a good omen towards improving the interaction impact of corporate financing and industrial output on pollution. This result is in line with those of Mol (2012) and Riti et al. (2017) that financing can mitigate the flow of carbon pollution. It also corroborates Zhou et al. (2020) on confirmation that green finance is potentially suitable to lower pollution.

5. Conclusion

We employ the Pool Mean Group (PMG) framework to examine the effect of corporate finance and industrial performance on environmental quality in Africa from 1990 to 2020. The PMG, MG and panel DFE results are presented, while the Hausman results allude to the PMG as the most appropriate. The first result reveals that corporate finance negatively affects pollution in the short term, while it exerts a significant positive impact on pollution in the long run. The second result shows that industrial performance has a negative and insignificant influence on carbon emissions in both short and long-run periods. This might not be unconnected with the recent advocacy on adopting environmentally friendly production techniques in the region owing to the involvement of African countries in the task to reduce global pollution below the 2^0C mark and the United Nation's Sustainable Development Goals. However, we attribute the insignificance of the industrial impact to the low level of industrial productivity on the continent. The third result is the most striking as the interaction between financing and industrial performance is significantly negative on pollution in both periods. The decrease in industrial pollution conditioned by corporate finance is caused by the reduction in industrial emissions in Africa. It also attests to the fact that although industrial output on the continent is low, it has the potential to lower the amount of pollution vis-à-vis corporate financing. Hence, green financing for the industrial sector must be made a top priority among the countries in Africa. In ensuring this, all African nations must be encouraged to participate actively in the green bonds' initiatives, which is only being massively explored by a few large nations such as Egypt, Nigeria, South Africa and Nigeria. This can provide the needed impetus to boost green investment for environmental sustainability in the continent. Also, low-interest loans can be made available for producing plants that comply fully with environmental reduction standards in the continent. Lastly, efforts should be made to promote the growth of environmentally sound production plants in the continent through the removal of credit facilitation bottlenecks. This can be achieved through a joint action plan by the financial regulatory authorities and the financial institutions to sustain the industrial pollution reduction task. Regarding the study's limitation, since our study only focuses on the emissions from industrial activities, the story might be slightly different if the overall emissions are considered. This potential limitation should interestfuture research in this area. However, within the scope of this study and the specific research questions set out, industrial contribution to pollution fits perfectly well with what we have done.

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Third Author: Literature review, and editorial. (15%)

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