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Impact of Foreign Direct Investment on Ecological Sustainability in Ghana

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Abstract

This study conveys an empirical investigation of the link between Foreign Direct Investment (FDI) and environmental sustainability in Ghana, covering the period 1970–2021. Concerns about environmental degradation have arisen as Ghana's economy grows and FDI inflows increase. To evaluate the influence of FDI on CO2 emissions, the research uses a robust econometric framework that includes Ordinary Least Squares (OLS), Fully Modified Ordinary Least Squares (FMOLS), and Dynamic Ordinary Least Squares (DOLS) regression approaches, as well as T-bound and F-bound tests. The findings show a substantial positive relationship between FDI inflows, GDP growth, population growth, and increased CO2 emissions, indicating that economic benefits are accompanied by environmental issues, which supports the pollution haven theory. By exploring these processes, the research sheds light on the complexity of sustainable development in Ghana's rising economy.

Key Words: Ghana,Carbon Dioxide (CO2) Emission, Environmental Sustainability, Foreign Direct Investment(FDI),Economic growth.

1. Introduction

Ghana is a shining example of Foreign Direct Investment (FDI) on the African continent because of its abundance of natural resources. The country's attraction to foreign investment is not unjustified; it is based on a historically stable political environment, a welcoming investment climate, and significant economic growth potential, all of which together foster an atmosphere that is favorable to foreign investors. The industries that have historically attracted the greatest investment—mining, agriculture, and manufacturing—also happen to be those that walk a tightrope between advancing economic development and environmental preservation, even as Ghana markets itself as a hub for FDI. The flood of FDI has two effects: although it stimulates growth and job creation, it also poses serious obstacles to environmental preservation. The literature has extensively documented the empirical relationship between economic activities linked to FDI and environmental degradation. It has been observed that the extraction of natural resources is frequently associated with environmental costs, including pollution, habitat destruction, and biodiversity loss (Jenkins & Yakovleva, 2006; Zoomers, 2010).

Furthermore, the environmental Kuznets curve (EKC) hypothesis indicates that environmental degradation initially rises as an economy grows until a certain income level is reached, after which it starts to decline (Grossman & Krueger, 1991). The EKC hypothesis postulates an inverted U-shaped relationship between income levels and environmental degradation. Though these countries frequently lack the strict environmental regulations and enforcement mechanisms that can help them through the later stages of the EKC, the validity of the EKC hypothesis in the context of developing nations like Ghana is debatable (Dasgupta, Laplante, Wang, & Wheeler, 2002). Moreover, the involvement of multinational enterprises in resource extraction—a frequent consequence of FDI in developing nations—increases financial gains while concurrently elevating the risks associated with environmental conservation. Through their operations, these companies have the potential to affect local populations and ecosystems by introducing pollutants and technical developments (Lorentzen, 2008).

The document's regression analysis highlights the strong positive relationship that exists between FDI, Gross domestic product (GDP), population growth, and the rise in CO2 emissions, which is key evidence of environmental effects. These results underline the necessity of a nuanced strategy for FDI, one that incorporates environmental accountability and sustainable practices as fundamental elements of economic development strategies, in addition to providing incentives for investment (He, 2006; Frankel & Rose, 2005). Given this complicated environment, Ghana must not only seek FDI for economic development but also implement well-thought-out laws to protect its natural heritage. Not only is the story of progress and sustainability aspirational, but it is also vitally necessary. The nation must balance the conflicting demands of environmental preservation and economic growth as it advances, making sure that the advancements made thus far do not jeopardize the welfare of coming generations.

Study Area: Ghana

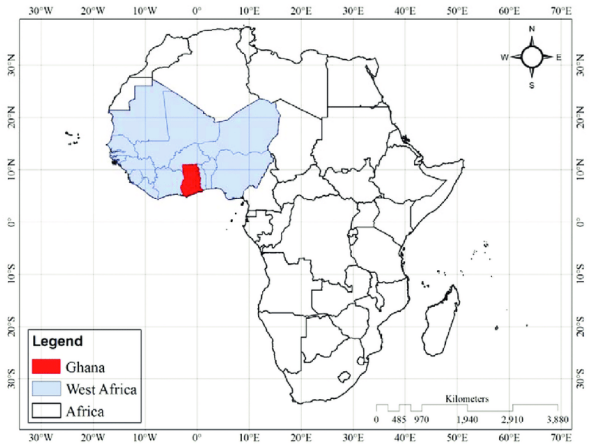


Fig.1. Map of Africa

Fig.2. Map of Ghana

Source: Google

Ghana is situated in West Africa, bordering the Gulf of Guinea and the Atlantic Ocean. The region is renowned for its abundant and varied wildlife, remote and isolated beaches, as well as historic fortifications. Ghana, having achieved independence from colonial authority in 1957, holds the distinction of being the first sub-Saharan African country to do so. Since then, it has served as a prominent example of peace and democracy within the area. The nation functions as a unitary presidential constitutional democracy and is renowned for its extensive history and cultural legacy.

Ghana possesses a substantial quantity of natural resources, which contributes to its economic prosperity. The Ghanaian economy relies heavily on gold, cocoa, and more lately, oil, which have played a crucial role in driving economic expansion. Agriculture continues to be a substantial industry, employing a considerable proportion of the population. The nation has achieved notable progress in its economic advancement, successfully turning into a lower-middle-income economy

2. Literature Review

2.1. Theoretical Review

2.1.1. Pollution Haven Hypothesis (PHH)

According to the Pollution Haven Hypothesis, FDI that produces a lot of pollution is drawn to nations with lenient environmental restrictions. This theory applies to nations like Ghana, particularly in industries like manufacturing and mining. Due to the challenges in quantifying the strictness of regulations and the interaction between pollution levels and regulation, validating this theory is difficult. Regulations have little discernible impact on industry sites, according to earlier studies; but more recent studies employing advanced techniques have identi-

fied considerable consequences. Grossman and Krueger (1991) propose that companies from developed nations should transfer their environmentally harmful operations to countries with lenient environmental legislation, as recommended by the PHH. Assessing Ghana's suitability as a location for industries, particularly in mining and heavy manufacturing, as examined by Jenkins and Yandle in 1998.

The 2004 model by (Copeland and Taylor 2004), which suggests a two-country trading framework distinguished by pollution intensity and human capital, is seminal in this field. Variations in human capital have an impact on trade, regulations, income, and pollution levels, as demonstrated by the model. According to this concept, pollution is an inevitable result of manufacturing and its management will cost money and affect how much goods are produced.

According to the Pollution Haven Hypothesis, nations with tight environmental rules experience a decrease in pollution as a result of free trade, which causes industries that produce a lot of pollution to relocate to those with laxer restrictions. An empirical investigation has been conducted to support this theory, specifically focusing on the 'pollution haven effect,' which argues that trade flows of items with high levels of pollution are affected by additional laws. This study uses this theoretical framework to investigate how FDI affects environmental sustainability in Ghana.

The classic Pollution Haven Hypothesis has been extended by recent theoretical developments, which now consider global value chains and the significance of technology transfer (Javorcik and Wei, 2022). Applying this viewpoint can help you see how Ghana fits into these global trends.

The Pollution Haven Hypothesis has evolved considerably as a result of Li and Zhou's (2021) study, particularly when considering globalization and complex investment choices. This transition suggests a more complicated, but possibly more advantageous, relationship with FDI for nations such as Ghana, especially about sustainable development and the environment.

2.1.2. Sustainable Development Objectives of FDI

The FDI and SDG links are intricate and multidimensional. Even though FDI has the potential to greatly aid in the accomplishment of the SDGs, this result is not guaranteed. It calls for well-considered laws and rules that direct FDI in the direction of sustainable ventures. Zhou (2020) and colleagues' research highlights the need to take into account the potential benefits and drawbacks of FDI in the context of sustainable development. It also highlights the necessity of strategically aligning investment flows with the more expansive goals of the Sustainable Development Goals (SDGs).

The importance of FDI in sustainable development has been highlighted by theoretical models more and more, especially in poor nations like Ghana (Kolk and Van Tulder, 2021). These models investigate how FDI can lessen its negative environmental effects while promoting sustainable economic growth.

In 2021, Yeboah, T., and K. A. Agyei published "FDI and Environmental Sustainability in Ghana: The Role of Environmental Regulations." 121, 78–88, Environmental Science and Policy. This study explores the relationship between FDI, environmental laws, and sustainability in Ghana. It provides information on how regulatory frameworks can mitigate the environmental effects of FDI.

Journal of Environmental Management, 255, 109896. Boachie, M. K., & Ramu, K. (2020). "Environmental Impacts of FDI in the Mining Sector in Sub-Saharan Africa. “This study focuses on how FDI in mining affects the environment in Sub-Saharan Africa.

2.2. Empirical Review

Asamoah et al.'s empirical study from 2021 focuses on how FDI in Ghana's mining industry degrades the environment. Their results point to a link between higher mining-related FDI and environmental hazards, such as deforestation and water pollution. A study conducted in Ghana in 2022 by Darko et al. looks at how FDI affects sustainable farming methods. They discovered that although FDI brings cutting-edge agricultural technologies, its total impact on sustainable practices is constrained by things like weak local infrastructure and lax environmental legislation.

Asiedu and Lien's (2011) study examine how FDI affects the environment in developing nations, with particular relevance to Ghana. According to their findings, depending on the industry and kind of investment, FDI can have a mixed impact on the environment. A study conducted in Ghana in 2022 by Darko et al. looks at how FDI affects sustainable farming methods. They discovered that although FDI brings cutting-edge agricultural technologies, its total impact on sustainable practices is constrained by things like weak local infrastructure and lax environmental legislation.

A study by Mensah et al. (2023) evaluated Ghana's environmental laws' efficacy in light of rising FDI. They noticed that even while rules are in existence, they are not consistently enforced, which results in varying environmental effects for various FDI projects. The social and environmental effects of FDI on Ghana's mining industry are examined in studies by Hilson and Maconachie (2020). Their findings raise concerns about the sustainability of such expenditures by bringing to light problems including pollution, community dislocation, and land deterioration.

Ofori and Lartey's (2021) research of a case study sheds light on the environmental sustainability of both problematic and successful FDI operations in Ghana. These case studies paint a nuanced picture, with some FDI projects adopting praiseworthy ecological practices and others having a major negative impact on the environment. Amponsah and Owoo's (2014) study looks at how FDI helps Ghana promote sustainable farming methods. They discovered that although FDI can bring forth sustainable technology, inadequate regulatory frameworks frequently restrict its total influence.

Boakye-Danquah et al. (2015) conducted an analysis that looks at Ghana's environmental regulatory framework for foreign direct investment. They contend that even with policies in place, there are still major obstacles to compliance and enforcement. Mensah (2014) investigated the effects of Ghana's environmental laws on FDI flows, with a focus on environmentally sensitive businesses. According to the research, although laws were getting better, enforcement was still difficult, which had an impact on how long FDI projects could last (Mensah, 2014). The environmental effects of FDI on Ghana's mining industry were studied by Akpalu and Parks (2007), who identified substantial problems with water pollution and land degradation. According to the study, FDI in the mining industry resulted in significant environmental deterioration in addition to economic growth (Akpalu & Parks, 2007).

Amponsah and Owoo's (2014) study looks at how FDI helps Ghana promote sustainable farming methods. They

discovered that although FDI can bring forth sustainable technology, inadequate regulatory frameworks frequently restrict its total influence. The social and environmental effects of FDI on Ghana's mining industry are examined in studies by Hilson and Maconachie (2020). Their findings raise concerns about the sustainability of such expenditures by bringing to light problems including pollution, community dislocation, and land deterioration. Boakye-Danquah et al. (2015) conducted an analysis that looked at Ghana's environmental regulatory framework for foreign direct investment. They contend that even with policies in place, there are still major obstacles to compliance and enforcement. Ahenkan and Boon's (2011) case study on FDI in Ghana's forestry industry sheds light on effective sustainable practices. They give instances of how foreign investment has benefited community development and environmental preservation.

The existing research suggests that there is an intricate correlation between FDI and the preservation of the environment in Ghana. FDI, or foreign direct investment, has a positive effect on economic growth. However, it can also have negative consequences on the environment, particularly when there are no strong regulations and enforcement in place. The impact of environmental policies and regulations in Ghana seems to be a crucial determinant of the sustainability of FDI. This emphasizes the necessity for more robust institutional frameworks and stricter enforcement procedures. The socio-economic ramifications of FDI, specifically in the mining and agriculture sectors, underscore the interdependence between economic progress, ecological sustainability, and societal well-being. It is essential to comprehensively address these areas to attain sustainable growth.

The amalgamation of empirical research indicates the necessity for a more equitable strategy towards FDI in Ghana, wherein the economic advantages are meticulously evaluated for the environmental and social drawbacks. Future research should prioritize investigating novel approaches that can amplify the beneficial effects of FDI while alleviating its adverse environmental repercussions. Furthermore, there is a demand for more extensive data and studies to gain a deeper understanding of the enduring effects of FDI on Ghana's environmental sustainability. This synthesis offers a comprehensive and detailed analysis of the existing research on the topic, emphasizing the intricate nature and difficulties associated with harmonizing FDI with environmental sustainability in Ghana. Therefore, this Research aims to explore the Impact of FDI on Ecological Sustainability in Ghana.

3. Methodology

The present study employed the Ordinary Least Squares (OLS) econometric technique to analyze secondary time series data covering 1970 to 2021. The World Bank and our World in Data were the sources of this information.

Table 1. Variables Description

Variables	Unit	Source
CO_2	(kt)	Our World in Data
FDI	(Current US dollars)	World Bank
GDP	(Current US dollars)	World Bank

Population	(% Total)	World Bank

This model looks into how Ghana's environmental sustainability is affected by FDI. The dependent variable in this model is carbon dioxide (CO2) emissions, which operate as a stand-in for environmental impact. The population (POP), GDP, and FDI are the model's independent variables. The functional form of the relationship is as follows.

ADRL

F-Bound test.

$$\Delta_{yt} = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta_{yt-1} + \sum_{j=0}^{q} \beta_j \, \Delta x_{t-j} + \gamma y_{t-1} + \delta' X_{t-1} + \epsilon_t \qquad (1)$$

Δ denotes the difference operator. y_t is the dependent variable at time t. x_t is a vector of independent variables at time t.α_0 is the intercept. α_i and β_j are the short-run dynamic coefficients of the model. p and q are the lag orders of the dependent variable and independent variables, respectively. γ captures the speed of adjustment back to the long-run equilibrium after a change in the dependent variable. ′δ′ is a vector of coefficients associated with the lagged level of the independent variables, representing the long-run relationship. ϵ_t is the error term.

T-Bound test

$$\Delta_{yt} = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta_{yt-1} + \sum_{j=0}^{q} \beta_j \, \Delta x_{t-j} + \gamma y_{t-1} + \epsilon_t \qquad (2)$$

Δ represents the difference operator. yt is the dependent variable at time t. xt is a vector of independent variables at time t. α0 is the intercept. αi are the coefficients for the lagged differences of the dependent variable. βj are the coefficients for the lagged differences of the independent variables. p and q represent the lag length for the dependent and independent variables, respectively. γ is the coefficient for the lagged level of the dependent variable. ϵt is the error term.

Regressions

OLS

$$y = X\beta + CO_2 + FDI + GDP + POP + \epsilon \qquad (3)$$

FMOLS Estimates

$$y_{it} = \alpha_i + \beta_1 CO_{2_{it}} + \beta_2 FDI_{it} + \beta_3 GDP_{it} + \beta_4 POP_{it} + \epsilon_{it} \qquad (4)$$

DOLS

$$y_{it} = \alpha_i + \beta_1 CO_{2_{it}} + \beta_2 FDI_{it} + \beta_3 GDP_{it} + \beta_4 POP_{it} + u_i + \epsilon_{it} \qquad (5)$$

yit is the dependent variable for entity i at time t. αi is the unique intercept for each entity (individual fixed effect). it is the vector of independent variables for entity i at time t. β is the vector of coefficients to be estimated. ϵit is the error term for entity i at time t. ui is the random effect for entity i which is assumed to be uncorrelated

with Xit and has a mean of zero.

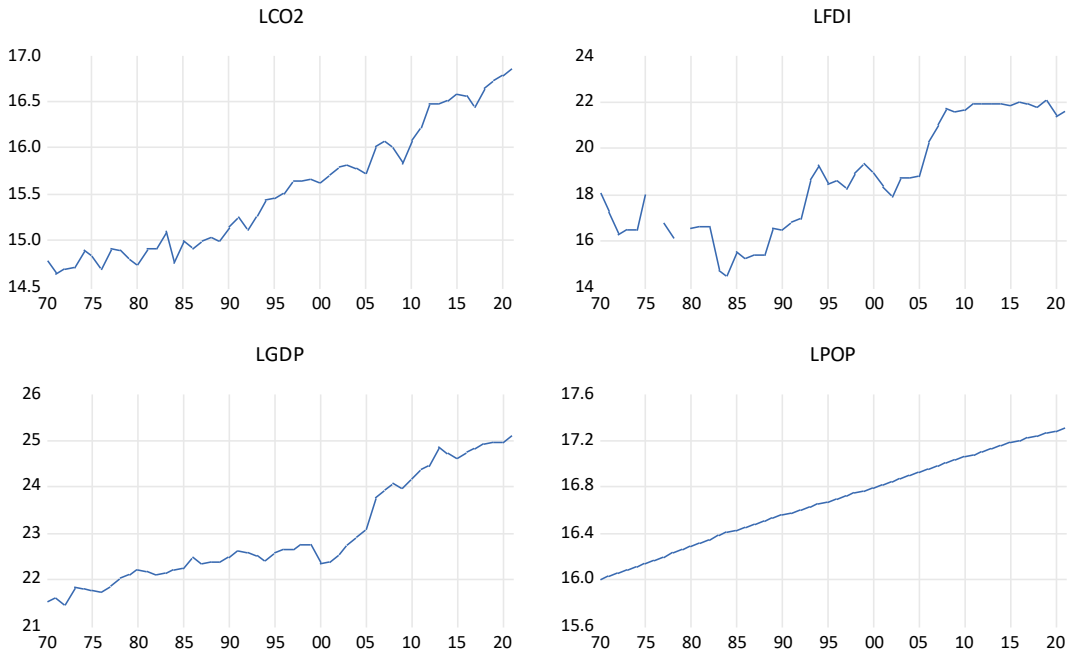
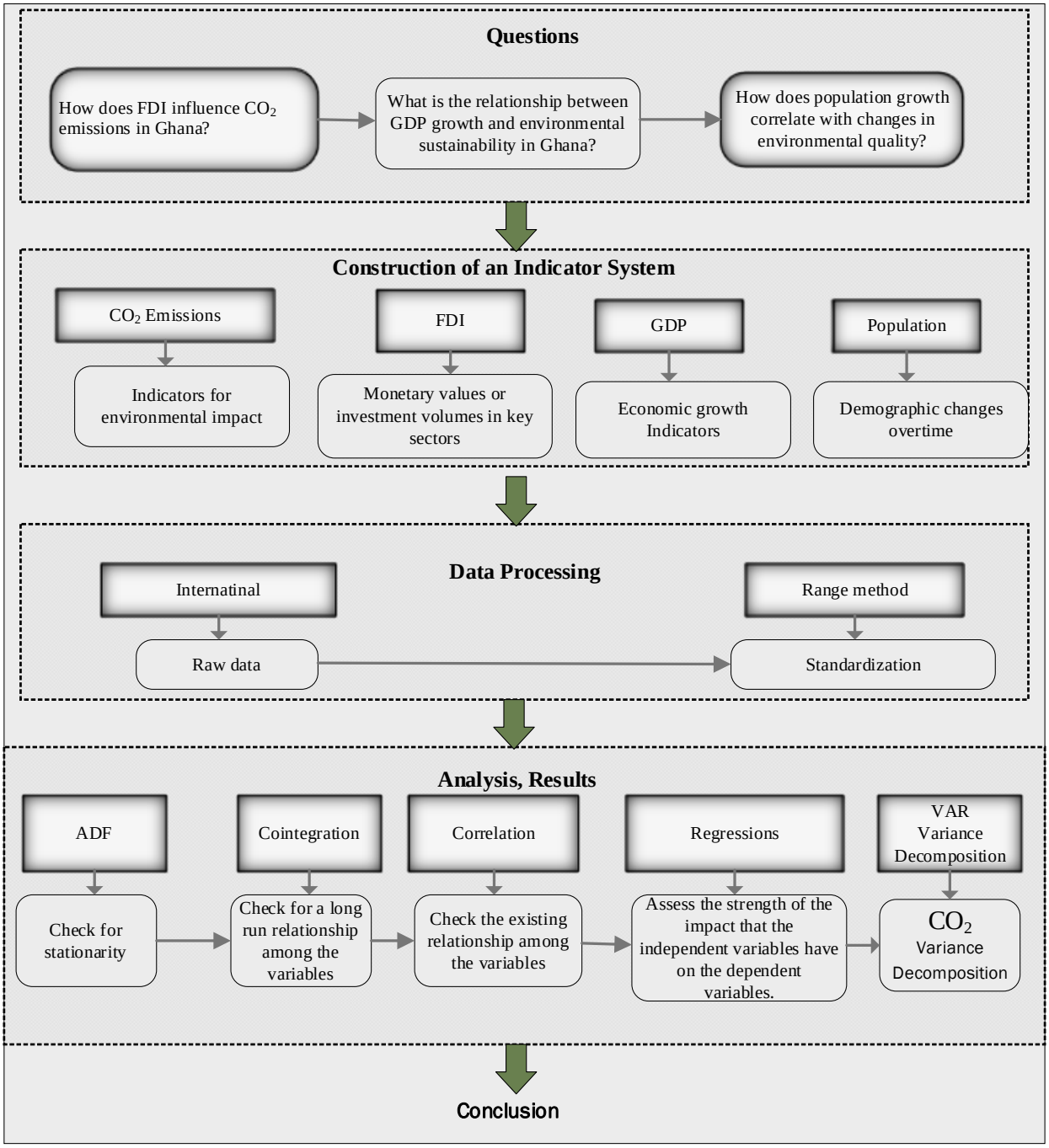


Figure.3. Trend of the Variables

CO2 has a general rising tendency throughout time. There are a few swings, but the main trend is upward. This suggests growth or of CO2. FDI is also expanding, but with more volatility. There are times when the variable drops greatly before beginning its rising trend. This shows that CO2 is susceptible to abrupt shifts or shocks, despite the fact that the long-term trend remains positive. GDP Similar to CO2, this measure exhibits a clear and consistent rising trend throughout time. The path is smoother than FDI, indicating less volatility and a steadier pace of growth. POP demonstrates the most obvious trend of all, a clear and continuous growth with almost no oscillations. This signifies consistent growth with no short-term fluctuations.



Source: Author's construction

Figure 4. Research Framework

The main components of this research structure are summarized in Figure 1, which offers a clear path from the opening inquiries to the concluding outcomes discussion. The combined insights into a logical conclusion by drawing on the results of your analysis. In the context of Ghana, this finding emphasized the difficulties and complexities of striking a balance between environmental preservation and economic progress. In addition to making policy recommendations that could help Ghana move towards a more environmentally sustainable future while still enjoying the benefits of economic development, it emphasized the necessity of sustainable approaches to foreign direct investment.

From the first inquiries to the last policy recommendations, this research trip offered a thorough grasp of the complex relationship between foreign direct investment (FDI) and environmental sustainability in Ghana. The research output produced by the structured approach—which combined a reliable indicator system with meticulous data processing and rigorous analysis—contributes to scholarly discourse and provides useful insights for stakeholders and policymakers in the field of sustainable development.

4. Model Analysis

Table 2. Augmented Dickey-Fuller Test

	ADF		PP	
	Levels	1st Difference	Levels	1st Difference
CO2	0.989	0.000	0.999	0.000
FDI	0.860	0.000	0.867	0.000
GDP	0.982	0.000	0.981	0.000
POP	0.189	0.000	0.004	0.000

For the variable CO2, both the ADF and PP tests provide p-values of about 0.989 and 0.999 at levels, indicating that the null hypothesis of non-stationarity cannot be rejected at conventional significance levels. Similarly, the p-values for FDI and GDP are around 0.860 and 0.982 for ADF at levels, and 0.867 and 0.981 for PP at levels, respectively, showing that these variables are likewise non-stationary. However, for the variable POP, there is a significant difference in p-values between levels and first differences. At these levels, the p-values are exceedingly low (0.189 for ADF and 0.004 for PP), indicating strong evidence against stationarity. However, after accounting for the first difference, both tests have p-values of 0.000, providing strong evidence of stationarity.

Table 3. F-Bounds Test Results

Test	Value	signif	I (0)	I(1)
F-statistic	6.241	10%	2.72	3.77
K	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

At all significance levels (10%, 5%, 2.5%, and 1%), the observed F-statistic of 6.241351 is significantly greater than the critical values. This finding suggests a long-term relationship between the variables (CO2, FDI, GDP, POP), as it strongly rejects the null hypothesis that there is no relationship beyond the 1% significance level.

Table 4. T-Bounds Test Results

Test	Value	signif	I(0)	I(1)
t-statistic	-5.266	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	--3.43	-4.37

At significance levels ranging from 10% to 1%, the t-statistic of -5.266 is less than or more negative than any of the crucial values that were supplied. This supports the results of the F-Bounds test, which shows that there is a statistically significant long-run relationship between the tested variables and suggests that the null hypothesis, that there is no such relationship, is rejected.

Strong evidence is presented against the null hypothesis of no levels of association by both the F-bounds and T-bounds tests. At the 1% significance level, the t-statistic is below the lower bound of the critical values and the F-statistic is significantly beyond the upper bound. These findings strongly imply that the data under analysis contains some degree of linkage. This would suggest that there is a long-term equilibrium relationship between the variables investigated, i.e., that they are cointegrated.

Table 5. Correlation Matrix

	Co2	FDI	GDP	POP
CO2	-	-	-	0.964
FDI	0.908	-	-	-
GDP	0.951	0.886	-	-
POP	0.964	0.851	0.931	-

The correlation matrix illustrates the linear correlations between CO2 emissions, foreign direct investment (FDI), GDP, and population (POP). Notably, CO2 emissions have a high positive association with both GDP (0.951) and population (0.964), showing that as economic activity and population grow, so do CO2 emissions. Furthermore, FDI (0.908) with also a significant positive correlation with CO2 emissions and GDP, implying that increasing foreign investment leads to higher CO2 emissions and economic production.

4.2. Impact of FDI on Sustainability in Ghana

The Ordinary Least Squares (OLS) approach is used to analyze the effects of FDI on environmental sustainability, starting with the stationary linear combination as a basis. The results are shown in detail below.

Table 6. Ordinary Linear Regression Result

	PLS		FMOLS		Dolc	
	Coefficients	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
FID	0.067***	0.017	0.083***	0.023	0.072***	0.030
GDP	0.139***	0.053	0.102***	0.0664	0.095***	0.082
POP	0.952***	0.137	1.003***	0.183	1.026***	0.230
R2	0.963		0.961		0.968	
Ad R2	0.960		0.958		0.954	
Prob(F-Statistics)	0.000	-			-	
Sample			1970-2021			
Obs			50			

The coefficients for FDI, GDP, and POP in all three models are consistently positive and statistically significant at conventional levels. This suggests that increases in FDI, GDP, and population are linked to greater levels of CO2 emissions. The coefficients for FDI in the models are 0.067, 0.083, and 0.072 respectively indicating that a

one-unit increase in FDI leads in a proportional rise in CO2 emissions equal to the coefficient values. Similarly, the coefficients for GDP 0.139, 0.102, and 0.095, indicating that increasing economic production correlates to higher CO2 emissions. Furthermore, the coefficients for POP 0.952,1.003 and 1.026, demonstrating that population expansion is substantially linked to increased CO2 emissions in all models. These results illustrate the enormous influence of economic activity and population dynamics on CO2 emissions, emphasising the need for sustainable development strategies to combat environmental deterioration. Furthermore, the high R-squared (96%),(96%), and(96%) respectively and modified R-squared (96%),(95%),and (95%) values across all models suggest that the models account for a significant percentage of the variation in CO2 emissions, confirming the robustness of the regression relationships.

Table 7. Variance Decomposition CO2 Emissions

Period	S.E.	CO2	FDI	LNGDP	LNPOP
1	0.115242	100.0000	0.000000	0.000000	0.000000
2	0.129381	94.86672	3.549035	1.018334	0.565906
3	0.142296	88.52397	8.701673	1.838868	0.935490
4	0.151597	81.89988	13.94902	3.006853	1.144245
5	0.158704	76.83444	17.85572	4.146415	1.163421
6	0.163901	73.08564	20.61840	5.189954	1.106005
7	0.167727	70.34947	22.52875	6.057773	1.064005
8	0.170609	68.29462	23.87228	6.729086	1.104019
9	0.172868	66.68919	24.84695	7.202152	1.261714
10	0.174729	65.37259	25.58709	7.494926	1.545394

The shocks specific to LNCO2 are responsible for the bulk of its predicted error variation in all periods. However, the percentage gradually declines from 100% in period 1 to around 65.37% in period 10. The influence of LFDI on LCO2 gradually grows over time, starting at 0% in period 1 and reaching around 25.59% by period 10. This implies that as time progresses, LFDI gains more importance as a factor influencing the variability in LCO2. The influence of LGDP on LCO2 increases over time, starting at 0% in period 1 and reaching 7.49% in period 10. This suggests a moderate impact on the variability of the forecast error for LCO2. The contribution of LPOP to the variance of forecast errors for LCO2 initially has a minimal impact, but gradually increases to around 1.55% by the tenth period.

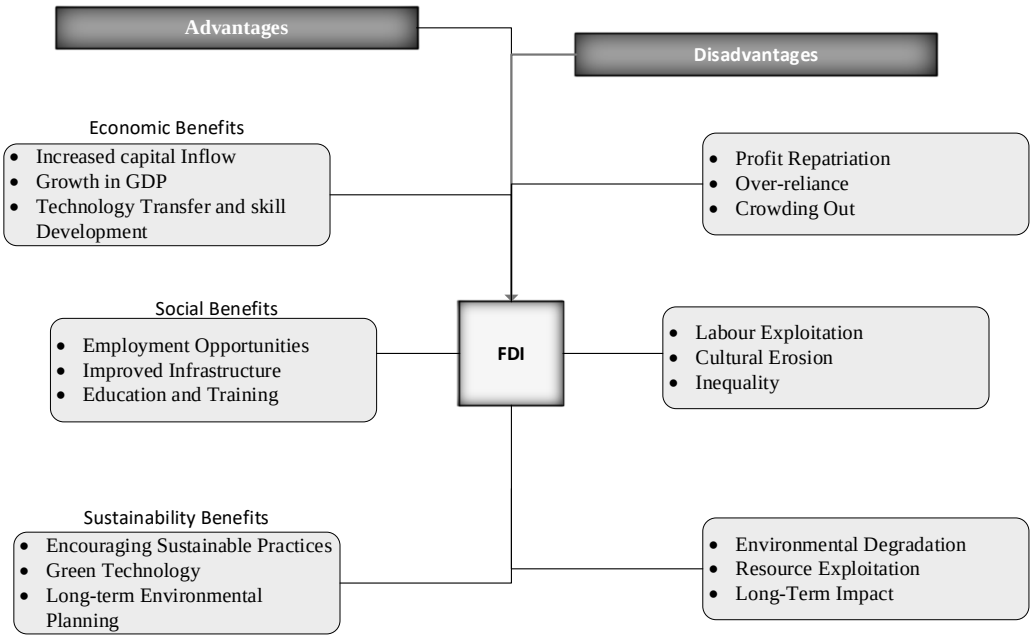
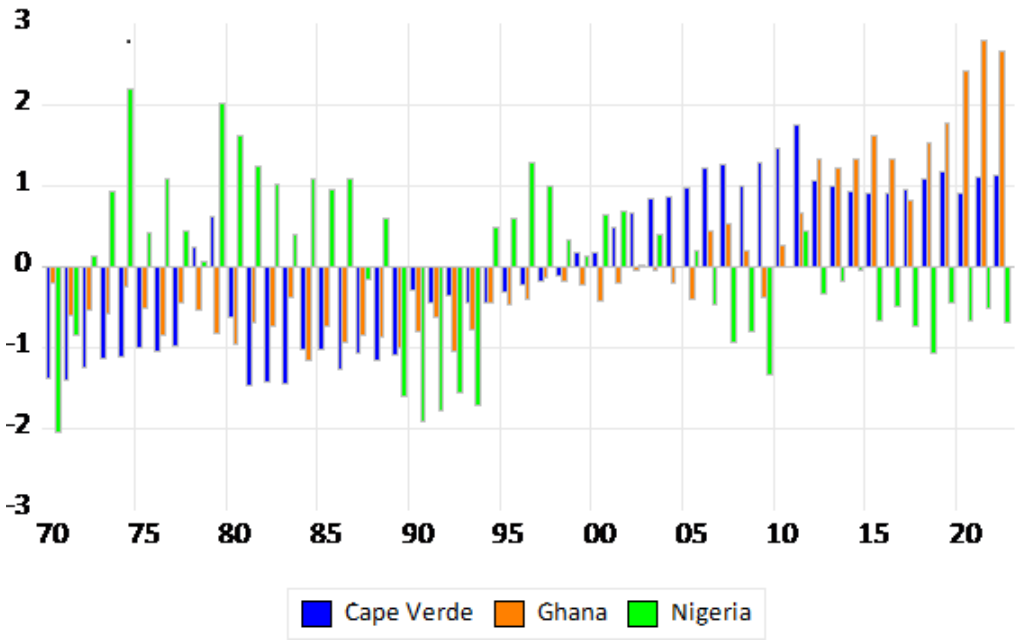


Figure 5. Benefits of FDI

Based on the analysis and findings of this study, it is clear that foreign direct investment (FDI) has both advantages and disadvantages in different areas. The impact of Foreign Direct Investment (FDI) on Ghana's economy and societal progress is mainly positive. However, the sustainability outcomes are significantly influenced by the regulatory framework and the characteristics of the investments. Effectively controlled foreign direct investment (FDI) can contribute to the achievement of sustainable development goals. However, this requires careful strategic planning and rigorous regulation to guarantee the long-term availability of resources and the protection of the environment. It is essential to combine environmental sustainability objectives with foreign direct investment (FDI) in order to fully use its capabilities. Although there are advantages, there are also substantial impediments to address, including economic, social, and environmental concerns, as well as societal and political barriers. To effectively address these drawbacks, it is crucial to handle them with careful attention, proactive involvement, strong regulatory structures, and well-thought-out strategies. The government and regulatory organizations of Ghana have a crucial role in managing the possible negative effects of foreign direct investment (FDI) while also using it to stimulate economic growth. To maximise the advantages of Foreign Direct Investment (FDI), it is crucial to create a favorable business climate and implement legislation that safeguards both social and environmental concerns.



Source: Author's construction

Figure 6 Developing countries' carbon emissions comparison (1970-2022)

The graph displays the normalized CO2 emissions statistics for three African countries—Ghana, Nigeria, and Cape Verde—from 1970 to 2022.

Cape Verde Exhibits a consistent overall increase in CO2 emissions during the given timeframe, accompanied by occasional variations. The upward trend becomes more prominent in the latter years, suggesting a potential rise in industrial activity, energy consumption, or alterations in energy production or regulation.

Ghana has a more erratic pattern characterized by substantial swings in CO2 emissions across the entire duration. There is a clear rise in emissions observed after the year 2000, indicating a period of economic expansion and heightened energy use potentially associated with industrialization.

Nigeria Displays the highest level of fluctuation in carbon dioxide emissions. The data shows that although there have been some periods of decrease, the general pattern during the early 2000s demonstrates a significant rise in emissions. This could be attributed to Nigeria's economic growth, particularly in the oil and gas industries.

General observations: Each of the three countries exhibits a rise in CO2 emissions during the 52-year period, with significant expansion in the 21st century. The emissions trend for Cape Verde is characterised by its stability and relatively lower magnitude in comparison to Ghana and Nigeria. Nigeria's emissions exhibit the most instability and the most significant growth, especially in recent years, which might be linked to its position as the major oil producer in Africa. The rise in CO2 emissions in Ghana post-2000 could be linked to swift economic growth and heightened reliance on fossil fuels. Overall, there is a rise in emissions across all three countries. However, the pace of growth, volatility, and likely underlying causes differ, indicating the distinct economic, demographic, and environmental circumstances of each country.

4.3. Research Contribution

An empirical analysis is conducted to examine the impacts of FDI in Ghana. This research provides empirical data on the environmental effects of FDI in Ghana. The analysis offers measurable data on the correlation between FDI, GDP, population increase, and carbon dioxide CO2 emissions. An empirical foundation is crucial for developing policies and comprehending the environmental impact of economic growth in developing nations. This research emphasizes the frequently neglected environmental expenses of economic expansion, particularly in developing nations like Ghana, by showing a statistical connection between economic indices and environmental degradation.

(1) Policy Implications: The results of the research provide valuable insights for the development of government policies. By showcasing the ecological consequences of economic activity supported by FDI, it lays the groundwork for the development of more equitable economic strategies that take into account environmental sustainability.

(2) Methodological Contribution: The application of regression analyses to elucidate intricate economic links offers a replicable and adaptable framework for future studies investigating the effects of economic activity on the environment.

(3) Addressing a Research Void: This study has the potential to address a void in the current body of literature by offering updated analysis or by concentrating on certain sectors within Ghana's economy that have not been thoroughly examined previously.

(4) Sustainability Discourse: This research enhances the ongoing discussion on sustainable development by highlighting the environmental impacts of FDI and promoting a harmonious equilibrium between economic progress and environmental preservation.

(5) Practical Recommendations for Sustainability: This work goes beyond academic research by proposing policy changes that have practical applications. These suggestions can aid in formulating solutions to alleviate adverse environmental effects.

(6) Awareness and Promotion: The research enhances consciousness of the importance of environmental factors in the quest for economic progress. It can function as a tool for environmental groups and other stakeholders advocating for sustainable investment practices.

5. Conclusion and Recommendations

5.1. Conclusion

The examination of the influence of foreign direct investment on environmental sustainability in Ghana has yielded persuasive evidence of the dualistic character of economic growth. The use of T-bound and F-bound tests shows the presence of a cointegrating connection between the analysed variables, laying the groundwork for the future OLS, FMOLS, and DOLS investigations. These regression methodologies consistently show that FDI, GDP, and population increase all contribute to growing CO2 emissions, raising worries about the long-term environmental consequences. The study's results support the premise that Ghana's economic success, which is powered in part by FDI, may come at a cost to the environment. As a result, FDI policies must be re-

evaluated strategically, with an emphasis on sustainable practices that may match Ghana's economic goals with environmental protection. The study recommends striking a careful balance between FDI-induced economic growth and the need to preserve ecological integrity, ensuring that Ghana's development efforts do not harm the country's environmental well-being.

5.2. Recommendations

Based on the identified correlations between FDI, GDP growth, population growth, and the rise in CO2 emissions in Ghana, it is imperative to provide numerous policy proposals to achieve sustainable development:

(1) Environmental Regulations for FDI: Implement rigorous environmental restrictions for industries that receive substantial FDI, specifically in the sectors of mining, manufacturing, and agriculture. This may involve compulsory evaluations of the environmental effects, compliance with global environmental criteria, and the adoption of optimal sustainability methods.

(2) Methods to mitigate pollution: Enforce pollution mitigation strategies that mandate industries to decrease emissions. This may entail implementing emission limits, advocating for more environmentally friendly industrial methods, and providing incentives for carbon reduction tactics.

(3) Green Investment Incentives: Promote FDI in environmentally friendly sectors by providing tax exemptions, subsidies, and additional financial benefits to encourage investments in renewable energy, waste management, and eco-friendly technologies.

(4) Sustainable Resource Management: Establish and implement policies for the sustainable management of natural resources to mitigate the risk of excessive exploitation. These activities encompass sustainable forestry, fishery management, and ethical mineral exploitation. Invest in capacity building to ensure that local authorities, businesses, and communities acquire extensive knowledge about sustainable practices. Education campaigns can enhance public knowledge and understanding of the significance of environmental conservation.

(5) Community Engagement: Incorporate local communities into decision-making processes regarding FDI projects, particularly when these initiatives have an impact on local resources. Implementing this can guarantee that development initiatives adhere to environmental and social criteria.

(6) Sustainable Urban Design: Given the correlation between population growth and heightened CO2 emissions, it is imperative to advocate for urban design strategies that integrate green spaces, foster energy efficiency, and mitigate the carbon footprint of cities. Formulate comprehensive approaches for climate change mitigation and adaptation to decrease susceptibility to the detrimental consequences of climate change.

5.3. Discussions

(1) Environmental Impacts of FDI: This entails investigating the impact of sectors that get the highest inflow of FDI, such as mining, agriculture, and manufacturing, on environmental concerns such as pollution, deforestation, and biodiversity depletion.

(2) Balancing Economic Growth with Environmental Sustainability: Discuss ideas to promote economic growth through FDI while maintaining environmental integrity and sustainability. This entails assessing the compro-

mises between the financial advantages and ecological drawbacks.

(3) Policy Responses and Regulations: Examine the necessity of strong environmental policies and regulations that oversee FDI activities. This entails assessing the efficacy of current policies and pinpointing areas where new or modified rules are necessary.

(4) The role of multinational corporations (MNCs): Analyse the role of multinational corporations (MNCs) in the preservation of the environment. Examine methods to motivate or require these organizations to embrace more environmentally friendly practices and technologies.

(5) Sustainable Investment Practices: Analyse strategies for Ghana to attract FDI that is in line with the objectives of sustainable development. This entails advocating for sustainable investments and taking environmental factors into account when making financial choices.

(6) Adaptation and Mitigation Strategies: Discuss how to lessen the adverse effects of FDI on the environment and adjust to the changes these investments bring about. These covers talk about the importance of eco-friendly technologies, sustainable agriculture, and renewable energy.

(7) Global and Regional Comparisons: Evaluate Ghana's experience in controlling the environmental implications of FDI by contrasting it with that of other nations, particularly those in Sub-Saharan Africa.

(8) Long-Term Sustainability Vision: Talk about how Ghana intends to balance FDI with environmental sustainability in the long run. Planning for environmentally friendly infrastructure and sustainable urban development falls under this category.

(9) Research and Innovation: Discuss the need for additional studies and creative solutions in the fields of environmental technology and practices to help lessen the adverse effects of FDI.

6. Limitations of the study

Scope of Data: The study encompasses data from 1970 to 2021, offering a thorough temporal perspective. Nevertheless, the dynamic characteristics of the worldwide economy and environmental regulations can necessitate the use of more up-to-date data to accurately depict the most current patterns and consequences.

External Validity: The conclusions are limited to Ghana and may not apply to other nations, particularly those with distinct economic structures, resource endowments, or environmental regulations.

Limited Variables: The research examines GDP, population, and FDI as explanatory factors, but it acknowledges that there may be additional influential factors affecting CO2 emissions, such as energy consumption habits, technical breakthroughs, or international environmental agreements, which were not taken into account in the analysis.

Environmental Measures: CO2 emissions serve as a surrogate measure for gauging environmental effects. Nevertheless, there exist additional aspects of ecological sustainability, like water quality, soil degradation, and bio-

diversity loss, that are not encompassed by this measure.

Economic Development Stages: The paper may not address the different stages of economic development in Ghana and how the relationship between FDI and environmental impact might change as the country develops.

Technological Change: The potential for technological transfer and improvements, which can mitigate the negative environmental impacts of FDI, may not be adequately represented in the study.

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