Journal of Enterprise and Development (JED)
Vol. 6, No. 3, 2024
ISSN (PRINT): 2715-3118, ISSN (ONLINE): 2685-8258

Endogenous Growth and Environmental Kuznets Curve: Lessons from FDI Impact on Economic Growth in Sub-Saharan Africa

Joseph Asante Darkwah[1], David Boohene[2,*], David Oyekunle[3], Faikai Dorley[4], Patrick Gbolonyo[5]
Fuzhou Melbourne Polytechnic, China[1]
University of Energy and Natural Resources, Ghana[2]
University of Salford, United Kingdom[3]
William V.S. Tubman University, Liberia[4]
Wilfrid Laurier University, Canada[5]
Corresponding e-mail: dboohene@gmail.com*

HISTORY

Received
31 March 2024

Revised
8 May 2024
17 May 2024
23 May 2024
29 May 2024
31 May 2024

Accepted
28 August 2024

ABSTRACT

Purpose: This study aims to determine the influence of Foreign Direct Investments (FDI) on economic growth in Sub-Saharan Africa (SSA). It examines the endogenous growth theory and the Environmental Kuznets Curve (EKC) theory, and how they relate to the regional data.

Method: Using panel quantile autoregression models, this study explores the relationship between FDI inflows into SSA with energy consumption, carbon emissions, and economic growth. The study is based on data from 1975 to 2018.

Result: The study findings conclusively demonstrate that foreign direct investment has a significant impact on the economic growth of the SSA region. Furthermore, the study reveals that energy consumption and carbon emissions in the SSA have consistently increased throughout the study period, with foreign direct investment being identified as the primary driver of this trend. These findings are consistent with the Environmental Kuznets Curve (EKC) hypothesis, as well as the endogenous growth theory, which suggests that FDI operations can have negative consequences on the host environment.

Practical Implications for Economic Growth and Development: The study suggests that Sub-Saharan Africa should manage FDI carefully to balance economic growth with environmental sustainability by promoting green investments and creating an investment-friendly environment.

Keywords: *foreign direct investment, energy consumption, carbon emissions, economic growth, endogenous growth, environmental kuznets curve*

How to cite: Darkwah, J. A., Boohene, D., Oyekunle, D., Dorley, F., & Gbolonyo, P. (2024). Endogenous Growth and Environmental Kuznets Curve: Lessons from FDI Impact on Economic Growth in Sub-Saharan Africa. *Journal of Enterprise and Development (JED)*, *6*(3), 527–540. https://doi.org/10.20414/jed.v6i3.9908

INTRODUCTION

Endogenous growth theory, developed in the late 20th century, emphasizes the role of internal factors in driving economic growth rather than external influences. In contrast to exogenous growth models, which attribute long-term economic growth to external factors like technological advancements, endogenous growth theory suggests that factors within the economy, such as human capital, innovation, and knowledge spill overs, primarily determine economic growth (Romer, 1990). Additionally, the Environmental Kuznets Curve (EKC) hypothesis proposes an inverted U-shaped relationship between environmental degradation and economic development. According to this hypothesis, as an economy grows, environmental degradation initially increases up to a certain point, after which it begins to decline as the society becomes wealthier and can afford better environmental policies and cleaner technologies (Grossman & Krueger, 1995).

Foreign direct investment (FDI) operations in the Sub-Saharan Africa (SSA) region date back to the early sixties (Agbokah et al., 2022). Over the years, a crucial question for researchers has been how these FDI inflows into the region impact the host's livelihood, including their standard of living and environmental factors such as air quality and energy consumption. Researchers believe that these factors influence the quality of life in Sub-Saharan Africa (Boohene & Darkwah, 2023a; Darkwah & Boohene, 2023; Shabani & Shahnazi, 2019; Essandoh et al., 2020; Akinlo, 2004). Previous research on the impact of FDI has also explored how it influences economic growth, the role of environmental quality, and how these dynamics interact within the framework of endogenous growth and the EKC hypothesis (Acheampong, 2018; Martínez-Zarzoso & Maruotti, 2011). For example, Borensztein et al. (1998) argue that FDI contributes to economic growth through technology transfer and human capital enhancement. They suggest that the impact of FDI on growth depends on the host country's absorptive capacity, particularly its level of human capital (Borensztein et al., 1998).

By analyzing the endogenous growth theory and the environmental Kuznets Curve (EKC) theory and how they connect to the data in the sub-Saharan region, this study seeks to ascertain the effect of FDI on socioeconomic development in SSA. In addition to providing important insights on the effects of FDI on environmental sustainability and economic growth in sub-Saharan Africa, the paper aims to explain the dynamics of endogenous growth and the Environmental Kuznets Curve.

FDI is commonly used to transfer resources to the host country in order to maximize production and generate profits in the short or long term (Darkwah et al., 2023). However, this process often creates a negative externality, as increased production can have a detrimental impact on the environment through carbon emissions resulting from high energy consumption. This poses a dilemma for many production firms and economies, highlighting the importance of researching how industrialization is affecting socioeconomic development in the sub-Saharan African region. Consequently, this research explores the relationship between FDI inflows into SSA and the nexus between energy consumption, carbon emissions, and economic growth within the sub-Saharan African region.

METHOD

To assess how foreign direct investment affects economic development, energy consumption, and carbon emissions, the authors adopted the panel quantile autoregression model using data from 17 Sub-Saharan African nations (Botswana, South Africa, Gabon, Ghana, Mauritius, Nigeria, Senegal, Tanzania, DR Congo, Republic of Congo, Ethiopia, Kenya, South Sudan, Central African Republic, Togo, Zambia, and Sudan). The investigation was conducted using data from 1975 to 2018 to measure the impact of foreign direct investment inflows on energy consumption, carbon emissions, and economic growth.

Quantile Autoregressive (QAR) Model

This study employed a quantile autoregression (QAR) as utilized by Gaglianone et al. (2018) to test for specified quantiles and distinguish between nonlinear and stationary results. The authors let $\{Ut\}$ be a series of randomly generated i.i. d. standard variables and define the autoregressive $p - th$ order procedure as follows:

$$Yt = \alpha 0(Ut) + \alpha 1(Ut-1)Yt-1 + \ldots + \alpha p(Ut-p)Yt-p,\ t = 1, 2, \ldots, n \quad (1)$$

Where $Yt = \pi t - \mu$, πt and μ represent the rates for the dependent variable and its long-run equilibrium values respectively and α is undefined parameter (0,1)

Eq. (1) is entirely rising with Ut, then the $\tau - th$ conditioned quantile parameter of Yt, which is conditional on its past dataset $It-1$ could be written as a continuous equation of $Yt-1$ with the lagged variables of Yt as follows:

$$Qyt(\tau|Yt-1, \ldots, Yt-p) = \alpha 0(\tau) + \alpha 1(\tau)Yt-1 + \ldots + \alpha p(\tau)Yp-1 = Qyt(\tau|Ft-1 = xt\alpha(\tau) \quad (2)$$

Where $Ft-1$ refers to the σ-domain holding relevant data up to period $t - 1$, $xt = (1, Yt-1, \ldots, Yt-p)$ and $\alpha(\tau) = (\alpha 0(\tau), \alpha 1(\tau), \ldots, \alpha p+1(\tau))$, with $\alpha 0(\tau)$ representing the τ^{th} quantile of ut. The $\alpha 1(\tau)$ evaluates the frequency of conditional volatility of Yt for each specified quantile.

The model in Eq. (2) has been extended to a quantile framework and introduced the following basic form of the QAR (1) model.

$$QYi,t = \alpha 0(\tau) + \alpha 1(\tau)Yi,t-1 + \alpha 2(\tau)X1i,t-1 + \alpha 3(\tau)X2i,t-1 + \alpha 4(\tau)X3i,t-1 + \varepsilon t(\tau) \quad (3)$$

Where $\varepsilon t(\tau) = Yt-1 - QYi,t(\tau|Ft-1)$ with $QYi,t(\tau|Ft-1)$ as the τ^{th} quantile of the dependent variable conditional on the information set $Ft-1$. $X1 \ldots X3$ denotes the independent variables indexed by countries i at time $t - 1$ while denotes the time in years. The authors therefore transformed the model in Eq (3) into a panel quantile autoregression model given the following models.

$$QEGRi,t = \alpha 0(\tau) + \alpha 1(\tau)EGRi,t-1 + \alpha 2(\tau)FDIi,t-1 \quad (4)$$

The effect of FDI inflow on economic growth rate (EGR) is displayed in Eq. (4)

$$QECi,t = \alpha 0(\tau) + \alpha 1(\tau)ECi,t-1 + \alpha 2(\tau)FDIi,t-1 \quad (5)$$

The effect of FDI inflow on energy consumption (EC) is displayed in Eq (5)

$$QCEi,t = \alpha 0(\tau) + \alpha 1(\tau)CEi,t-1 + \alpha 2(\tau)FDIi,t-1 \quad (6)$$

The effect of FDI inflow on carbon emission (CE) is displayed in Eq (6). Where i represents the countries index. $EGit$, $ECit$ and $CEit$ are the indicator for economic growth, energy consumption and carbon emission indexed by countries i at time $t - 1$.

Data Source and Description

Data was collected annually from the World Bank's WIR and WDI and compared to country information agencies. The number of nations sampled and the variables used were determined based on data availability. The natural logarithm was used for all variables. Table 1 provides a summary of the dataset. It is important to note that the researcher calculated the economic growth rate using the GDP of the selected countries.

Table 1. Sources and Description of Data

Variables	Description	Measurement	Source
FDI	Foreign Direct Investment	FDI Net Inflows (BOP US$)	WDI
EC	Energy Consumption	Energy Cons. Per Capita	WDI
EG	Economic Growth Rate	GDP (Current US$)	WDI
C02	Carbon Dioxide Emission	Total C02 Emissions	WDI

Source: Compiled by the authors (2024)

Hypotheses Development

Foreign Direct Investment and Economic Growth

The endogenous theory is used to explain the relationship between investment inflow in the SSA and its economic growth. There has been extensive research on the relationship between foreign direct investment and economic growth, using the growth theory of FDI. However, the findings have been inconclusive. For example, Hermes and Lensink (2003) suggest that foreign direct investment has a negative impact on economic growth. This finding is supported by Okada and Samreth (2014), who argue that foreign direct investment alone does not have a positive influence on economic growth. On the other hand, other researchers have developed models and analyzed data to demonstrate that foreign direct investment positively influences economic growth (Rao et al., 2023a; Raza et al., 2021). Therefore, based on this, the authors propose the following hypothesis:

H1: Foreign direct investment has a positive impact on economic growth in Sub-Saharan Africa

Foreign Direct Investment and Energy Consumption

By applying the Kuznets inverted-U theory, the authors suggest that FDI inflows into the SSA region increase economic activity, leading to higher levels of energy consumption. It is believed that governments in most developing countries do not sufficiently implement measures and laws to protect the environment (Alshehry & Belloumi, 2015). Even when these rules are in place, they are often not enforced. This means that the impact of FDIs on energy consumption could vary based on the geographical area and the rule of law. Since environmental laws differ, there may be mixed findings regarding the relationship between foreign direct investment and energy consumption. For example, Polat and Naci (2018) studied the BRICS countries and found that foreign direct investments have a negative impact on energy consumption. However, Rafindadi et al. (2018) established a positive impact of foreign direct investment on energy consumption in the GCC countries. What is the situation in Sub-Saharan Africa? A negative or positive impact may indirectly reflect the level of region's growth, according to Kuznets' (1955) theory. Therefore, the authors propose the following:

H2: Foreign direct investment positively influences energy consumption in Sub-Saharan Africa

Foreign Direct Investment and CO_2 Emissions

The Environmental Kuznets curve theory establishes a relationship between regional growth and its ecological footprint. When considering the developmental stage of a region, one might be tempted to believe that foreign direct investment (FDI) contributes to carbon emissions. This is based on the theory proposed by Kuznets in 1955, which suggests that wealthier regions tend to prioritize environmental protection more than struggling or poor regions. However, what does the data from the region indicate?

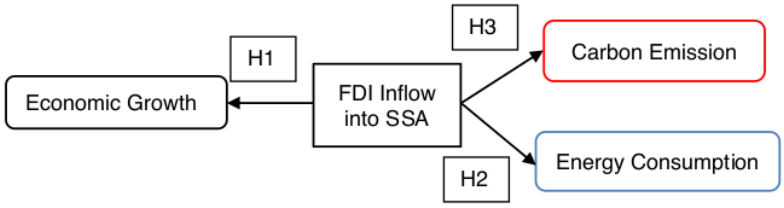
Over the past two decades, industrialization has often been blamed for carbon emissions. However, it is possible that industrialization and FDI have little to do with the recent decline in air quality. In fact, a study by He et al. (2020) found no significant relationship between FDI and carbon emissions in the BRICS countries. Could this also be the case for emerging and developing economies? According to data from the World Bank, the air quality index in sub-Saharan Africa stands at PM2.5, which refers to tiny particles or droplets in the air that are two and a half microns or less in width.

This level of air quality is far from ideal, as it exceeds the 1 percent standard set by the World Health Organization (WHO). Therefore, prompt action is necessary. It raises the question: if sub-Saharan Africa is among the least industrialized regions in the world, what is causing this poor air quality? In Nigeria, Odugbesan and Adebayo (2020) found a long-term linear relationship between foreign direct investment and carbon emissions. While this finding is concerning, it is based on a single country and may be an isolated case.

To gain a broader perspective on the subject, the authors gathered data from the region. This led to the development of the following hypothesis, which aims to find answers to the questions raised:

H3: Foreign direct investment negatively influences CO_2 emissions in Sub-Saharan Africa

Figure 1. Research Framework



Source: Developed by the authors (2024)

RESULT AND DISCUSSION

Descriptive Statistics

The results in Table 2 present the mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and the Jarque-Bera test statistics of normality. According to the results, the mean values for FDI inflow, energy consumption, CO_2 emissions, and economic growth rate were 2.150, 27.110, 27775.882, and 0.079, respectively.

These positive mean values indicate an increasing trend in all the economic variables over the study period. Additionally, the standard deviation values for all the variables, except for FDI inflow and economic growth rate, are positive and above one. FDI inflow and economic growth rate have standard deviation values less than one. CO_2 emissions are found to be the most volatile variable, followed by energy consumption, FDI inflow, and finally economic growth rate.

Moreover, the study shows a positive skewness for all the variables, while the kurtosis and the Jarque-Bera test for all the variables indicate a normal distribution at a 1% significance level for the study period.

Table 2. Descriptive Statistics

	FDI Inflow	Energy Consumption	CO_2 Emissions	Economic Growth
Mean	2.150	27.110	27775.882	0.079
Median	1.184	18.827	4080.686	0.066
Maximum	42.440	90.506	447980.000	3.052
Minimum	-10.775	0.000	187.017	-0.610
Stan. Dev.	3.871	23.747	78452.973	0.210
Skewness	4.844	1.090	3.784	5.838
Kurtosis	39.524	0.389	13.848	75.376
JB	51906.62*	153.593*	7808.255*	182329.1*

*Note: * p-value<0.01, JB=Jarque-Bera test*

Source: Processed data (2024)

Augmented Dickey-Fuller (ADF) Unit Root and Stationarity Tests

The study utilized standard stationarity and unit root tests, such as the Augmented Dickey-Fuller (ADF) and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test. These tests were employed to assess the stationarity and unit root of the panel time series variables. The goal was to accurately predict and forecast the quantile effects of the explanatory variables on the response variables.

Table 3 reveals that the null hypothesis of a unit root was rejected at all levels, as the ADF test statistic values for each variable exceeded the absolute values of the critical values for all levels of significance (1%, 5%, 10%), except for CO_2 emissions, which had a value lower than the critical values at a 1% significance level. However, the researchers did not reject the null hypothesis of stationarity in all cases of the KPSS test at all levels of significance, except for CO_2 emissions, which became stationary after first differencing.

Table 3. Panel Unit Root Test at Level and First Difference

	At Level		At 1st Difference	
Variable	**ADF**	**KPSS**	**ADF**	**KPSS**
FDI Inflow	-18.215	0.325		
Energy Consumption	-5.044	0.404		
CO_2 Emission	-3.304	1.087	-27.006	0.024
Economic Growth	-26.306	0.104		

Note: Critical Values (1%, 5%, 10%): ADF (intercept) (-3.43, -2.86, -2.57) and KPSS (intercept) (0.74, 0.46, 0.35)

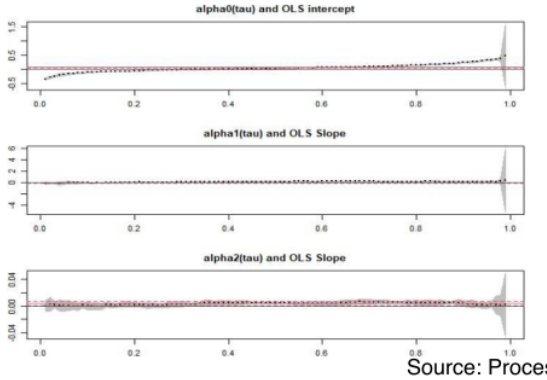
Source: Processed data (2024)

Estimation of Panel Quantile Autoregression Models for the Effect of FDI Inflow on Economic Growth Rate, Energy Consumption, and CO_2 Emission

The study measures the parameters of the quantile autoregression estimates and checks the plots of the point coefficients estimates for the various quantiles according to each model. The researchers used the simplest quantile autoregression models to estimate the point coefficients of the explanatory variables on the response variables for a range of quantiles

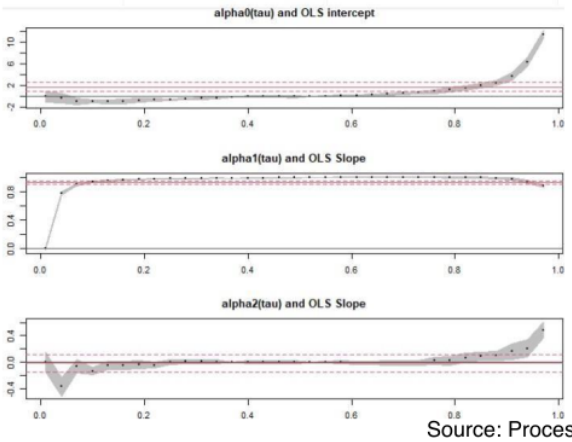
from 0.01 to 0.99, as shown in Figures 2, 3, and 4. The researchers obtained the plots after estimating the quantile autoregression models in equations (1), (2), and (3). The plots display the quantile autoregression (QAR) coefficients and ordinary least square (OLS) estimates for the impact of foreign direct investment inflow on economic growth rate, energy consumption, and CO_2 emissions. The range of quantiles is shown on the horizontal axis, and the degree of the estimated coefficients is shown on the vertical axis. The red solid and dashed lines respectively indicate the estimated and regression coefficients of the OLS slope, with their 95% confidence levels. The shaded parts represent the estimated intercept and the regression coefficients of the quantile regression models, along with their 95% confidence levels. Alpha0(tau), alpha1(tau), alpha2(tau), and alpha3(tau) denote the coefficient estimates for the constant and the explanatory variables for each model, respectively, across quantiles. The advantage of the quantile autoregression (QR) model over the ordinary least squares (OLS) model is evident from the plots.

Figure 2. Quantile Autoregression (QAR) Coefficients and Ordinary Least Squares (OLS) Estimates for the Effect of FDI Inflow on Economic Growth



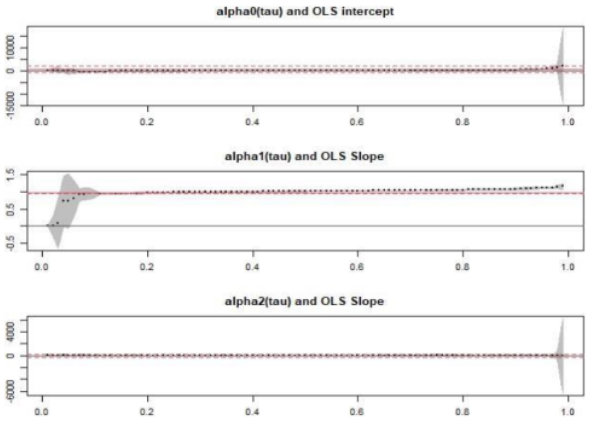
Source: Processed data (2024)

Figure 3. Quantile Autoregression (QAR) Coefficients and Ordinary Least Squares (OLS) Estimates for the Effect of FDI Inflow on Energy Consumption



Source: Processed data (2024)

Figure 4. Quantile Autoregression (QAR) Coefficients and Ordinary Least Squares (OLS) Estimates for the Effect of FDI Inflow on Carbon (CO_2) Emissions



Source: Processed data (2024)

Quantile Autoregression (QAR) Coefficient Estimation of Economic Growth

The estimated quantile coefficients for each model are presented in Table 4, Table 5, and Table 6. These results demonstrate a dynamic relationship between the estimated regression parameters of the quantile autoregression models and the respective explanatory variables at different quantiles.

Table 4. Quantile Autoregression (QAR) Coefficient Estimation of Economic Growth

		EGR (-1)	FDI (-1)
Quantile (τ)	**(τ)**	**â1(τ)**	**â2(τ)**
ΔEGRt 0.1	-0.098***	-0.014*	0.001
	7.737)	0.695)	(0.128)
0.2	-0.054***	0.102**	0.002
	(-6.458)	(1.985)	(1.005)
0.3	-0.005	0.116***	0.003
	(-0.684)	(2.726)	(1.268)
0.4	0.015***	0.190***	0.005***
	(2.987)	(5.781)	(2.984)
0.5	0.042***	0.207***	0.005***
	(6.875)	(5.604)	(04.161)
0.6	0.071***	0.246***	0.004**
	(11.054)	(6.680)	(2.140)
0.7	0.099***	0.244***	0.006***
	(11.967)	(4.641)	(2.967)
0.8	0.147***	0.226***	0.005**
	(12.916)	(12.032)	(2.492)
0.9	0.245***	0.135	0.004*
	(15.951)	(1.481)	(1.657)

*Note: ***p-value<0.01, **p-value<0.05 and *p-value<0.1. The t-values are in parenthesis ( )*

Source: Processed data (2024)

Table 4 presents the estimates of the quantile autoregression coefficients for the impact of FDI inflow on economic growth rate. Our findings indicate that the coefficients of economic growth rate at lag 1 consistently increase from quantiles 0.1 to 0.6 but decrease from quantiles 0.7 to 0.9. However, the coefficients for the economic growth rate at lag 1 were statistically significant across the specified quantiles, except for quantiles 0.1 and 0.9, where the results differ. Furthermore, we observe that the effect of FDI inflow at lag 1 on economic growth is positive across the specified quantiles and statistically significant at quantiles 0.4 to 0.9, with a significance level of 1% and 5%. However, the effect is statistically insignificant at quantiles 0.1 to 0.3. It is evident that there is a symmetric relationship between economic growth and its explanatory variables (specifically FDI inflow) at various quantile levels within its restricted distribution.

Quantile Autoregression (QAR) Coefficient Estimation of Energy Consumption

Table 5 presents the estimation of quantile autoregression coefficients for the impact of FDI inflow on energy consumption. The results reveal that the coefficients of energy consumption at lag 1 are positive and consistently increase across the specified quantiles but begin to decrease at the 0.9 quantile. However, the coefficients of energy consumption at lag 1 are statistically significant across the specified quantiles at a 1% significance level, except for the 0.9 quantile which is found to be statistically insignificant. Furthermore, the results indicate that the effect of FDI inflow at lag 1 on energy consumption is statistically significant at the 0.1, 0.06, and 0.9 quantiles at both the 1% and 5% significance levels. This clearly suggests that there is an asymmetric relationship between energy consumption and the explanatory variables (specifically FDI inflow) at different quantile levels within its restrictive distribution.

Table 5. Quantile Autoregression (QAR) Coefficient Estimation of Energy Consumption

		EC(-1)	FDI(-1)
Quantile (τ)	**(τ)**	**â1(τ)**	**â2(τ)**
ΔECt 0.1	-0.875***(-11.532)	0.944***(60.789)	-0.132***(-10.139)
0.2	0.614***	0.977***	-0.043
	(-3.260)	(109.034)	(-0.806)
0.3	-0.348***	0.989***	0.009
	(-2.710)	(198.218)	(0.245)
0.4	0.001	0.995***	0.001
	(0.0001)	(293.568)	(0.0001)
0.5	0.001	1.001***	0.001
	(0.0001)	(0.381.666)	(0.0001)
0.6	0.246***	1.005***	-0.006**
	(2.592)	(324.867)	(-1.889)
0.7	0.624***	1.006***	-0.016
	(3.809)	(226.921)	(-0.441)
0.8	1.395***	1.005***	0.017
	(5.303)	(196.147)	(0.248)
0.9	3.097***	0.994	0.112***
	(4.572)	(92.621)	(2.996)

*Note: ***p-value<0.01, **p-value<0.05 and *p-value<0.1. The t-values are in parenthesis ( )*

Source: Processed data (2024)

Quantile Autoregression (QAR) Coefficient Estimation of CO_2 Emissions

The results of the quantile autoregression coefficient estimation for the impact of FDI inflow on carbon (CO_2) emissions are displayed in Table 6. The researchers found that the

coefficients of carbon (CO_2) emissions at lag 1 are positive and monotonically increasing across the specified quantile range. Additionally, the coefficients of carbon (CO_2) emissions at lag 1 are statistically significant across the specified quantiles at a 1% significance level. The results show that the effect of FDI inflow at lag 1 on CO_2 emissions is positive and statistically significant at quantiles 0.1, 0.2, 0.6, and 0.8 at a 1% significance level. However, it is statistically insignificant across the remaining quantiles with diverse coefficients. These results clearly suggest that there is an asymmetric relationship between CO_2 emissions and the explanatory variable (FDI inflow) at different quantile levels in its restrictive distribution.

Table 6. Quantile Autoregression (QAR) Coefficient Estimation of CO_2 Emissions

		CE (-1)	FDI (-1)
Quantile (τ)	**(τ)**	**â1(τ)**	**â2(τ)**
ΔCEt 0.1	-263.366**(- 2.318)	0.940*** (14.634)	10.608*** (3.025)
0.2	-111.723**	0.971***	5.175***
	(-2.193)	(55.308)	(4.025)
0.3	-68.656*	0.995***	2.175
	(-1.703)	(108.533)	(0.493)
0.4	-20.187	1.011***	3.691
	(-0.518)	(111.959)	(0.858)
0.5	27.679	1.024***	1.889
	(0.781)	(121.429)	(0.626)
0.6	67.345**	1.033***	2.522**
	(2.207)	(172.227)	(2.998)
0.7	140.603***	1.043***	-0.176
	(3.892)	(173.266)	(-0.021)
0.8	266.245***	1.054***	8.915***
	(4.200)	(85.198)	(3.002)
0.9	544.092***	1.080***	5.345
	(4.496)	(48.590)	(0.255)

*Note: ***p-value<0.01, **p-value<0.05 and *p-value<0.1. The t-values are in parenthesis ( )*

Source: Processed data (2024)

Discussion

Effect of FDI Inflow on Economic Growth

The authors demonstrate that the SSA confirms the endogenous theory, which suggests that the inflow of investments leads to economic growth under effective management. Additionally, there is a strong relationship between FDI and economic growth in the SSA. The analyzed data reveals a significant and positive influence of foreign direct investment on economic growth at both lower and upper quantiles. This means that in the SSA, FDI influences economic growth, implying that an increase in FDI inflow will positively impact economic growth, and vice versa. These findings align with the growth theory and are supported by extensive research in this area (Adedoyin et al., 2020; Asamoah et al., 2019; Baiashvili et al., 2020; Boohene & Darkwah, 2023; Rao et al., 2023; Raza et al., 2021). Raza et al. (2021) categorically states that FDI influences economic growth in OECD countries, with the research data spanning from 1996 to 2013. Considering this, it can also be concluded that foreign direct investment inflows into the Sub-Saharan region positively influence its economic growth.

Impact of FDI Inflow on Energy Consumption

The authors examined whether the study's findings align with the EKC hypothesis, which states that energy consumption increases as the economy grows but eventually decreases after reaching a certain level of growth. Thus, the upper and lower quantiles support the EKC hypothesis.

The results of the study show that the lag 1 effect of FDI inflow on energy consumption is statistically significant. However, the impact of foreign direct investments on energy consumption varies. In the lower quantile, there is a negative relationship between FDI and energy consumption, which is consistent with the findings of Martínez-Zarzoso and Maruotti (2011). This suggests that when the magnitude of the observation decreases, an increase in foreign direct investment does not lead to an increase in energy consumption in Sub-Saharan Africa. The number of observations in the lower quantiles is fewer compared to the higher quantiles, indicating that recent data shows a negative relationship between FDI and energy consumption. This is likely because energy consumption has been increasing throughout the study period.

Therefore, an increase in FDI at the higher quantiles results in an increase in energy consumption in Sub-Saharan Africa. This conclusion suggests that the manufacturing processes associated with FDI in the region are not environmentally friendly. This could include the use of outdated manufacturing processes and mechanisms that are no longer allowed in industrialized countries or countries with stricter environmental regulations. While developing countries benefit from the income and jobs generated by FDI, special attention should be given to procedures that harm the environment in order to ensure the well-being of their inhabitants. This finding is consistent with the studies conducted by Amoako and Insaidoo (2021), Muhammad and Khan (2019), and Rafindadi et al. (2018).

Impact of FDI Inflow on Carbon Emissions

Findings from this survey on carbon emissions in the SSA confirm the Environmental Kuznets Curve hypothesis. Thus, the inflow of funds in the form of FDI is increasing carbon emissions in the region, given that the region is not wealthy. The theory is clear on the notion that poor regions will emit more carbon since they prioritize growth over the ecological footprint. The principal greenhouse gas emitted by human activity is carbon dioxide (CO_2). The primary sources of CO_2 emissions from humans are the use of fossil fuels (coal, natural gas, and oil) for energy and transportation. CO_2 is also emitted by some industrial activities and land-use changes.

Furthermore, the results from the study showed that the effect of FDI inflow at lag 1 on CO_2 emissions is positive and statistically significant at different quantiles. Therefore, this means that foreign direct investment inflow in Sub-Saharan Africa positively influences carbon emissions on both lower and upper quantiles, consistent with the EKC theory.

In this light, all efforts to promote FDI inflows exacerbate the region's carbon emissions. This demonstrates that either the regulations are insufficient to check the operations of these FDIs or they are not being implemented in the region. It must also be noted that the region is keen to alleviate poverty and generate jobs and other opportunities for its residents, which may cause them to compromise on environmental rules designed to safeguard the region from pollution and environmental degradation. However, contrary to this finding, Blanco et al. (2013) and He et al. (2020) found no robust relationship between FDI and CO_2 emissions. He et al. (2020) conducted research on the BRICS countries, and Blanco et al. (2013) worked on Latin American countries. These research regions have economic features that differ from those of Sub-Saharan Africa. This finding, however, is in line with research done by Blanco et al. (2013), Boohene & Darkwah (2023b), and Odugbesan & Adebayo (2020). Odugbesan & Adebayo (2020) used yearly data spanning from 1981 to 2016 and employed linear ARDL and non-linear ARDL techniques. Odugbesan & Adebayo (2020)'s findings from the estimations show that FDI and energy consumption have a long-run linear relationship with

CO_2 in Nigeria. This paper therefore augments Odugbesan & Adebayo (2020)'s findings to a broader spectrum, suggesting that the relation is not isolated to Nigeria but rather applies to the whole region.

CONCLUSION

The study examines the impact of foreign direct investments (FDI) on economic growth in sub-Saharan Africa (SSA) by analyzing the endogenous growth theory and the Environmental Kuznets Curve (EKC) theory, and how they relate to the data in the region. The study findings indicate that foreign direct investment significantly affects regional economic growth in SSA. Furthermore, the study reveals an increase in energy consumption and carbon emissions in the SSA during the study period, with foreign direct investment being the primary driver. These findings support both the EKC hypothesis and the endogenous growth theory. In accordance with the EKC theory, the efforts by governments in SSA to stimulate economic growth have a significant impact on the environment. Additionally, the study notes that foreign direct investment inflows into the region significantly contribute to energy consumption, which, if left uncontrolled, could have negative effects on air quality, harsher weather conditions, and more severe wet seasons.

The practical and social implications of the study's findings are noteworthy for SSA communities, businesses, and politicians. Firstly, it emphasizes the importance of attracting foreign direct investment (FDI) to enhance regional economic growth, stressing the need for implementing laws that promote an investment-friendly environment. However, it also highlights the environmental impact of increased FDI, leading to higher energy consumption and carbon emissions, which calls for the implementation of sustainable development policies. Legislators must create policies and incentives that encourage green investments and technology transfer to strike a balance between environmental preservation and economic growth. Additionally, companies operating in SSA should adopt eco-friendly practices to reduce their carbon footprint and improve the well-being of the communities they serve. In the future, systematic investigations on the impact of foreign direct investment (FDI) on the entire African continent could extend beyond the sub-Saharan African region.

REFERENCES

Acheampong, A. O. (2018). Economic Growth, CO_2 Emissions and Energy Consumption: What Causes What and Where? *Energy Economics, 74,* 677–692. https://doi.org/10.1016/J.ENECO.2018.07.022

Adedoyin, F. F., Bekun, F. V., Driha, O. M., & Balsalobre-Lorente, D. (2020). The Effects of Air Transportation, Energy, ICT and FDI on Economic Growth in the Industry 4.0 Era: Evidence from the United States. *Technological Forecasting and Social Change, 160.* https://doi.org/10.1016/j.techfore.2020.120297

Agbokah, T. E., Boohene, D., Amita, M., Darkwah, J. A., & Marfo, E. (2022). Corporate Governance and Foreign Direct Investment in Sub-Saharan Africa. *Journal of International Research in Business Studies*, *7*(2), 115-132. https://doi.org/10.6084/m9.figshare.22647655

Akinlo, A. E. (2004). Foreign Direct Investment and Growth in Nigeria: An Empirical Investigation. *Journal of Policy Modeling, 26(5),* 627–639. https://doi.org/10.1016/J.JPOLMOD.2004.04.011

Alshehry, A. S., & Belloumi, M. (2015). Energy Consumption, Carbon Dioxide Emissions and Economic Growth: The Case of Saudi Arabia. *Renewable and Sustainable Energy Reviews, 41,* 237–247. https://doi.org/10.1016/J.RSER.2014.08.004

Amoako, S., & Insaidoo, M. (2021). Symmetric Impact of FDI on Energy Consumption: Evidence from Ghana. *Energy, 223.* https://doi.org/10.1016/j.energy.2021.120005

Asamoah, L. A., Mensah, E. K., & Bondzie, E. A. (2019). Trade Openness, FDI and Economic Growth in Sub-Saharan Africa: Do Institutions Matter? *Transnational Corporations Review, 11(1),* 65–79. https://doi.org/10.1080/19186444.2019.1578156

Baiashvili, T., & Gattini, L. (2020). Impact of FDI on Economic Growth: The Role of Country Income Levels and Institutional Strength. *European Investment Bank.* https://doi.org/10.2867/846546

Blanco, L., Gonzalez, F., & Ruiz, I. (2013). The Impact of FDI on CO_2 Emissions in Latin America. *Oxford Development Studies, 41(1),* 104–121. https://doi.org/10.1080/13600818.2012.732055

Boohene, D., & Darkwah, J. (2023a). The Interconnection of Economic Growth, Carbon Dioxide Emission, Foreign Direct Investment and Energy Consumption: Evidence from Sub-Saharan Africa. *Aswan University Journal of Environmental Studies, 4(1),* 4–23. https://doi.org/10.21608/aujes.2023.168361.1099

Boohene, D., & Darkwah, J. A. (2023b). Antecedents of Foreign Direct Investment: A Review Study. *International Journal of Research in Business Studies, 8(1),* 69. https://doi.org/10.6084/m9.figshare.23600358

Borensztein, E., De Gregorio, J., & Lee, J. W. (1998). How Does Foreign Direct Investment Affect Economic Growth? *Journal of International Economics, 45(1),* 115–135. https://doi.org/10.1016/S0022-1996(97)00033-0

Darkwah, J. A., & Boohene, D. (2023). Trade Openness in China's Economy: A Review Study. *Interscience Management Review, 6(2).* https://www.interscience.in/imr/vol6/iss2/2

Darkwah, J. A., Boohene, D., Coffie, C. P. K., Addae-Nketiah, A., Maxwell, A., & Sarfo, J. O. (2023). Human Development, Corruption Control, and Foreign Direct Investment Revisited: The Case of Sub-Saharan Africa. *Journal of Enterprise and Development (JED)*, *5*(2), 137-153. https://doi.org/10.20414/jed.v5i2.6809

Essandoh, O. K., Islam, M., & Kakinaka, M. (2020). Linking International Trade and Foreign Direct Investment to CO_2 Emissions: Any Differences Between Developed and Developing Countries? *Science of the Total Environment, 712.* https://doi.org/10.1016/j.scitotenv.2019.136437

Gaglianone, W. P., Guillén, O. T. de C., & Figueiredo, F. M. R. (2018). Estimating Inflation Persistence by Quantile Autoregression with Quantile-Specific Unit Roots. *Economic Modelling, 73,* 407–430. https://doi.org/10.1016/j.econmod.2018.04.018

He, F., Chang, K. C., Li, M., Li, X., & Li, F. (2020). Bootstrap ARDL Test on the Relationship Among Trade, FDI, and CO_2 Emissions: Based on the Experience of BRICS Countries. *Sustainability, 12(3).* https://doi.org/10.3390/su12031060

Hermes, N., & Lensink, R. (2003). Foreign Direct Investment, Financial Development and Economic Growth. *Journal of Development Studies, 40(1),* 142–163. https://doi.org/10.1080/00220380412331293707

Kuznets, S. (1955). Economic Growth and Income Inequality. *The American Economic Review, 45(1),* 1–28.

Martínez-Zarzoso, I., & Maruotti, A. (2011). The Impact of Urbanization on CO_2 Emissions: Evidence from Developing Countries. *Ecological Economics, 70(7),* 1344–1353. https://doi.org/10.1016/j.ecolecon.2011.02.009

Muhammad, B., & Khan, S. (2019). Effect of Bilateral FDI, Energy Consumption, CO_2 Emission and Capital on Economic Growth of Asia Countries. *Energy Reports, 5,* 1305–1315. https://doi.org/10.1016/J.EGYR.2019.09.004

Odugbesan, J. A., & Adebayo, T. S. (2020). The Symmetrical and Asymmetrical Effects of Foreign Direct Investment and Financial Development on Carbon Emission: Evidence from Nigeria. *SN Applied Sciences, 2(12).* https://doi.org/10.1007/s42452-020-03817-5

Okada, K., & Samreth, S. (2014). How Does Corruption Influence the Effect of Foreign Direct Investment on Economic Growth? *Global Economic Review, 43(3),* 207–220. https://doi.org/10.1080/1226508X.2014.930671

Polat, B., & Naci, N. (2018). The Influence of FDI on Energy Consumption in Developing and Developed Countries: A Dynamic Panel Data Approach. *Journal of Yasar University, 13(1).* www.worldbank.org

Rafindadi, A. A., Muye, I. M., & Kaita, R. A. (2018). The Effects of FDI and Energy Consumption on Environmental Pollution in Predominantly Resource-Based

Economies of the GCC. *Sustainable Energy Technologies and Assessments, 25,* 126–137. https://doi.org/10.1016/j.seta.2017.12.008

Rao, D. T., Sethi, N., Dash, D. P., & Bhujabal, P. (2023). Foreign Aid, FDI and Economic Growth in South-East Asia and South Asia. *Global Business Review, 24(1),* 31–47. https://doi.org/10.1177/0972150919890957

Raza, S. A., Shah, N., & Arif, I. (2021). Relationship Between FDI and Economic Growth in the Presence of Good Governance System: Evidence from OECD Countries. *Global Business Review, 22(6),* 1471–1489. https://doi.org/10.1177/0972150919833484

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy, 98(5),* part II.

Shabani, Z. S., & Shahnazi, R. (2019). Energy Consumption, Carbon Dioxide Emissions, Information and Communications Technology, and Gross Domestic Product in Iranian Economic Sectors: A Panel Causality Analysis. *Energy, 169,* 1064–1078. https://doi.org/10.1016/J.ENERGY.2018.11.062

Artikel 1 (527-540).pdf

ORIGINALITY REPORT

14%	14%	10%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journal.uinmataram.ac.id Internet Source	4%
2	www.researchgate.net Internet Source	3%
3	doaj.org Internet Source	2%
4	Submitted to University of Plymouth Student Paper	1%
5	core.ac.uk Internet Source	1%
6	www.oer.unn.edu.ng Internet Source	1%
7	Ganda Fortune. "The influence of democracy, corruption, economic growth and ICT on carbon emissions in Sub-Saharan African countries: Does FDI matter?", Journal of Open Innovation: Technology, Market, and Complexity, 2024 Publication	1%

8	Ashoka Mody, Catherine Pattillo. "Macroeconomic Policies and Poverty Reduction", Routledge, 2004 Publication	1 %
9	mpra.ub.uni-muenchen.de Internet Source	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		

Artikel 1 (527-540).pdf