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Foreign Direct Investment, Trade Openness and Environmental Degradation in SSA Countries. A Quadratic Modeling and Turning Point Approach

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ABSTRACT

The consequences of carbon dioxide (CO_2) emissions in Sub Saharan Africa (SSA) countries cannot be ignore given it adverse effect on human health and global warming. With rising CO_2 emissions and fallen volume of trade openness and FDI inflows in recent time, we seek to examine the effect of trade openness and foreign direct investment (FDI) on environmental degradation using time series data from 1975 to 2020 in SSA. Using the environmental Kuznets curve (EKC) framework, the study employs a quadratic modeling and turning point approach to realize the study objectives. The findings reveals that (1) the trade openness-EKC and FDI-EKC does not hold given the presence of decreasing effects in the short run and increasing effects in the long run; (2) it confirms that a U-shaped trade openness-emissions and FDI-emission nexus holds given the decrease in trade openness and FDI in the short run and an increase in trade openness and FDI in the longrun; (3) The analysis supports the halo effect hypothesis before the turning point but the pollution haven hypothesis sets in after the turning point; (4) it shows evidence that trade openness and FDI contributes to reduce CO_2 emissions in the short but increase it in the long run. The study recommends that SSA countries should adopt stringent environmental policies to attain sustainable economic growth without associative harm to the environment.

INTRODUCTION

Attaining environmental sustainability is indispensable to any nation irrespective of any economic activity. Hence, understanding and reducing carbon dioxide(CO_2) emission and other forms of emissions on the environment is paramount to every nation to attain the United Nations Sustainable Development Goal by 2030 which aims to address climate change (Adeleye *et al.*, 2022). Hossain (2012) reveal that the surge in CO_2 emission is a main threat to global warming and climate change for both developing and developed countries. Recent environmental statistics further reveal that CO_2 emission has grown drastically in the last three decades because of human activities(Duodu *et al.*, 2021). As a result, environmental concern has attracted a lot of attention especially with the launch of the Paris Agreement and the Kyoto Protocol to combat climate change and mitigate the effects of CO_2 emissions on the environment (Duodu *et al.*, 2021).

The situation is precarious in SSA countries with less stringent environmental policies and high poverty rate. The World Bank report of 2020 indicates that Sub-Sahara Africa has witnessed an increase in carbon dioxide emissions (in Kilotons) from 708066.43 in 2010 to 823424.72 in 2018 (see figure 1). The trend further shows a continuous but fluctuating rise in CO_2 from 1990 to 2020. In 2014, it witness a double rise in CO_2 by 7.52% compared to 1.88% in 2013. However, in 2015 the carbon emissions reduces by 4.11% but a 2.6% increase was again witnessed in 2016 and after 2016, there has been a continuous increased (see figure 1). With this increase in CO_2 emissions, environmental quality is adversely affected especially with the inflow of FDI and openness to trade.

It is argued that FDI inflows lead to more CO_2 emissions especially as investors explore cheaper means of production which is hazardous to the environment(Nyeadi, 2022). This is particularly true for developing countries like SSA with relaxed environmental regulations thereby attracting firms with high pollution levels from developed countries- a situation known as pollution haven hypothesis (PHH) (Yakubu & Musah, 2022). At the same time, it is claimed that FDI contributes positively to the economy of the host country in the domain of knowledge diffusion, technological transfer, and access to markets(Wei & Zhou, 2022). However, due to the consequences of FDI on the environment, most countries in SSA have started putting in strict environmental policies for investors to achieve sustainable development reason why FDI has dropped in recent times. The World Bank report indicates that FDI as a percentage of GDP increased from 2.3% in 2010 to 2.6% in 2015 but it has witnessed a drop of 1.9% in 2016 to 1.8% in 2020.

Trade openness is also a key factor that worsens environmental degradation as it increases the size of the economy leading to an increase in pollution (Nguyen, 2022). Pollution can be exported through the importation of goods and services when free trade increases. This put more pressure on the environment as inputs such as energy and timber increase the volume of water and air pollution emissions. Many empirical studies in SSA have validated the PHH on trade-emissions nexus by revealing that trade in SSA increases environmental pollution (Duodu *et al.*, 2021). However, the World Bank reports indicates that Trade openness as a percentage of GDP in SSA has drop from 22.4% in 2017 to 20% in 2020.

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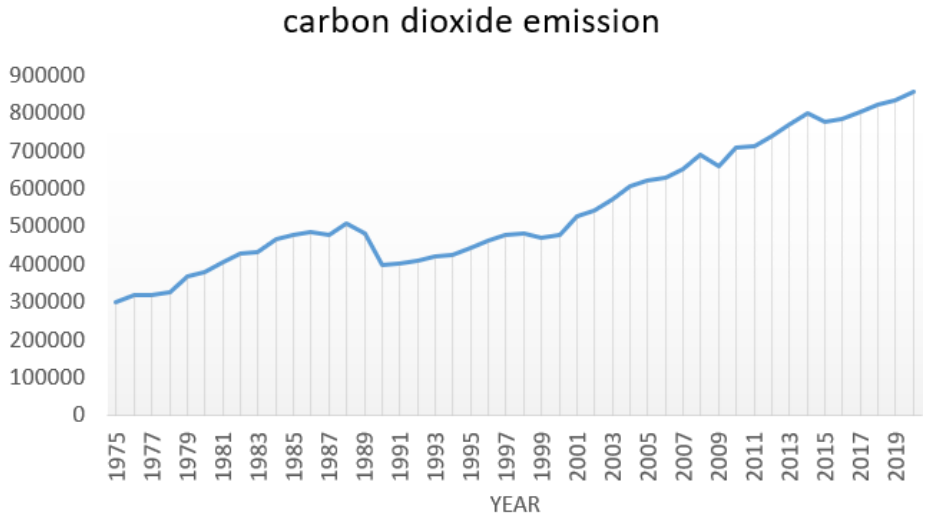

Figure 1: Trend of CO_2 (kilo tons) from 1975 to 2020
Source: Author's computation

There is still an ongoing debate regarding the relationship between FDI, trade openness, and environmental degradation. While some previous studies find FDI and Trade openness to positively affect the environment, others believe they are environmentally friendly especially with ecologically friendly technologies. This research contributes to the ongoing debate in the context of SSA countries in the following ways; (1) by testing the validity of the PHH and polo hypothesis. (2) To establish the exact turning point of trade openness and FDI, (3) To assess if the trade openness- Kuznets curve hypothesis holds (4) To test if the FDI-Kuznets hypothesis holds (5) To find out if trade openness and FDI exhibit a monotonic (increasing or decreasing) relationship with environmental degradation in SSA.

LITERATURE REVIEW

The relationship between trade openness, FDI, and carbon dioxide emission is diverse with a heterogeneous conclusion. The difference in conclusion is based on variables used, method of data analysis, and scope of study. Different factors influence environmental degradation which will be examined in the course of the extant literature. However, the literature will be examined under separate headings.

Trade Openness and Carbon Dioxide Emissions

There is a lack of consensus concerning trade openness and CO_2 emission (Karedla *et al.*, 2021). While some studies support the hypothesis that trade openness intensifies environmental degradation(Al-Mulali *et al.*, 2016; Jun *et al.*, 2020; Shahzad *et al.*, 2017; Tariq *et al.*, 2018; Wen & Dai, 2020), others are in support that environmental degradation reduces when trade openness increases (Cui *et al.*, 2015; Ghazouani *et al.*, 2020; Shahbaz & Sinha, 2017).

Sun *et al* (2020) reveals that trade will decrease environmental pollution in SSA countries in the longrun. The square term for trade openness further indicates the presents of environmental Kuznets curve (EKC) hypothesis. Similarly, Simplice & Nicholas (2021) using 49 SSA countries as a case study from 2000–2018 found that increasing trade openness affects CO_2 emissions while increased in FDI negatively affects CO_2 emissions. They also found a Kuznets shape between trade and CO_2 emissions while a U-shape relationship was found between CO_2 emissions and FDI inflows. Contrary, Asongu & Odhiambo (2020) using 49 SSA countries from 2000-2018 reveals that trade has a negative and significant effect on carbon dioxide emissions. The study further indicates that the minimum trade threshold for SSA countries to experience green economy as a percentage of GDP is 100.

Yue *et al* (2021) Conclude that trade openness affects carbon emission positively in China, Japan, and ROK FTA countries from 1970 to 2019. Similarly, Duan *et al* (2022) indicates that financial development and trade openness boost CO_2 emissions in China from 1997 to 2020 using a PVAR model. Also, Alfred & Haug (2019) using a linear and nonlinear ARDL found that an increase in imports positively affect CO_2 emissions in the long run while an increase in export does not increase CO_2 emissions in Turkey. Similarly, Muratn (2019) using Developing Countries found that in the long run, trade openness and FDI are the main determinants of CO_2 emissions. Likewise, Chen *et al* (2021) in a panel data of 64 countries along the Belt and Road for 18 years indicate that trade openness improvement has a significantly positive effect on CO_2 emissions. In a related study, Hdom & Fuinhas (2020) indicates that the more the Brazilian economy is open to trade, the more polluted it becomes. Rauf *et al* (2018) indicates that in industrialized economies, manufacturing contributes positively toward pollution levels. Equally, Chhabra *et al* (2023) reveals that trade openness is the cause of environmental degradation in the BRICS nations from 1991 to 2019. Sajeev & Kaur (2020) indicates that developing countries that have fewer environmental regulations and are open to trade and FDI,

witness an increase in CO_2 emissions. Similarly, Yu *et al.* (2019) indicated that trade openness has a double-edged effect when decrease indirectly in CIS countries. They found trade openness to increase CO_2. Likewise, Ertugrul *et al* (2016) found that in the top ten developing countries, trade openness and energy consumption are key factors of CO_2 emissions which results in high pollution.

Contrary, Karedla *et al* (2021) using ARDL for a period of 45 years reveals that in the longrun, trade openness significantly decreases CO_2 emissions in India. Zhang *et al* (2017) found that trade openness negatively affects carbon emissions in ten countries. Similarly, (Appiah *et al*., 2022; Dauda *et al*., 2021; Khan *et al*., 2022) found a significant negative effect of trade on environmental sustainability. However, (Keun-yeob & Bhuyan, 2018) using Bangladesh as a case study for 38 years reveals that in both the short and longrun, a negative and insignificant relationship exist between trade liberalization and environmental degradation.

Other studies found contradictory results. Keho (2016) using ECOWAS as a case study obtain mixed results across countries. He reveals that in some countries trade worsens degradation via air quality while it is environmentally friendly in other countries. Wang & Zhang (2021) observed that in low-income countries there is a positive relationship between pollution and trade openness while in middles income countries the nexus is negative. Similarly, Jayanthakumaran *et al* (2012) also observed the relationship is negative in China but positive in India. Le *et al* (2016) stressed that the quality of the environment may be worsen through trade but the effect differs across regions. Sun *et al* (2019) using SAARC countries found both positive and negative impacts of trade on emissions. They found that in SAARC countries, trade and FDI have a long run positive effect on environmental degradation while in the short run, a negative relationship was witnessed between FDI and trade inflows with CO_2 emissions.

FDI and Environmental Degradation

The "pollution heaven" hypothesis indicates that in the host country, FDI affects the natural environment while the "pollution halo" hypothesis points out that FDI improves the natural environment of the host country (Wei & Zhou, 2022).

Starting with regional specific studies, Duodu *et al* (2021) employs the GMM across 23 SSA countries and conclude that in the short run when FDI is merged with policies and institutions for environmental sustainability, it deteriorates environmental quality but in the long run, the quality of the environment is improved. Equally, Kivyiro & Arminen (2014) using six SSA countries from 1971-2009 in an ARDL framework concludes that FDI has a positive and significant effect on carbon emissions in Zimbabwe but a negative and significant impact in South Africa, Kenya, and the Democratic Republic of Congo. Ojewumi & Akinlo (2017) also used Panel Vector Error Correction to reveal that FDI positively and significantly affects CO_2 emissions in 33 SSA countries from 1980 to 2013. Similarly, Ssali *et al* (2019) examine the relationship between CO_2 emission, economic growth, and FDI in 6 selected SSA countries from 1980-2014. Using the ARDL and PMG Estimator, the results reveal that FDI does not have any significant impact on CO_2 emission while GDP and energy use reduce environmental quality. In addition, Asongu & Odhiambo (2020) using 49 SSA countries from 2000-2018 reveals that FDI has a positive and significant effect on carbon dioxide emissions. The study further indicates that the minimum FDI threshold for SSA countries to experience green economy as a percentage of GDP is 200. Contrary, Adams *et al* (2020) also found that FDI and regulatory quality has a significant negative effect on environmental quality across 19 SSA countries for 31 years using DFE model and GMM. Ganda (2020) Using 44 SSA countries for 14 years showed that renewable energy consumption and financial development negatively affect environmental quality while economic growth positively affects environmental quality.

In other economies, Bongsuk *et al* (2018) found that FDI decreases CO_2 emission levels in the Chinese manufacturing sector from 2002–2015. Similarly, Abdulkadir *et al* (2018) using PMG estimators found that FDI inflows negatively affect environment degradation in GCC for 24 years. Also, Binyam & Sylvanus (2020) using a meta-analysis of 65 primary studies indicates that FDI can significantly reduce CO_2 only after accounting for heterogeneity. To *et al* (2019) with a focus on emerging markets in Asia from 1980–2016 found that FDI has a strong impact on the environment. Likewise, Huang *et al* (2022) using G20 economies from 1996 to 2018 reveals that the nexus between FDI inflows and CO_2 emissions is positive. However, in countries with advanced development and regulatory quality, carbon emissions can be mitigated. Similarly, Nyeadi (2022) found a positive and significant relationship between FDI and carbon dioxide in low-income countries.

Based on the pollution heaven hypothesis and fully modified least squares (FMOLS) technique Yakubu & Musah (2022) concludes that FDI inflows positively and significantly drive environmental pollution in Ghana from 2000Q1-2017Q4. Bunyaminu & Yakubu (2022) also found that FDI inflows decreases renewable energy demand but increases carbon dioxide emissions in Africa, hence supporting the PHH. Similarly, Khalid & Zaitouni (2021) support the PHH in Philippines only while in Malaysia and Singapore they support the pollution halo hypothesis. Also, some empirical studies rebut the PHH by indicating that FDI reduces environmental pollution(Al-Nimer *et al*., 2022; Kathuria, 2016; Nathaniel *et al*., 2020; Pradhan *et al*., 2022; Shahbaz *et al*., 2019; C. Zhang & Zhou, 2016). However, some empirical studies found contradictory results by accepting or rejecting the PHH base on the nexus between FDI and environmental pollution(Huynh & Hoang, 2019; Kisswani & Zaitouni, 2021; Yilanci *et al*., 2020).

Some empirical studies did not find any significant relationship between FDI and CO_2 emissions. Ponce *et al* (2022) used 100 countries for 39years to conclude that the role of foreign direct investment on the environment is not stable over time. Similarly, Jugurnath & Emrith (2018) found that FDI does not significantly increase the levels of CO_2 emissions in SIDS countries. In addition, Alfred & Haug (2019) found that increases in FDI have no long-run significant effects on CO_2 emissions per capita.

METHODOLOGY

Data

The study makes use of time series data in SSA from world development indicators from 1975 to 2020. Carbon dioxide emission measured in kilo tons per capita is the dependent variable while trade openness (% of GDP) and FDI inflows (% of GDP) are the independent variables. Population growth and economic growth in dollars are control variables. Past studies have made use of these control variables. For economic growth see (Adedoyin *et al*., 2021; Akam *et al*., 2021; Chontanawat, 2020), for population growth see (Adedoyin & Bekun, 2020; Bhat, 2018; Yasin *et al*., 2020)

Estimation Technique

We initiate our empirical analysis by first conducting the unit root test to ascertain the order integration. The risk of non-stationary series cannot be over emphasized as it results to spurious regression(Gujarati, 2004). Hence, the study make use of ADF and Zivot Andrew unit root test, which shows evidence of I(1) series (see appendix 3 and 4). We also conducted the summary statistics to display the averages, deviations, minimum, and maximum values (see appendix 1) and the correlation test to make sure no multicollinearity exist in the series (see appendix 2). The pairwise correlation table in appendix 2 reveals that all variables are positively link to carbon missions. In addition, there is no evidence of exact linear dependence among the regressors as all the correlation statistics are below 0.70(Ewane & Abonongi, 2022)

Since our interest is to find out if the relationship between trade openness, FDI, and CO_2 emission is non linear or monotonic, we employ a quadratic function which allows the effect of the independent variable (X) on the dependent variable to change. That is as the value of X increases, the impact of the dependent variable increases or decreases. The technique is use to find the equation of the parabola that best fits a set of data- a second order polynomial model with the presence of a square term. As a result, we get an equation of the form: $y=aX^2+bX+c$ where $a\neq0$.

Empirical Specification

Adopting the study of Adeleye *et al* (2022) and Adeleye (2023), the model with carbon dioxide emission express as a linear function of control variables is specified as follows;

$$logC0_{2t} = \beta_0 + \beta_1 logTO_t + \beta_2 logPOP_t + \beta_3 logGDP_t + \mu..1$$

$$logC0_{2t} = \beta_0 + \beta_1 FDI_t + \beta_2 logPOP_t + \beta_3 logGDP_t + \mu\ldots\ldots2$$

To find evidence of the trade openness-EKC and FDI-EKC, both the level and square term of trade openness and FDI are included in equations 1 and 2 as shown below.

$$logC0_{2t} = \beta_0 + \beta_1 logTO_t + \beta_2 (logTO_t)^2 + \beta_3 logPOP_t + \beta_4 logGDP_t + \mu\ldots\ldots3$$

$$logC0_{2t} = \beta_0 + \beta_1 FDI_t + \beta_2 (FDI_t)^2 + \beta_3 logPOP_t + \beta_4 logGDP_t + \mu\ldots\ldots4$$

Where CO_2 is the carbon dioxide emission per capita; TO is trade openness; FDI is foreign direct investment; POP is population; GDP is growth domestic product. β_1, β_2, β_3, β_4 are parameters to be estimated while μ is the error term.

From equation 3 and 4, the various forms of the relationship between trade openness, FDI, and carbon dioxide emission can be tested as follows;

$\beta_1 < 0$, $\beta_2 > 0$, the relationship is a U-shaped

$\beta_1 > 0$, $\beta_2 < 0$, the relationship is inverse U-shaped

$\beta_1 > 0$, $\beta_2 > 0$, the relationship is monotonically increasing linear

$\beta_1 < 0$, $\beta_2 < 0$ the relationship is monotonically decreasing linear

$\beta_1 = 0$, $\beta_2 = 0$, the relationship is level.

However, deriving the turning point works with the outcome of $\beta_1 < 0$, $\beta_2 > 0$,

$\beta_1 > 0$, $\beta_2 < 0$, and β_1 and β_2 must be significant(Adeleye *et al*., 2022)

The turning points from equation 3 and 4 can be obtained by taking the first derivatives and setting the equation to zero as follows;

$$(\partial logC0_2/\partial logTO) = \beta_1 + (\beta_2 * 2) logTO = 0$$

$$\beta_1 = -(\beta_2 * 2) logTO \rightarrow logTO^* = -0.5 (\beta_1/\beta_2)$$

$$(\partial logC0_2/\partial logFDI) = \beta_1 + (\beta_2 * 2) logFDI = 0$$

$$\beta_1 = -(\beta_2 * 2) logFDI \rightarrow logFDI^* = -0.5 (\beta_1/\beta_2)$$

Where $logTO^*$ and $logFDI^*$ represents the threshold of trade openness and FDI outside which it decreases or increases carbon emissions based on the signs of β_1 and β_2

Such that: $\beta_1 < 0$, $\beta_2 > 0$ for U-shape relationship or $\beta_1 > 0$, $\beta_2 < 0$ for inverse U-shape relationship. The trade or FDI turning point of this curve is computed as follows;

$\tau = 0.5 (\beta_1/\beta_2)\ldots\ldots\ldots5$

However, equation 5 has to be converted into it exponential form to obtain the real values. The exponential form of the equation become thus;

$\tau = exp0.5 (\beta_1/\beta_2)$

To make sure the turning point stays within the limit values of trade openness and FDI, some variables are estimated at levels while others are in their log forms. The a priori expectation is such that β_1, β_2, β_3, $\beta_4 > 0$.

RESULTS AND DISCUSSION

The linear results in Table 1 reveals that population

Table 1: linear and nonlinear regression

VARIABLES	Equation (1) estimates		VARIABLES	Equation (2) estimates	
	linear	Non-linear		linear	Non-linear
LogPOP	0.299***	0.337***	logPOP	-0.585***	-0.500***
	-0.0738	-0.0902		-0.0701	-0.0993
logGDP	0.227***	0.209***	logGDP	0.193***	0.178***
	-0.0336	-0.039		-0.028	-0.03
logTO	-0.168***	-1.783**	FDI	-0.0163	-0.105***
	-0.0531	-2.082		-0.0157	-0.0628
LogTOsquare		0.251***	FDIsquare		0.0228*
		-0.324			-0.013
Turning point		3.5393973	Turning point		2.1865719
constant	1.536*	3.832	Constant	7.505***	6.255***
	-0.764	-2.931		-0.788	-1.235
Observations	46	46	Observations	46	46
R-squared	0.945	0.945	R-squared	0.651	0.673
F-Statistic	699.19	715.86	F-Statistic	49.4	44.79
Prob > F	0	0	Prob > F	0	0

*Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*
Source: Author's computation

and economic growth positively affect environmental degradation. Hence, a 1% increase in each of them will increase cardo dioxide emission by 29.9% and 22.7% respectively and both are significant at 1% level. The results is consistent with the nonlinear results. Thus, rising population and advanced economic growth in SSA countries deteriorate environmental degradation.

The linear result of trade openness is negatively related to environmental degradation. A 1% increase in trade openness reduces CO_2 emissions by 16.8% at a 1% significant level. Furthermore, the nonlinear square term of trade openness is positive and significant violating the inverted U-shaped EKC theory (see figure 2) but validates a U-shape relationship. This implies that countries in SSA countries reach a threshold limits after which the deteriorating effect of trade openness on the environment starts to increase. With a turning point of 3.54 (see figure 2), trade openness initially declines environmental degradation but as trade advances outside the optimal point of 34.5 (% of GDP), the level of emissions rises causing environmental degradation

The second estimate is that where FDI is the main explanatory variable. The linear results indicate that population negatively affects environmental degradation while economic growth has a positive impact at a 1% significant level. The findings is also true with that of the nonlinear results. Also, the linear results reveal that FDI has a negative impact on environmental degradation. That is a percentage increase in FDI reduces carbon dioxide emission by 10.5% at a 1% significant level. The linear results of equation 1 and 2 indicates that liberalizing trade and encouraging FDI decreases the adverse effect of CO_2 emissions in SSA, which improve environmental quality (Acheampong *et al.*, 2019; Alvarado *et al.*, 2022)

However, the non linear square term of FDI is positively related to environmental degradation, which contradicts the EKC theory (see figure 2). This indicates that in the long run, FDI cause harm to the environment. This conclusion is vital because SSA countries attract FDI by adopting less stringent environmental laws. The turning point occurs at 2.19(see figure 2) indicating that at 8.9% (% of GDP) turnaround point, carbon emission starts to increase. This implies that SSA witness a fall in environmental sustainability at the early stage of development through FDI but once a threshold point is attain, the effect on the environment deteriorates. Hence, the early development stage supports the halo effect hypothesis while the pollution haven hypothesis sets in after the turning point. The rationale for this positive rise in environmental degradation is due to reallocation of firms with high polluting from developed countries with high-income who have strict rules on regulating quality to developing countries with low-income who have less strict environmental regulations (Chang *et al.*, 2019; Doytch & Uctum, 2016).

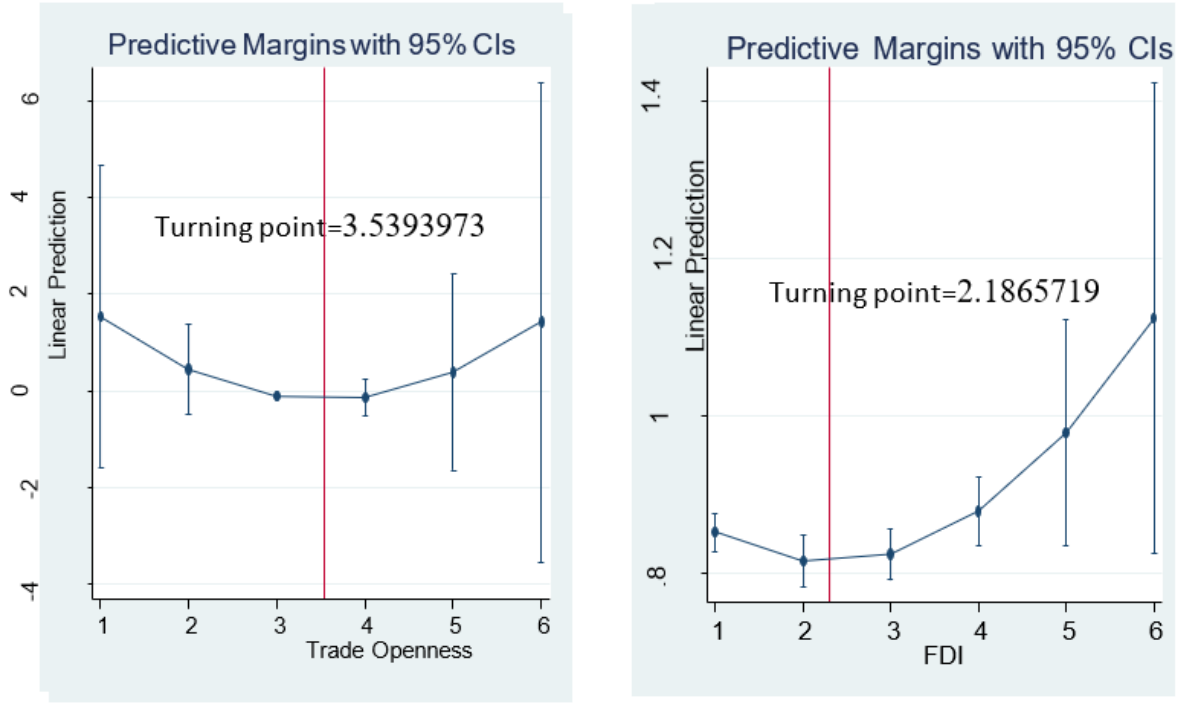

Figure 2: Turning points of trade openness and FDI from QM technique.
Notes exp^3.54=34.5(% of GDP), exp^2.19=8.9(% of GDP)
Source: Author's computations

CONCLUSION

The link between FDI, trade openness, and carbon dioxide emissions is an ongoing debate. We contributes to the recent debate by means of a time series data in SSA countries from 1975 to 2020. Employing a quadratic modeling and turning point technique, we found that;

(1) the trade openness and FDI does follow the EKC hypothesis due to the presence of decreasing effects in the short run and increasing effect in the long run;

(2) The U-shaped trade openness and FDI-emission nexus holds given the decreasing effect of trade openness and FDI in the short run and an increasing effect of trade openness and FDI in the long run;

(3) The analysis supports the halo effect hypothesis before the turning point but the pollution haven hypothesis sets in after the turning point; (4) it shows evidence that trade openness and FDI negatively and significantly effect environmental degradation in the short run but positively and significantly contributes to environmental degradation in the long run.

The negative effect of trade openness and FDI on environmental degradation can be mitigated through stringent environmental policies to safeguard environmental sustainability. This is plausible through the adoption of green technologies that are environmentally friendly in producing goods and services. Also, the transport sector which is recognized as the sector with high CO_2 emissions should be modernized to avoid CO_2 emissions to the earth's surface which causes health problems. In addition, to avoid pollution, the government of each SSA country should initiate a CO_2 emission management schemed to reduce the negative effects of CO_2 emissions. Trade openness should be encouraged among member countries in SSA countries as they share a similar idea of CO_2 emission reduction strategy. In this case, they can easily adopt a suitable technology like green technology that is CO_2 emission friendly in their manufacturing sector.

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APPENDIXES

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
logco2	46	13.169	0.294	12.616	13.66
logpop	46	20.245	0.365	19.622	20.851
loggdp	46	26.999	0.816	25.617	28.246
logto	46	3.232	0.148	2.876	3.502
fdip	46	1.438	.987	.069	3.854

Source: Authors' computations

Table 2: Pairwise correlations

Variables	$LogCO_2$	logPOP	logGDP	logTO	FDI
$LogCO_2$	1.000				
logPOP	0.949	1.000			
logGDP	0.963	0.653	1.000		
logTO	0.154	0.253	0.230	1.000	
FDI	0.704	0.575	0.517	0.516	1.000

Source: Authors' computations

Table 3: ADF unit root test

Variables	Test statistics at levels	P-Value	Test statistics at first difference	p-vales	Decision
CO_2	-0.783	0.8241	-4.353	0.0004	1(1)
logPOP	-1.568	0.4998	-3.765	0.0033	1(1)
logGDP	-1.093	0.7180	-3.661	0.0047	1(1)
logTO	-2.511	0.1128	-6.114	0.0000	1(1)
FDI	-1.161	0.6903	-5.432	0.0000	1(1)
logFDI	-0.625	0.8653	-6.814	0.0000	1(1)

Source: Authors' computations

Table 4: Zavot-Andrew unit root test

Variables	Test statistics at levels	Test statistics at first difference	Break date	Decision
CO_2	-2.859	-6.459	1995	1(1)
logPOP	-3.523	-2.603	1996	1(1)
logGDP	-3.083	-4.578	1984	1(1)
logTO	-3.897	-6.359	2001	1(1)
FDI	-3.357	-6.374	2000	1(1)
logFDI	-4.252	-11.065	1998	1(1)

Note CV @ 5%=-4.42, Source: Authors' computations