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Energy Consumption and Inclusive Growth in Sub-Saharan Africa: Does Foreign Direct Investment Make a Difference?

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Abstract

This paper examines the potential impact of energy consumption and foreign direct investment (FDI) on inclusive growth in 32 Sub-Saharan Africa (SSA) countries from 2000 to 2019. The results from the 2-stage system generalised method of moment (GMM), reveal that energy consumption induces inclusive growth. The results also show a substantial impact of non-renewable energy, relative to renewable energy, on inclusive growth. Additionally, the results further reveal that FDI has a non-linear relationship with inclusive growth, where FDI dampens inclusive growth to a certain point and begins to induce it after that point. Moreover, FDI effectively forms synergies with energy consumption towards promoting inclusive growth in SSA. The interactive term results revealed that FDI forms synergies with both renewable and non-renewable energy to promote inclusive growth in SSA. We recommend that African leaders focus on attracting FDIs towards financing their energy needs, particularly in the area of low-carbon or renewable energy sources, by leveraging private sector capital investments to achieve inclusive growth whilst attaining sustainable development.

Keywords: SSA; Renewable Energy Consumption; Non-Renewable Energy Consumption; FDI; Inclusive Growth

JEL Code: *02; Q42; F20*

1. Introduction

Recent developments have necessitated the need for policymakers, donors, institutions, and non-governmental organisations (NGOs) to focus on promoting a growth agenda which ensures that a greater number of the citizenry benefits from national economic growth (Anyanwu et al., 2013; Odusola et al., 2017; World Bank, 2018; Bishoge *et al*., 2020). The devastating impact of the coronavirus (COVID-19) pandemic has further heightened the need for developing countries, including those in Sub-Saharan Africa (SSA), to adopt a paradigm shift from the traditional income growth agenda to one that promotes shared prosperity (inclusive growth), which emphasises that economic growth must enhance the overall well-being of the citizenry. Inclusive growth is the integration of various variables, such as income levels, poverty rates, employment opportunities, and the distribution of resources, aiming to provide fair and just advantages to all sectors of society (Anyanwu et al., 2013; Odusola et al., 2017; World Bank, 2018; Bishoge *et al*., 2020). This approach goes beyond the conventional measure of economic growth (Gross Domestic Product or Gross National Product) and is in harmony with broader welfare and development objectives, as articulated in Sustainable Development Goals (Anyanwu et al., 2013; Odusola et al., 2017; World Bank, 2018; Bishoge *et al*., 2020).

Despite the remarkable economic growth achieved by most SSA economies, the stack reality is that high poverty rates, high unemployment rates and high socioeconomic inequalities remain high, a clear indication that the growth recorded has not benefited the poor that much (African Development Bank, 2020; World Bank, 2020b; Zamfir, 2016). This situation may worsen income inequality and poverty in Africa, leading to job losses, increased food prices, slow recovery of informal sectors, and insufficient social protection (UNDP, 2020). About 87% of the world's poorest people will likely reside in SSA by 2030 if current economic challenges are not tackled head-on[1] (World Bank, 2020a). We reckon that achieving social progress in SSA is imperative for addressing possible human capital development, social cohesion, and political stability setbacks. This study contributes to the current shared growth policy discourse on SSA by deviating substantially from the traditional economic growth approaches (GDP/GNP); in doing so, we focus on how policymakers can achieve all-inclusive growth in SSA with a rigorous empirical study. In this regard, we identify two channels that align with the SSA's shared growth agenda: energy consumption and foreign direct investment.

The literature notes that energy consumption enhances factors of production towards achieving economic growth and development (see e.g., Amin & Alam, 2018; Bhattacharya et al., 2016; Romer, 1990b; Stern & Cleveland, 2004). As captured in SDG 7, access to clean, affordable and reliable energy is required to foster socioeconomic and environmental sustainability. At the national level, greater access to reliable energy has been identified as a means for boosting economies and lives through income generation, as well as greater economic specialisation and economic efficiency. At the household level, access to cheap and reliable energy can also free up both time and income to induce welfare (Fouquet & Johansson, 2008; Iddrisu et al., 2023). In marginalised settings like SSA where population growth outweighs durable employment generation, access to energy can contribute to welfare by supporting the creation of small businesses and enterprises, facilitating the reallocation of household time (especially by women) from energy provision to improved education, and ensure access to greater market size due to lower transportation and communication costs (Odhiambo, 2009)

Additionally, access to affordable energy could contribute to human capital development and the quality of life through reduced indoor smoke, cleaner water, and improved

[1] Brown *et al.* (2020) point out that in SSA, environmental and social protection modules for coping with shocks are weak.

refrigeration (Barreca et al., 2022; Dinkelman, 2011; Lipscomb et al., 2013). Notwithstanding our recognition of the opposing view stressing the minimal role of energy in growth as apparent in the neutrality hypothesis and its implication for the quality of life (Menegaki, 2011; Menegaki, 2020; Narayan & Doytch, 2017; Umurzakov et al., 2020) we reckon that the current development agenda of SSA places energy at the heart of shared prosperity. Hence, safe, cheap and reliable energy consumption could prove crucial for fostering equitable income growth and distribution by directly functioning as an input for sustained growth.[2]

The optimism with FDI in spurring inclusive growth is that the SSA remains a fast-growing destination for foreign investors due to the liberal investment policies (UNCTAD, 2018). Developments such as the Special Economic Zones (SEZs) and the African Continental Free Trade Area (AfCFTA) could be game-changers in incentivising FDI inflows to SSA which could be momentous in spurring SSA's quest to achieve a continent of shared income growth and distribution (Iddrisu, Ofoeda, et al., 2023; Ofori & Asongu, 2022). To foster shared prosperity in unequal societies like SSA. FDIs can help generate durable and equitable wealth through technological transfer, innovation diffusion, industrialisation, macroeconomic stability, employment, and poverty alleviation (Ofori & Asongu, 2022; Opoku et al., 2019; Sakyi & Egyir, 2017).

FDI flow may form a synergy with energy consumption to further influence inclusive growth through project selection (Argiro, 2003; Mohanasundaram & Karthikeyan, 2015; Udeh & Odo, 2017; Susilo, 2018; Mohamed et al., 2021). For example, the literature shows institutional investors help reduce firms' carbon emissions (Safiullah et al., 2022). Implicitly, institutional investors may choose to be involved in cross-border deals that potentially have lower carbon emissions. Further, investors are noted to consider their business activities' environmental and social impact before making investment decisions (OECD, 2020). Domestic

[2] This is the energy-growth hypothesis.

businesses also consider the ecological effects of their choices, including energy consumption (Chatterji et al., 2009; Liesen et al., 2017). By implication, cross-border fund flow or FDI would gravitate towards projects with lower carbon emissions. This has important implications for the inclusive growth prospects of economies, taking cognisance of the critical role of renewable and non-renewable energy consumption.

Nevertheless, the extant literature examining energy consumption and economic growth and development has largely not considered inclusive economic growth (e.g., Abdouli & Hammami, 2017a; Awodumi & Adewuyi, 2020; Fon et al., 2021; Iyke, 2015; Omri & Kahouli, 2014b; Zeng et al., 2020). This paper used an inclusive growth index generated using Principal Component Analysis (PCA), a method that isn't novel but offers potential for innovation in research methodologies. Using an inclusive economic growth measure based on PCA is an innovation as it goes beyond higher production and enables a better alignment between policy interventions and the general welfare in emerging countries. From the existing inclusive growth models such as the Human Development Index (HDI), and other frameworks proposed by empirical literature (see, Anand et al., 2013; Ianchovichina & Lundstrom, 2009; Mlachila et al., 2016), Asian Development Bank (ADB, 2013), we find the inclusive growth framework by the ADB most appropriate for this study due to its extensive and comprehensive coverage. For instance, the ADB framework captures poverty and inequality, economic growth and employment, infrastructure, education and health access, basic infrastructure utilities and services, gender equality, social safety nets, energy consumption and governance.

Although there are some studies on the relationship between FDI and inclusive growth (see Adegboye et al., 2020a, 2020b; Iddrisu et al., 2023; Ofori & Asongu, 2022, 2021), none of these studies examined the moderation role of FDI on energy consumption nexus. This paper contributes to the extant literature in several ways. First, the paper explores the effect of energy consumption on inclusive growth. Kahia et al. (2017) suggest the need to disaggregate energy consumption to examine their unique impact on economic growth. Also, given the recent push towards promoting renewable energy consumption, total energy consumption may mask the unique effects of the various sources towards inclusive growth.

Consequently, the paper examines the impact of disaggregated energy consumption on inclusive growth. Further, the paper examines the direct effect of FDI and its squared term on inclusive growth to determine whether there is a threshold of FDI beyond which any increase boosts inclusive growth or otherwise. This is to determine whether the relationship between FDI and inclusive growth is non-linear. Also, the paper investigates the joint effect of energy consumption and FDI on inclusive growth in SSA. Particular attention is paid to the interaction term to determine whether FDI flows channelled into energy consumption can help spur inclusive growth in SSA. The contributions from this research are important to Africa's effort to develop its energy potential to promote shared growth and prosperity without compromising environmental sustainability.

The remainder of the paper is organised as follows: Section 2 presents the theoretical reasoning and empirical literature. Section 3 outlines the material and methods. While Section 4 presents the results and discussions, Section 5 provides the conclusion, implications and limitations.

2. Theoretical reasoning and empirical literature

2.1. Theoretical reasoning

The theoretical link between energy consumption and economic growth originates from Solow's (1956) neoclassical growth theory. The model suggests that total output in an economy is produced using capital and labour, which continuously vary and are linked through the production function with constant returns to scale. Romer (1989) extends the Solow (1956) model by including technological progress as an endogenous variable in the growth process. The model attributes output growth to capital accumulation and technological change, driven by profit-maximising agents' investment decisions in response to market incentives. As Hidalgo (2011) reckons, the traditional wisdom that only two factors (i.e., capital and labour) drive growth, as espoused in the Solow (1956) model, is flawed. Amin and Alam (2018) highlight the critical role of energy consumption in the production process. They suggest that the second law of thermodynamics underscores the necessity of energy in all matter transformations, including production processes. Thus, the underlying assumption of equation (3.2) is that production relies on a mix of capital, labour, and energy sources (not only capital and labour).

Also, the effectiveness of technology hinges on energy availability, confirming the important role of energy in the growth model. Ecological economists emphasise that without energy, the factors of production cannot substitute for or operate effectively, thereby, limiting economic growth (Belloumi, 2009; Stern, 2011). The attendant theory, often referred to as the energy-growth theory, highlights the possibility of improvement in technical efficiency through energy consumption (Brown & Wolk, 2000; Solow, 1974, 1998; Stiglitz, 1997, 2010). Apart from its impact on income growth, access to energy is fundamental for people to realise their innovative and entrepreneurial potential (Gaye, 2007; IEA, 2019). Therefore, improving accessibility to energy services remains critical for reducing poverty, income inequalities, gender inequalities and spatial inequalities. This intuition stems from the claim that energy accessibility can influence income distribution by increasing private sector productivity and job opportunities (Dinkelman, 2011; IRENA, 2021).

The theoretical linkages between FDI and shared growth stem from the argument that by specialising in cross-border production activities in which they have abundant factors, countries can put natural resources to use to the benefit of the masses. Thus, FDIs can drive shared growth through job creation, revival of the industrial capacity of recipient countries, and corporate social responsibility (Bello et al., 2022; Ofori & Asongu, 2021a; Ohlin, 1933). The neoclassical theory of economic growth by Swan (1956) and Solow (1956) considers FDI as an important growth factor for emerging countries as it enhances productivity via capital accumulation, technological know-how, and input imports for sustainable economic growth (Herzer et al., 2008). The dependency theory also suggests that foreign investors inject capital and technology, which can boost host countries' industrial capacity, create jobs, and promote corporate social investments (Kotler & Lee, 2005). However, there is an offsetting effect as it may also create unemployment due to new production techniques and innovations and income inequality in the short term due to skill set mismatch (Girling, 1976). Foreign enterprises gaining assets in host nations may lead to macroeconomic instability, capital flight, and domestic firm failures (Ndikumana & Sarr, 2019). Similar to the dependency theory, the modernisation theory also suggests that FDI can accelerate the transfer of new technologies, employment creation and economic linkage to host countries, thereby affecting energy sector investments for inclusive growth (e.g., Lucas, 1988; Taylor et al., 1993; Kotey & Abor, 2019). Also, the Bhagwati hypothesis emphasises that the inflow of external finance can boost innovation and productivity (e.g., Sakyi & Egyir, 2017; Bhagwati, 1973; Ofori et al., 2021). Thus, FDIs may stimulate economic growth and shared wealth from different perspectives.

2.2 Empirical Literature

2.2.1 Energy consumption and economic growth

The empirical relationship between energy consumption and economic growth can be categorised into four testable hypotheses: the growth, conservation, feedback, and neutrality hypotheses (see, Apergis & Payne, 2010; Damette & Seghir, 2013). Initially proposed by Kraft and Kraft (1978), the growth hypothesis holds that energy consumption drives economic growth. Several studies have documented evidence supporting this hypothesis. For example, Esen and Bayrak (2017), using panel data analysis of 75 developed and developing net energy-importing countries from 1990 to 2012, show that energy consumption positively impacted economic growth. Also, Dogan et al. (2020) found that renewable energy usage increased economic growth in 32 European nations, using data between 1995 to 2014. Further, Kouton (2021) found that renewable energy consumption increased inclusive growth, proxied by GNP, in 44 African countries. The use of GNP as a proxy for inclusive growth is, nevertheless, problematic as its focus is national income but not social equity.

The conservation hypothesis presumes that the main factor of energy consumption will follow economic growth. A strand of empirical studies provides evidence confirming the *conservation hypothesis*. For instance, Abosedra and Baghestani (1989) document evidence suggests that the US GNP causes energy usage. In support of this hypothesis, Ashraf et al. (2013) also show that Pakistan's economic growth between 1971 and 2008 increased energy demand. Using a panel Granger causality test, Umurzakov et al. (2020) found unidirectional causation from economic growth to energy consumption for 26 countries, using data from 1995 to 2014.

Other studies have provided evidence supporting the *feedback hypothesis*, which emphasises a bi-directional causality between energy consumption and economic growth. Apergis and Payne (2010), using heterogeneous panel cointegration to test for causality between renewable energy consumption and economic growth for 13 Eurasia countries from 1992–2007, find a bi-directional causality. Kristjanpoller et al. (2018), applying wavelet analysis to 74 developing and emerging nations from 1972 to 2014, also confirm the feedback hypothesis. Similar results confirming the *feedback hypothesis* can be found in Omri and Kahouli (2014), Saidi and Mbarek (2015), Saidi et al. (2017), and Yildirim et al. (2012). In this scenario, implementing policies that result in using less energy could hurt economic growth. Nevertheless, it is instructive to note that some researchers have argued that adopting energy efficiency policies may not adversely impact economic growth under this hypothesis (Cantore et al., 2016; Lin & Zhou, 2022).

The *neutrality hypothesis* suggests no causal relationship exists between energy use and economic growth. Empirical investigations into this hypothesis show some evidence supporting the hypothesis. For example, Jobert and Karanfi (2007), using data between 1960 and 2003 and applying cointegration and Granger causality tests, did not find any evidence supporting a long-term link between energy use and income in Turkey. Also, Menegaki (2011), using the dynamic error correction for 27 European countries from 1997 to 2007, found no correlation between renewable energy consumption and economic growth. Bulut and Menegaki (2020) employed panel cointegration and causality approaches for the top 10 solar-installed energy capacity countries over the period 1999–2015 and found no causation between solar (renewable) energy and GDP. Further, evidence documented by Narayan and Doytch (2017), and Umurzakov et al. (2020) supports the energy consumption-economic growth neutrality hypothesis.

The empirical studies discussed have applied varied econometric methodologies focusing on different countries, regions, and periods and adopting different proxy variables. Given that the policy implications depend on the relationship established, the choice of proxies is a significant matter. For instance, studies examining the link between energy and economic growth rely extensively on traditional measures of economic growth, such as GDP or GNP, which only focus on national income (e.g., Apergis & Payne, 2009; Ozturk, 2010; Kahia et al., 2016; Muhammad & Khan, 2019; Akadiri & Ajmi, 2020; Dogan et al., 2020; Kouton, 2021;). As important as they are, results derived from such proxies do not reflect societal equity. This is reinforced by Ali and Son (2007) and Oluseye and Gabriel (2017), who confirm widening inequality despite a consistent increase in GDP per capita. Hence, using economic growth proxies in energy-growth studies that go beyond higher production enables a better alignment between policy interventions and general welfare. Therefore, this paper uses a broad-based inclusive growth measure that emphasises equitable growth.

In addition, several extant studies have primarily focused on aggregated energy consumption. Recent studies, argue for the need to disaggregate energy consumption (i.e., renewable and non-renewable) and observe their possible effects on economic growth (Kahia et al., 2017). This is important to achieve sustainable and reliable energy consumption in an environmentally sustainable manner (Bowen & Kuralbayeva, 2015; World Bank, 2018). Thus, this paper examines the disaggregated effect of energy consumption on inclusive growth.

2.2 FDI and economic growth

The empirical literature examining FDI and growth report findings support the positive impact of FDI on economic growth, thus confirming the theories. For instance, Agbloyor et al. (2014), applying the GMM method and using data between 1960 and 2014, found that FDI boosts economic growth in 38 African countries. Also, Appiah et al. (2019), using PMG on selected African nations, shows that FDI net inflows favourably affect economic growth. Further, Iheonu et al. (2017) and Ofori and Asongu (2021) documents a positive and significant impact of FDI on growth in SSA countries. UNCTAD (2014) also shows that FDI can enhance growth by increasing innovation, private sector competition and efficient use of resources to bring about economic sustainability. Nevertheless, several papers also show that FDI may dampen or negatively impact economic growth (e.g., Saltz, 1992; Anyanwu & Yameogo, 2015; Edrees, 2015; Kotey & Abor, 2019).

A thread of studies also shows that FDI and economic growth affect each other. For example, Amri (2016) and Abdouli and Hammami (2017a, 2017b) found a bi-directional relation between FDI and output per capita in 75 developed and emerging countries. Kaulihowa and Adjasi (2018) used PMG to analyse the effect of FDI on income inequality in 16 African nations from 1980 to 2013. The paper documents a U-shaped effect, suggesting a non-linear link. Also, the connection between FDI and growth may be conditional. For example, Ofori and Asongu (2022) find that FDI has little impact on growth in countries with weak governance. Further, Bello et al. (2022) find that ICT threshold levels in SSA limit the favourable impact of FDI on growth. Also, Kusumawati (2018) found that quality institutions help FDI boost growth in Indonesia.

Generally, research on energy consumption, FDI, and inclusive growth in SSA remains sparse. To the best of our knowledge, little or no study has examined the disaggregated effects of energy consumption (renewable and non-renewable) on inclusive growth in SSA. More importantly, whether renewable and non-renewable energy complementing FDI can foster inclusive growth in SSA remains unanswered. This paper fills these gaps.

3. Material and Methods

3.1 Material

The sample analysed in this paper includes 32 SSA countries, due to data availability spanning 1995 to 2019. The data is sourced from the World Bank [Development Indicators (WDI)] and the Energy Information Agency (EIA). Our dependent variable, inclusive growth, is proxied with an inclusive growth index. The inclusive growth variable is constructed as an index using PCA. Following the ADB inclusive growth framework, 18 variables are utilised to create the inclusive growth index used in this paper (see Table 1). Since the 18 variables are each measured differently, the paper normalised the individual variables before using them to construct the index. Panel normalisation minimises the effect of outliers on the results (Gygli et al., 2019). The index is then normalised to a scale of 0% – 100%, followed by an appropriateness test[3]. Our index has an average value of 41.047%. This indicates that inclusive growth in the SSA sample is low. At the country level, South Africa is detected to have the highest inclusive growth (89.8), whereas Niger (21.7) is characterised by low inclusive growth (see Fig. 1(a)).

[3] A Chi-square (X^2) statistic of 11941.612 and a p-value significant at 1% from the Bartlett (see Table A.1) test shows that our variables used to generate the index are interrelated. KMO statistic of 0.849 (see Table A.1) signifies the adequacy of our variables. Results in Table A.2 suggest that at least there are eigenvalues greater than 1

Table 1
Variable used to construct inclusive growth index

Variable	Variable Definition	Source
Clean energy	Access to clean fuels and technologies for cooking (% of population)	WDI
Electricity	Access to electricity (% of population)	WDI
Mobile cellular	Mobile cellular subscriptions (per 100 people)	WDI
Contributing worker	Contributing family workers, total (% of total employment)	WDI
Employment	Employment to population ratio, 15+, total (%) (modelled ILO)	WDI
Immunisation	Immunisation, DPT (% of children ages 12-23 months)	WDI
Mortality rate	Mortality rate, under-5 (per 1,000 live births)	WDI
Health expenditure	Government expenditure on health (% total government expenses)	WDI
Underweight	Prevalence of underweight, weight for age (% of children under 5)	WDI
Education	Primary education, duration (years)	WDI
Women in parliament	Proportion of seats held by women in national parliaments (%)	WDI
Pupil-teacher ratio	Pupil-teacher ratio, primary	WDI
Equality in primary	School enrolment, primary (gross), gender parity index (GPI)	WDI
Equality in secondary	School enrolment, secondary (gross), gender parity index (GPI)	WDI
Portable water	People using at least basic drinking water services (% of population)	WDI
Primary education	Number of years required to complete primary education	WDI
Sanitation	People using at least basic sanitation services (% of population)	WDI
GDP per capita	GDP per capita (% annual growth)	WDI

Note: WDI represents World Development Indicators. This Table shows the variables used to construct our inclusive growth index.
Source (World Bank Development Indicators, 2023)

The main variables of interest are energy consumption and FDI. Energy consumption was measured with a log of total primary energy consumption (quadrillion British thermal units (Btu) of a country. The paper disaggregates total energy into renewable and non-renewable sources to inform policy discussions on which form of energy promotes inclusive growth as shown in Table 2. Table 2 shows an average total energy consumption value of 31.734% signifying, on average, about 31.734% of the available energy is being used. In other words, around one-third of the total energy available is being consumed.

Table 2
Definition of variables

Variables	**Description**	**Source**	Obs	Mean	Std. Dev.	Min	Max
Inclusive Growth	Inclusive growth index calculated based on the PCA approach	Authors	620	41.047	17.076	0.000	100
Energy consumption (EC):							
Total energy	Log of total energy consumption		640	31.734	1.532	28.034	36.284
Renewable	Log of renewable energy consumption (% of total final energy consumption)	EIA	640	29.76	1.771	21.993	32.683
Non-renewable	Log of non-renewable EC which is fossil fuel comprising of coal, oil, petroleum, and natural gas products.	EIA	640	31.454	1.55	28.02	36.27
Foreign Direct Investment	Net Foreign Direct Investment Inflow (% GDP)	WDI	640	3.411	5.144	-11.199	39.828
Interaction term:	$(\text{Energy} \times \text{FDI})_{it}$	Authors					
Domestic Capital	Gross fixed capital formation (% of GDP)	WDI	640	21.188	9.222	-22.786	81.021
Trade Openness	Trade (% of GDP)	WDI	640	66.928	31.604	20.723	192.537
Inflation	Inflation, consumer prices (% annual)	WDI	607	9.226	31.668	-9.616	513.907
Population	Population growth (% annual)	WDI	640	2.491	.827	-.402	5.078
Control of corruption	Control of corruption, estimate	WDI	608	-.642	.567	-1.555	1.245
Oil rent	Oil rents are the difference between the value of crude oil production at regional prices and total costs of production.	WDI	636	3.823	10.201	0.000	57.513

Notes: EIA denotes Energy Information Agency; WDI is World Development Indicators. This Table features the variables used, the data sources, and how they are measured.
Sources: STATA Version 17, 2024

Table 3

Correlation matrix and variance inflation factor

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	VIF_1	VIF_2	VIF_3	VIF_4
(1) IG	1.000														
(2) TC	0.461	1.000										1.840			
(3) REC	0.183***	0.768***	1.000										1.760		
(4) NREC	0.496***	0.980***	0.664***	1.000										1.890	
(5) FDI	0.021	0.072*	0.141***	0.042	1.000										1.760
(6) GCF	0.216***	0.116***	0.050	0.148***	0.391***	1.000						1.760	1.760	1.760	1.760
(7) TO	0.357***	-0.041	0.111***	-0.066*	0.331***	0.287***	1.000					1.700	1.630	1.740	1.630
(8) cpi	-0.061	0.063	0.132***	0.020	0.045	-0.034	0.028	1.000				1.480	1.450	1.490	1.450
(9) pop	-0.454***	0.013	0.051	0.017	0.107***	0.199***	-0.350***	0.050	1.000			1.280	1.270	1.300	1.270
(10) cc	0.490***	0.010	-0.112***	0.037	-0.027	0.117***	0.219***	-0.109***	-0.402***	1.000		1.090	1.030	1.130	1.030
(11) oil	0.101**	0.127***	0.106***	0.147***	0.169***	0.284***	0.346***	0.130***	0.299***	-0.298***	1.000	1.040	1.480	1.040	1.480
Mean VIF												1.450	1.760	1.480	1.760

Notes: IGI index is Inclusive Growth Index, REC is log of renewable energy, NREC is log of non-renewable energy, FDI is foreign direct investment; GCF is gross capital formation; Lab is labour force; TO is Trade Openness; GDP is GDP per persons employed; *p<0.10; **p <0.05; ***p <0.01; VIF denote variance inflation factor; VIF_1 is when renewable was main variable of interest whereas VIF_2 is when non-renewable was main variable of interest.

Source: STATA, Version 17, 2024.

The country-level data shows South Africa (36.2) with the highest total energy consumption, whereas Comoros (28.5) consumes the lowest energy (see Figure 2(a)). Disaggregating energy consumption into renewable and non-renewable, the averages are reported to be 29.76 and 31.45, respectively. Also, South Africa consumes more non-renewable, with a share of 36.2%, whereas Mozambique leads in renewable consumption at 32.5% (see Fig. 2(b)). Data on FDI, proxied by FDI (%GDP), is obtained from WDI. FDI to the sample countries has a mean value of 3.411% and a minimum of -11.199%, which shows that SSA still has very low inflows of FDI. This indicates that, on average, the FDI inflow to these countries is relatively low, with some countries experiencing negative FDI, particularly in the Sub-Saharan Africa region. On a country level, Mozambique (11.8% of GDP) and Congo Republic (10% of GDP) are seen to have the greater inflow of FDI whilst Comoros (0.459%) and Burundi (0.461% of GDP) attracted the least inflow of FDI (see Fig. 1)

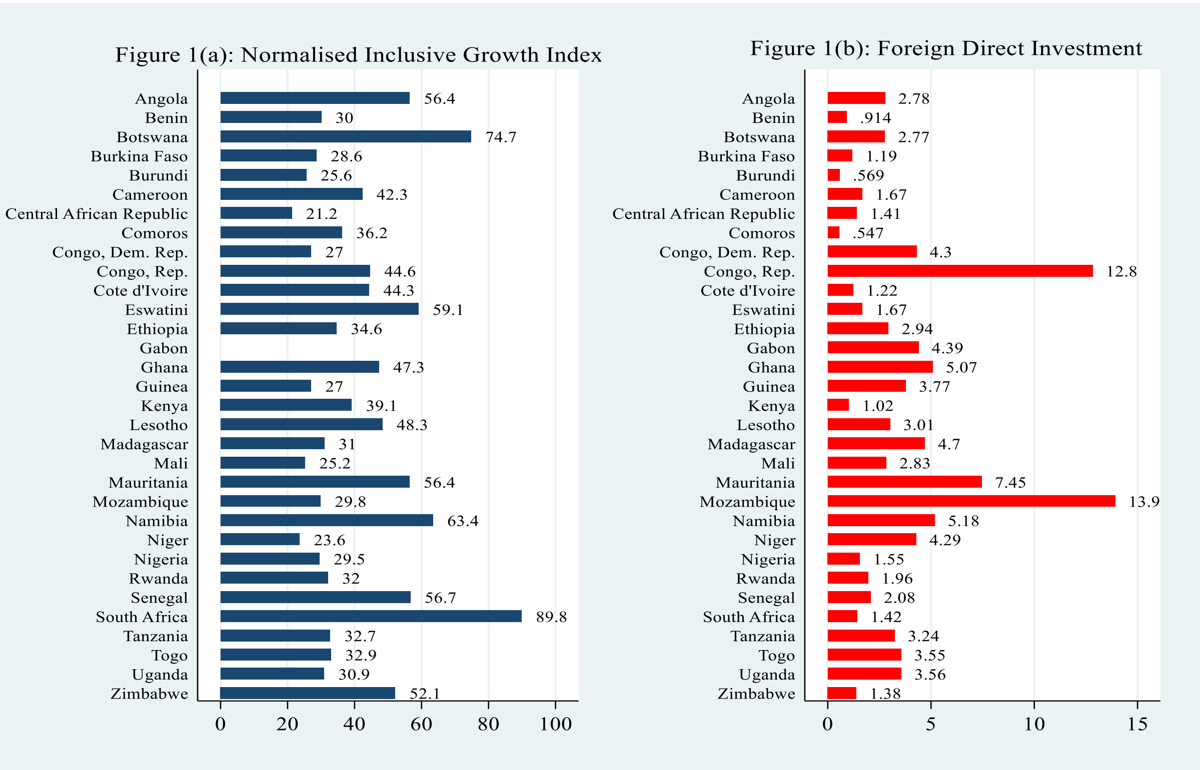

Fig. 1. In-country inclusive growth and FDI, 2000 -2019

Source: STATA Version, 2024.

Following the extant literature (Adegboye et al. 2020a, 2020b; Iddrisu et al., 2023; Ofori & Asongu, 2021a, 2021b), SSA characteristics and availability of data, the paper also includes several control variables in the estimated models. These are domestic capital, trade openness, inflation, population, control of corruption and oil rent (see Table 2). Domestic capital and inflation are proxied by gross capital formation (% GDP) and consumer prices (% annual), respectively. Trade openness, proxied by net trade (% GDP), captures trade liberalisation, whilst population growth shows the growth level of the population in percentage annually. While control of corruption measures how well corruption has been managed, oil rent denotes the difference between the value of crude oil production at regional prices and total production costs.

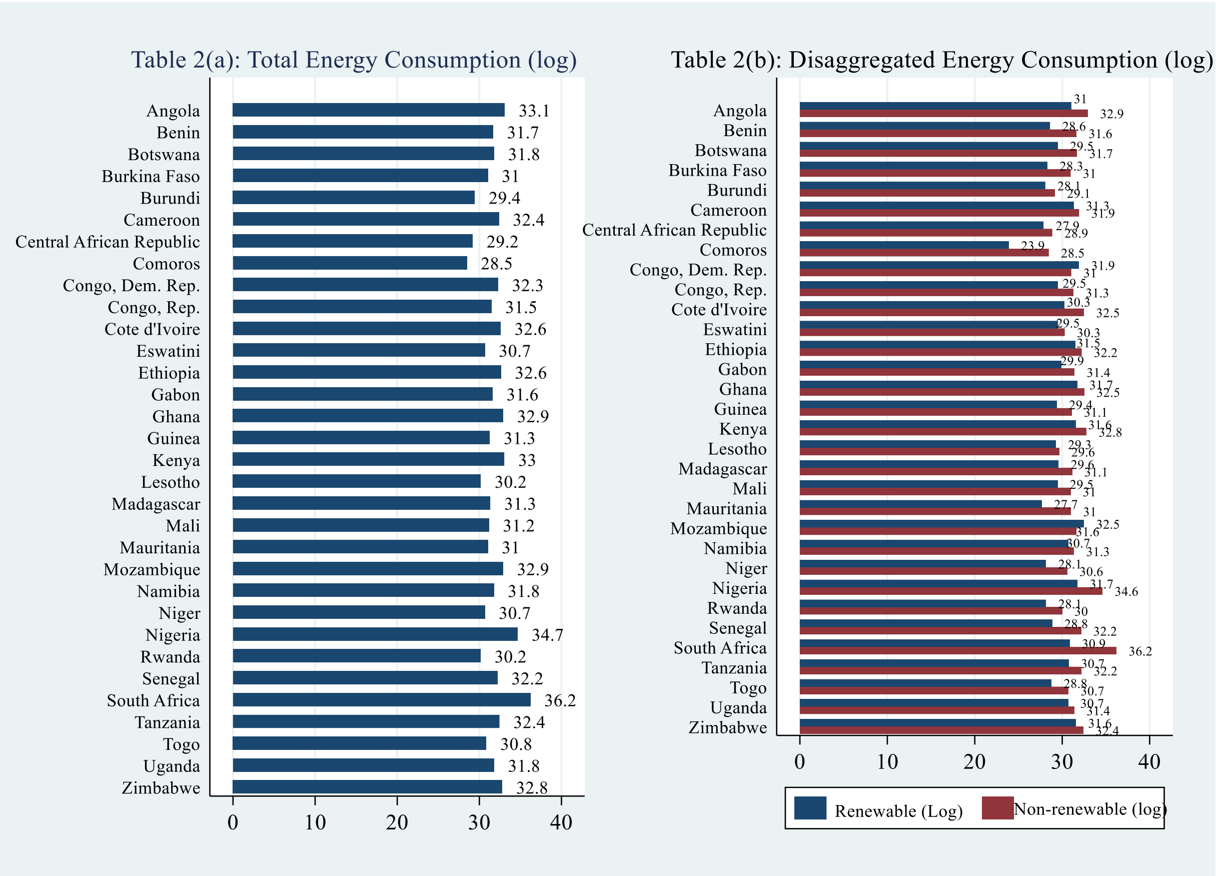

Fig. 2. In-country Energy Consumption, 2000 -2019

Source: STATA Version, 2024.

Table 3 presents the Pearson correlation for all variables included in the empirical analysis. The Table shows that all the variables significantly affect inclusive growth. Apart from the high correlations between total and disaggregated energy, all correlations are below 0.5. Nevertheless, we do not include both variables in the same estimated model so it does not present multicollinearity problems. A multicollinearity test was conducted using the Variance Inflation Factor (VIF) to ensure that no high correlation would affect our regression output. The findings, reported in Table 3 reveal the absence of multicollinearity, as indicated by individual VIFs below 5, and the average VIF below 10, aligning with the rule of thumb.

3.2 Method

3.2.1 Empirical model

Drawing upon neo-classical theory and some empirical studies (Adegboye et al. 2020a, 2020b; Iddrisu et al., 2023; Ofori & Asongu, 2021a, 2021b) as our foundation, we delineate our empirical model, initiating with the estimation of equation (1). This enables us to explore the direct influence of energy consumption and FDI on the promotion of inclusive growth. Equation (2) on the other side captures the non-linear relationship between FDI and inclusive growth. We delve into examining the interactive effect of energy consumption and FDI on inclusive growth which is specified in equation (3).

$$IG_{it} = a + \beta_0 IG_{it} + \beta_1 EC_{it} + \beta_2 FDI_{it} + \beta_3 GCF_{it} + \beta_4 TO_{it} + \beta_5 \mathrm{CPI}_{it} + \beta_6 POP + \beta_7 CC + \beta_8 OR + \varepsilon_{it} \quad (1)$$

$$IG_{it} = a + \beta_0 IG_{it} + \beta_1 FDI_{it} + \beta_2 FDI^2_{it\,it} + \beta_3 GCF_{it} + \beta_4 TO_{it} + \beta_5 \mathrm{CPI}_{it} + \beta_6 POP + \beta_7 CC + \beta_8 OR + \varepsilon_{it} \quad (2)$$

$$IG_{it} = c + \forall_0 IG_{it} + \forall_1 EC_{it} + \forall_2 FDI_{it} + \forall_3 GCF_{it} + \forall_4 TO_{it} + \forall_5 \mathrm{CPI}_{it} + \forall_6 POP + \forall_7 CC + \forall_8 OR + \forall_9 (EC \times FDI)_{it} + \varepsilon_{it} \quad (3)$$

From equations (1) to (3), IGI_{it} is the index for the inclusive growth of the country i at time t. EC_{it} represents the energy consumption of country i at time t, which captures *REC* and *NREC*. FDI denotes foreign direct investment. *GCF, TO, CPI, POP, CC* and *OR* represent domestic capital, trade openness, inflation, population, control of corruption and oil rent, respectively. In the equations, *i* is the country-specific dimension and *t* is the time period. The error term, ε_{it}, is decomposed into $k_i + m_t + \epsilon_{it}$, where; k_i represents the country-fixed effect, m_t represents the time-fixed effect and ϵ_{it} represents the error term that varies over entity and time. The interaction variable, $(EC \times FDI)$, in equation (4) indicates the interaction between energy consumption and FDI.

According to contemporary literature on interactive regressions (Iddrisu et al., 2023; Ofori & Asongu, 2021a, 2021b), to capture the value of the joint effect, the net effect must obtain by partially differentiating the dependent variable concerning the main variable of interest. Therefore, to obtain the net effect of energy consumption, we partially differentiate equation (4) with respect to energy consumption, which gives rise to equation (5).

$$\frac{\partial IG_{it}}{\partial Energy_{it}} = \forall_1 + \forall_9 \overline{FDI}_{it}, \quad (5)$$

where, $\overline{FDI}_{it}$ denotes the mean of FDI, ∂ is the difference operator, IG_{it} is the normalised inclusive growth index and $Energy_{it}$ is energy consumption. We proceed to examine the interactive term and threshold of FDI with renewable and non-renewable energy consumption on inclusive growth.

3.2.2 Estimation Technique

The paper uses the two-stage GMM system approach suggested by Blundell and Bond (1998) to estimate equations (3) and (4) due to concerns of endogeneity and the complex relationship between variables in a 32-country dataset over 25 time periods. The primary concern arises from endogeneity caused by including the lag of the dependent variable in both equations, creating a loop between variables. This endogeneity is amplified in first-difference estimations, affecting the reliability of the estimators. Arellano and Bond (1991) propose instrumenting endogenous variables to mitigate this issue, advocating for the system GMM estimator over the first-difference GMM. This approach is supported by some literature (Bond et al., 2001; Windmeijer, 2005) and updated by (Roodman, 2009). The study follows suit, employing Roodman (2009) approach by instrumenting level and first-difference equations with lagged variables differently, addressing concerns of bias and unreliable standard errors. To prevent instrument overuse, a two-step GMM system is adopted as recommended by Roodman (2009).

4. Empirical results and discussions

Tables 4 and 5 present two-stage system GMM findings on energy consumption, FDI, and inclusive growth. Both tables reveal a significant positive effect of lagged inclusive growth on current inclusive growth, implying present policies for inclusivity enhance future outcomes. This validates a prerequisite for a two-stage system GMM estimation. Endogeneity correction instruments are valid, indicated by statistically insignificant p-values in the Hansen test. Autocorrelation at order 2 is observed in the results. These findings underscore the importance of policy interventions for fostering inclusive growth and the effectiveness of the applied methodological approach in addressing endogeneity.

4.1 Direct effect of energy consumption and FDI on inclusive growth

Starting with the direct effect of energy consumption, Table 4 shows that energy consumption promotes inclusive growth in SSA. The reported positive and significant coefficient of 4.55 for total energy consumption implies that a unit increase in energy consumption promotes inclusive growth by 4.55 units, ceteris paribus (see column 1 of Table 4). By implication, energy consumption can promote inclusive growth by providing essential resources and opportunities across various sectors, thereby, reducing disparities and enabling broader participation in economic, social, and educational activities. This result confirms the assertion of the President of Senegal and chairperson of the African Union, who argued that energy consumption can promote economic growth and development, hence, the need to develop and exploit energy potentials in Africa[4] [5]. The positive relationship between energy consumption and inclusive growth in the region aligns with the objectives of SDG 7 of Agenda 2030 and Agenda 2050, emphasising the importance of reliable, accessible and affordable energy sources and their impact on development[6]. The empirical findings suggest that access to reliable and affordable energy can foster shared growth through private sector growth, industrialisation, and employment. Empirically, our result is consistent with results reported in other studies (see Adams et al., 2016; Akadiri & Ajmi, 2020; Doğan et al., 2020; Kouton, 2021).

The paper disaggregates energy consumption into renewable energy (REC) and non-renewable (NREC) to observe their impact on inclusive growth in Africa. The results in Table 4 (columns 2 and 3) reveal that both energy consumption promotes inclusive growth in Africa; however, NREC (*coefficient*; 6.6587) has a more positive significant impact on inclusive

[4] https://www.ucl.ac.uk/news/2022/nov/opinion-africa-has-vast-gas-reserves-heres-how-stop-them-adding-climate-change

[5] https://au.int/en/pressreleases/20220722/africa-speaks-unified-voice-au-executive-council-adopts-african-common#:~:text=The%20African%20Common%20Position%20encourages,the%20ambitions%20of%20Agenda%202063.

[6] This refers to efforts geared towards to achieving net zero carbon emissions and renewable energy has been identified as one of the key modules for achieving this target by 2050 (UNFCCC, 2015).

growth than REC (*coefficient;* 1.8935). This can be attributed to the fact that NREC, like coal or conventional fossil fuels, are cheaper in the short term than renewable energy sources, which often require substantial upfront investments in infrastructure (Jinapor et al., 2023).

Table 4
2SGMM results for energy consumption, FDI and inclusive growth

VARIABLES	(1) IG	(2) IG	(3) IG	(4) IG	(5) IG
L.IG	0.6424***	0.7176***	0.6812***	0.9043***	0.8994***
	(0.0711)	(0.0511)	(0.0813)	(0.0397)	(0.0288)
TC	4.5544***				
	(1.4781)				
REC		1.8935**			
		(0.7551)			
NREC			6.6587***		
			(1.4213)		
FDI				-0.9422***	-0.6625**
				(0.1981)	(0.2438)
FDI^2					0.0173***
					(0.0060)
GCF	0.0615	0.3248**	-0.4121***	0.2530***	0.1757**
	(0.1087)	(0.1383)	(0.1023)	(0.0706)	(0.0680)
TO	-0.1676***	-0.2165***	-0.0152	-0.0027	-0.0061
	(0.0509)	(0.0606)	(0.0203)	(0.0497)	(0.0113)
CPI	-0.1280***	-0.1168***	-0.0622*	-0.0477*	-0.0384
	(0.0322)	(0.0345)	(0.0311)	(0.0278)	(0.0263)
POP	-3.4774	-7.7551**	2.8042	-1.8032	-2.7801**
	(3.0187)	(3.0744)	(2.9755)	(2.2079)	(1.3313)
CC	-1.9323	-3.6162	2.1207	-2.1349	-2.5261
	(4.3538)	(4.0664)	(1.9455)	(4.7598)	(1.6691)
OR	0.9437**	1.2418***	0.4562*	0.2539***	0.3200**
	(0.4072)	(0.3657)	(0.2605)	(0.0819)	(0.1316)
Constant	-115.0112**	-22.7829	-195.2811***	5.1933	8.1421**
	(47.6493)	(23.2598)	(46.3841)	(7.9805)	(3.2348)
Observations	532	532	532	532	532
Number of id	31	31	31	31	31
Instruments	25	25	23	26	24
Wald Statistic	346.1	1212	238.2	7954	4167
Wald P-value	0	0	0	0	0
Hansen P-Value	0.203	0.200	0.505	0.217	0.301
Sargan P-Value	0.0573	0.145	0.0175	0.0592	9.35e-09
AR(1)	0.0203	0.0109	0.0318	0.00663	0.00599
AR(2)	0.267	0.603	0.316	0.467	0.0664

Note: The standard errors are in parentheses and brackets display the probability; *, **, *** means 10%, 5%, 1% critical level. L.IG, TC, REC, NREC, FDI, FDI2, GCF, TO, CPI, POP, CC and OR represent inclusive growth lag, total energy consumption, renewable energy consumption, non- renewable energy consumption, foreign direct investment and its square, domestic capital, trade openness, inflation, population, corruption control and oil rent respectively.

Source: STATA Version, 2024.

Therefore, making energy more accessible to certain communities with limited financial resources. For instance, in the initial phases of renewable energy utilisation, its primary adoption tends to concentrate more within urban regions than in rural or remote areas (see Bhat, 2018; Bhattacharya et al., 2016). Also, in SSA, a significant section of the population depends on non-renewable energy such as kerosene, petrol, diesel and other petroleum products, firewood and charcoal (without afforestation) due to low sources of income, inadequate knowledge or skill level in renewable energy.

Table 4 also reveals that FDI has a non-linear relationship with inclusive growth. It can be detected from the Table that while FDI has a significant and negative effect on inclusive growth, its squared term promotes inclusive growth (see column 5 of Table 4). This could imply that FDI might not significantly contribute to inclusive growth at low levels due to various challenges, such as a lack of a sufficiently large manufacturing sector and infrastructure base in the host country (Kang & Martinez-Vazquez, 2022). However, it is shown that as FDI increases beyond a certain threshold, its positive impacts become more pronounced, leading to a squared or amplified effect on inclusive growth, especially when coupled with policies that ensure equitable distribution and address social and economic disparities. The non-linear relationship could also signify that the inflow of FDI to SSA may not be adequate to spur inclusive growth, considering the current economic and social needs. Therefore, there is a need to implement diverse policies to attract more FDI to SSA to a point where it will start to enhance shared growth and prosperity. This aligns with empirical studies suggesting that while a certain level of FDI is coming into SSA, it falls short considering the continent's growth trajectory and developmental requirements (Adegboye & Okorie, 2023; Shittu et al., 2023). Our findings could also imply that FDI flowing into SSA is channelled into the service and extractive sectors where fewer jobs are generated annually for the masses; therefore, when proper policies are implemented later, the spillover effect can be efficiently and sufficiently allocated. Empirically, our findings do not support some studies (e.g., Iddrisu et al., 2023; Anand et al., 2013; Ofori & Asongu, 2021, 2022), who argue that the initial levels of FDI are an essential determinant of inclusive growth.

4.2 The moderation role of FDI on energy consumption-inclusive growth nexus

Evidence of the joint effect of energy consumption and FDI on inclusive growth in SSA can be seen in Table 5. The reported results suggest that FDI matters for the moderating effect of energy consumption towards attaining an inclusive growth agenda. To identify the magnitude of this effect, we compute the net effect of energy consumption on inclusive growth as specified in equation (5) which is presented in Table 5 as the net effect. To verify the statistical significance of this magnitude, we extended our analysis to examine the joint significant effect. Our findings indicate that energy consumption and FDI, together, have a significant collective influence on fostering inclusive growth in Africa (see Table 5). Table 5 shows that the coefficient (9.3867 unit) of the net effect of energy consumption implies that for SSA governments to extract benefits from energy consumption, they must promote and attract more FDIs into their economies. Also, the development of the energy sector is both capital and technology-intensive, requiring the support of foreign investors who can bring in the needed capital and technological know-how. Therefore, benefits from FDI via technological spillover, energy-saving and clean energy technologies can induce inclusive growth in SSA. This also means that, in settings like SSA where lags in meeting the growing energy demand[7] are apparent, FDI can also play a key role by providing the needed investment in the areas of generation capacity and energy management, which are essential for persistent energy supply, productivity and social inclusion. This, in effect, can fuel equitable income growth and distribution by reducing the cost of production, job creation and improvement in household consumption by reducing the share of income spent on energy.

Similar to the direct impact in Table 4, Table 5 shows a stronger synergy between FDI and non-renewable energy consumption (net effect: 6.5956) compared to renewable energy consumption (net effect: 4.9706). This is likely due to the substantial investment demands of non-renewable energy projects, which attract FDI through established markets and higher returns.

[7] As at 2018, 58 million people in SSA were without access to modern or clean energy (electricity) and it is estimated that 660 million people will be without access to electricity by 2030 following the aftermath of the COVID-19 pandemic (EIA, 2020).

Table 5
Moderation role of FDI on energy consumption-inclusive growth nexus

	(1)	(2)	(3)
Lag of inclusive growth	0.5582***	0.6457***	0.5676***
	(0.1523)	(0.0916)	(0.0743)
TEC	6.9117**		
	(3.1679)		
REC		3.4563**	
		(1.5150)	
NREC			9.2631***
			(1.1813)
FDI	-23.8046**	-13.8268***	24.9186***
	(9.8239)	(4.6357)	(8.0170)
GCF	-0.1526	0.2184	-0.2344***
	(0.1193)	(0.1474)	(0.0472)
Trade openness	0.0502	-0.0272	-0.0546*
	(0.0429)	(0.0485)	(0.0311)
CPI	-0.1274**	-0.1279***	-0.0411
	(0.0521)	(0.0395)	(0.0269)
Population growth	7.8847**	-0.1429	0.2490
	(3.4934)	(2.8432)	(1.9891)
Control of corruption	-2.3950	-3.7877	1.9842
	(4.8599)	(5.9875)	(2.6253)
Oil rent	0.6870**	0.8643***	-0.2448**
	(0.3194)	(0.2955)	(0.1065)
TC×FDI	0.7256**		
	(0.3046)		
REC×FDI		0.4439***	
		(0.1529)	
NREC×FDI			-0.7896***
			(.2542)
Net effects	9.3867***	4.9706***	6.5956***
Constant	-223.4284**	-94.5062**	-263.8533***
	(101.2241)	(44.9939)	(36.0001)
Observations	532	532	532
Number of C_ID	31	31	31
Instruments	24	24	29
F- Statistic	285.8***	184.1***	3570***
Hansen P-Value	0.380	0.154	0.167
Sargan P-Value	0.903	0.406	0.256
AR(1)	0.0510	0.0143	0.00414
AR(2)	0.897	0.714	0.323
Joint significant effect	10.23***	10.56***	22.09***

Note: The standard errors are in parentheses and brackets display the probability; *, **, *** means 10%, 5%, 1% critical level. L.IG, TC, REC, NREC, FDI, FDI2, GCF, TO, CPI, POP, CC and OR represent inclusive growth lag, total energy consumption, renewable energy consumption, non-renewable energy consumption, foreign direct investment and its square, domestic capital, trade openness, inflation, population, corruption control and oil rent respectively.

Source: STATA Version, 2024.

These sectors historically dominate global energy markets, aligning well with FDI preferences, while their stable infrastructure contrasts with the variable returns of renewable energy sources affected by weather patterns (IRENA, 2021).

4.3. The effect of the control variables on inclusive growth

Focusing on the control variables, the results in the Tables show that each variable (except proxy for corruption) impacts inclusive growth to some extent. However, Table 4 illustrates varying degrees of impact among these control variables. For instance, the study reveals that domestic capital promotes inclusion, except in the NREC model. Increased levels of inclusive growth are associated with higher domestic capital, consistent with growth theory (M. R. Solow, 1956; Stern, 2019), which suggests that domestic capital is an important determinant of growth. The results also indicate that trade openness negatively influences inclusive growth. Trade openness in Africa, reliant on raw commodity exports, amplifies vulnerability to global market shifts. While favouring specific sectors, it exacerbates inequalities, limiting inclusive growth by leaving some regions or industries behind. Our empirical do not support some empirical studies (Adom et al., 2019; Opoku et al., 2019).

According to Table 4, inflation disrupts inclusive growth by creating economic uncertainty, impeding businesses' ability to strategies and invest. This deters foreign investment, lowers consumer confidence, and hampers economic stability, impacting long-term growth opportunities. Table 4 shows that population growth constrains inclusive growth by burdening resources and infrastructure, resulting in difficulties in delivering vital services such as healthcare, education, and sanitation. This strains government finances and restricts investments crucial for inclusive development. Table 4 reveals that oil rent can contribute to inclusive growth in Africa through diversification of oil revenue to different sectors, job creation, and equitable distribution of benefits across society.

5. Conclusion and Policy Implications

5.1 Conclusion

In line with seeking broader welfare and development objectives, as articulated in Sustainable Development Goals, this study investigates (1) the effect of energy consumption and FDI on inclusive growth and (2) the joint effect of consumption and FDI on inclusive growth for 33 SSA countries spanning 2000 to 2019. To do this, the paper utilises the two-stage system GMM approach, keeping in mind the policy implications of the finding. This approach is more robust against misspecification and addresses endogeneity concerns. The results from this approach show a significant positive effect of lagged inclusive growth on current inclusive growth, implying prevailing policies for inclusivity enhance future outcomes. This validates a prerequisite for a two-stage system GMM estimation. The documented results also indicate that the endogeneity correction instruments are valid, as shown by the statistically insignificant p-values in the Hansen test. These underscore the importance of policy interventions for fostering inclusive growth and the effectiveness of the applied methodological approach in addressing endogeneity. The results also revealed that energy consumption broadly impacts inclusive growth positively. Disaggregating energy consumption into renewable (REC) and non-renewable (NREC) sources, the study finds both promote inclusive growth, with NREC having a more significant impact. There is a non-linear relationship between FDI and inclusive growth, where FDI initially dampens but eventually promotes growth after a threshold. FDI synergizes with energy consumption, enhancing inclusive growth, especially when high FDI levels increase energy consumption. Notably, FDI has a greater moderating effect on the NREC-inclusive growth nexus, due to SSA's abundance of non-renewable energy resources in commercial quantities compared to renewable resources.

5.2 Policy Implications

This paper contributes to the policy discourse aimed at identifying channels crucial for promoting inclusive growth in SSA. To this end, we pay attention to SDG 1, 5, 7, 8 and 10 and Aspiration 1 of Africa’s Agenda 2063 to examine pathways through which energy consumption and FDI can influence socioeconomic sustainability in SSA. Based on the empirical findings, several policy recommendations are made. Firstly, there is an urgent need for SSA’s economies to prioritise energy sector investments and development to ignite economic activities, generate employment, and enhance living conditions towards attaining inclusive growth. To achieve this, SSA economies must build adequate regulatory frameworks, develop an attractive energy market and improve energy sector governance to incentivise private capital investment in energy sector-related projects. Also, aligning energy initiatives with sustainable development goals integrates social, economic, and environmental factors, while partnerships between governments, private sectors, and global organisations can pool resources for robust energy infrastructure in SSA. In addition, given that energy sector investments are capital intensive, the SSA government are encouraged to control, exploit and transform its mineral resources locally with an emphasis on value addition to generate the much-needed financial resources for investments in energy-related projects. African leaders and policymakers should collaborate with National Development Banks, international development partners and specialised organisations towards building a strong and resilient financial market to unlock much-needed capital for sustainable energy projects on the continent. These partnerships can help leverage private sector capital to finance energy sector investments, especially in green energy. SSA countries must also develop the capacity to effectively utilise their domestic capital and gain greater access to global capital for energy sector investments. Secondly, although NREC has more effect on inclusive growth than REC, in light of the call to promote sustainable economic growth and the urgent need to ensure environmental sustainability, we strongly recommend SSA governments prioritise sustainable energy transition and adopt policies to unlock the continent's vast renewable energy potential to reduce overreliance on non-renewable energy. Various investment funds, such as the Africa Renewable Energy Fund and Clean Technology Fund, supported by governments and Development Finance Institutions, have profoundly impacted Africa's renewable energy landscape. SSA governments should seize the opportunity to secure funding for renewable energy projects by collaborating with such organisations. Thirdly, SSA should remain steadfast in implementing and leveraging existing policies such as SEs, AfCFTA, and NEPAD to attract more FDI. The non-linear relationship between FDI and inclusive growth indicates that, initially, FDI may reduce inclusive growth, but ultimately, it promotes it in the long term. This underscores the need for continued and enhanced efforts to draw more FDI into SSA, which can eventually foster inclusive growth. This can be achieved through policies that channel FDI inflows into critical sectors, ensuring that such investments promote inclusive growth. SSA governments must promote and provide a stable political environment, adopt laws that help attract private sector capital inflows, and enhance the fight against corruption. Fourthly, since FDI moderates the nexus between energy consumption and inclusive growth, it is recommended that FDI be attracted, especially those that consume more energy. This is because the inflow of FDI leads to high energy consumption, which induces inclusive growth. This can be achieved when policymakers invest in infrastructure, particularly in the energy sector, to support renewable and non-renewable energy projects, making the region more attractive to foreign investors. SSA countries have to incentivise the inflow of FDI towards clean energy investments to ensure sustainable development. This can be accomplished with appropriate and effective regulatory frameworks and fiscal policies, including tax cuts to foreign investments oriented towards renewable energy. Further policies such as carbon sinks, principles of polluter payment, and building capacity for project preparation, which are bankable and capable of attracting investments must be promoted. These policy interventions will certainly help attract foreign and local private investors to complement government efforts in energy investments, particularly in the area of renewable energy development.

5.3 Future directions

The study leaves room for further research as this study focuses on selected SSA countries; hence, any future study can explore a specific country-level analysis. In addition, future research studies can focus on the various components of renewable energy and their unique effect on inclusive growth.

Declaration of Competing Interest

The authors declare no conflict of interest.

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Authors' Contribution

Conceptualisation [JAJ, JYA]; Methodology [JAJ]; Software and validation [JAJ], Data curation [JAJ]; Writing- original draft preparation [JAJ]; Visualisation and investigation [JAJ]; Supervision [JYA, MG], Writing- Reviewing and Editing [JYA, MG].

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Appendix

Test A.1
Pre-Test for PCA

Kind of PCA test:	
Determinant of the correlation matrix	0.000
Kaiser-Meyer-Olkin Measure of Sampling (KMO)	0.849
Bartlett test of sphericity: Chi-square	11941.612
P-value	0.000

Table A.2
Principal components and eigenvalues (Inclusive growth index)

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	**8.075**	**5.738**	**0.385**	**0.385**
Comp2	**2.337**	**0.513**	**0.111**	**0.496**
Comp3	**1.824**	**0.583**	**0.087**	**0.583**
Comp4	**1.241**	**0.074**	**0.059**	**0.642**
Comp5	**1.167**	**0.217**	**0.056**	**0.697**
Comp6	0.950	0.166	0.045	0.743
Comp7	0.784	0.099	0.037	0.780
Comp8	0.685	0.113	0.033	0.813
Comp9	0.572	0.043	0.027	0.840
Comp10	0.529	0.056	0.025	0.865
Comp11	0.473	0.076	0.022	0.887
Comp12	0.397	0.057	0.019	0.906
Comp13	0.340	0.039	0.016	0.922
Comp14	0.301	0.039	0.014	0.937
Comp15	0.262	0.027	0.013	0.949
Comp16	0.235	0.026	0.011	0.961
Comp17	0.209	0.014	0.010	0.970
Comp18	0.195	0.029	0.009	0.980
Comp19	0.166	0.016	0.008	0.988
Comp20	0.149	0.038	0.007	0.995
Comp21	0.111	.	0.005	1.000