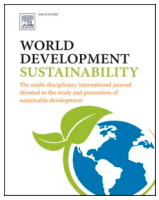
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Does the relative size of agricultural exports matter for sustainable development? Evidence from Sub-Sahara Africa

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A B S T R A C T

This study investigates the effect of the relative size of agricultural exports on sustainable development across 46 sub-Saharan African countries between 1999 and 2020. Using data on adjusted net savings and sustainable development indices as proxies for sustainable development, the empirical analysis applies the Driscoll-Kraay standard error method which accounts for cross-sectional dependence. The results indicate that the relative size of agricultural exports has a positive effect on sustainable development while agricultural non-export production is found to contribute more to sustainable development than agricultural exports. Given agriculture's dominance and the agro-based export potential for these economies, the study recommends pro-agricultural export policies aimed at expanding agricultural exports over non-agricultural exports if the choice is between exporting agricultural commodities and exporting non-agricultural commodities. However, the import substitution strategy should be prioritized over the agricultural export promotion strategy when choosing between exporting agricultural commodities and producing for domestic consumption for higher sustainable outcomes.

1. Introduction

The fundamental tenets of sustainable development are the abolition of poverty and resource neglect through increased self-reliance and enhanced social amenities within the constraints of natural resource availability [1]. In recent years, researchers and policymakers have focused more on the issue of sustainability, as simply continuing existing development strategies is unable to yield sustainable development. The idea is understood to be challenging, encompassing a wide range of issues [2]. Despite a few notable achievements in international cooperation as well as global anecdotes of the success of sustainable development, decades of development aid and national initiatives have not resulted in the abolition of extreme poverty for sizable portions of the global population or the creation of sustainable global economic advancement [3]. Goals 2 and 12 of the Sustainable Development Agenda, "End Hunger, Achieve Food Security, Improve Nutrition, and Promote Sustainable Agriculture," and "Responsible Consumption and Production" are accelerating goals that, by 2030, will bring other goals closer to being met. Specifically, SDG-2 is essential to the achievement of the entire Sustainable Development Goals agenda [4].

Agriculture has long been considered a vital development instrument for accomplishing sustainable development objectives, boosting economic growth, eliminating poverty and ensuring food security in sub-Saharan Africa [5]. However, the growth of agriculture in the region is still precarious, and it has yet to reach the sustained 6 % annual rate estimated as necessary to meet the Sustainable Development Goal of cutting poverty in half by 2030 [6]. Agricultural exports are a significant contributor to the economic growth of SSA countries. However, there are constraints behind, between, and beyond the border that have a direct and indirect impact on these countries' agricultural export performance. Overcoming these constraints, which are not limited to poverty and associated development challenges, are also critical for achieving SDGs 2 and 12, and agricultural production is a segment in which these SDGs can work in tandem [7]. As a result, most countries concentrate on agricultural exports to drive their economies to accelerate the attainment of sustainable growth. This includes Africa's developing countries, which are heavily reliant on agriculture, with agricultural exports being a crucial source of growth in these regions [8].

In conclusion, understanding the effect of the relative size of

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agricultural exports on sustainable development in Sub-Saharan Africa is crucial for policymakers, researchers, and development practitioners seeking to promote inclusive and resilient growth in the region. By shedding light on the complexities of this effect, this research aims to inform evidence-based policy decisions, foster sustainable agricultural practices, and contribute to the broader discourse on sustainable development in Sub-Saharan Africa. In this context, sustainable development includes not only economic growth but also social and environmental dimensions, such as poverty alleviation, food security, natural resource management, and climate change resilience. The paper will explore the theoretical and empirical effect of agricultural export on sustainable development in the region, which is anchored on the Neoclassical growth theory.

It is in this regard that the current study attempts to investigate the effect of the relative size of agricultural exports on sustainable development in sub-Sahara Africa. This research is novel in the sense that it focuses on the effect of agricultural export which is an area that has received little attention in previous empirical studies as most studies dwell more on the effect of economic-wide trade and sometimes, export on economic growth [9–12]. Furthermore, the study explores the differential effects of agricultural export production and agricultural non-export production on sustainable development as well as the relative effect of agricultural exports and non-agricultural export production on sustainable development. The outcome of the study will pave the way for a more specific and guided policy direction for policymakers by giving more clarity as to whether export promotion is better than import substitution or vice versa as well as where the comparative advantages of these countries lie.

The remainder of the paper presents the literature review, methodology, results and discussion, and conclusions with policy recommendations.

1.1. Stylized facts

Sub-Saharan Africa is a region characterized by significant economic diversity and a profound dependence on agricultural activities. According to the World Bank [13], agriculture remains a critical sector, employing approximately 60 % of the population and contributing between 15 and 20 % of the region's GDP. The economic landscape of Sub-Saharan Africa is unique, with agriculture playing a complex role in livelihood, food security, and economic development. The agricultural systems in Sub-Saharan Africa are highly diverse, spanning from smallholder subsistence farming to more commercialized agricultural production. Agricultural productivity in the region varies significantly, with some countries adopting advanced farming techniques, while others continue to rely on traditional, low-productivity methods [14].

The economic significance of agriculture in sub-Saharan Africa extends beyond mere production. Adeabah and Asongu [15] argue that agricultural exports represent a crucial mechanism for economic development, foreign exchange earnings, and poverty reduction. Agricultural exports are a cornerstone of many SSA economies. Countries such as Côte d'Ivoire and Ghana, which rely heavily on cocoa exports, or Kenya, known for tea and horticultural products, exemplify the region's reliance on agro-based exports. These exports are not only critical for foreign exchange earnings but also for financing development projects [8]. However, the sector faces numerous challenges, including limited technological adoption, climate vulnerability, and inadequate infrastructure, which constrain its full potential contribution to sustainable development.

Furthermore, the United Nations Conference on Trade and Development [16] reports that agricultural exports from Sub-Saharan Africa remain relatively low compared to global standards, accounting for approximately 2–3 % of global agricultural trade. This highlights the immense untapped potential for agricultural development and export diversification in the region. The limited integration into global agricultural value chains presents both a challenge and an opportunity for economic transformation.

2. Literature review

This study is anchored on the neoclassical growth theory, even though several theories have been proposed to explain sustainable development, such as Modernization, World Systems, ecologically unequal exchange theories and the Neoclassical growth theories.

The Modernization theory posits that with the existence of traditional and modern societies, the traditional society is riddled with norms and values that inhibit it from attaining development [17]. To attain development, therefore, these inhibiting values need to be abandoned for modern values of capital accumulation, industrialization and technology, which will bring about economic growth. The growth achieved therefrom is assumed to trickle down to improve the standard of living of the people. The work of Shah et al. [18] on the effect of agriculture on sustainable development using carbon dioxide (CO_2) emissions as a proxy in Brazil, Russia, India, China and South Africa (BRICS) from 1990 to 2019 follows this theory. Findings indicate that agriculture impacts negatively on sustainable development by causing higher CO_2 emissions and degrading the environment. However, further findings revealed that when renewable energy sources are adopted for agricultural processes, the incremental impact that agriculture exerts on CO_2 emissions is reduced, which boosts sustainable development. This result partly aligns with the study conducted for the Association of Southeast Asian Nations (ASEAN) countries by Shah et al. [18] where agriculture was found to worsen environmental quality and consequently, jeopardize the achievement of sustainable development. Similarly, Dar & Asif, [19] examined how agriculture affects sustainable development through agricultural activities and consumption of renewable energy in five South Asian Association for Regional Cooperation (SAARC) countries. The paper reveals that agriculture, proxied by both variables, deters the attainment of sustainable development. These findings follow the modernization theory where traditional activities such as agriculture are hypothesized to deter development as opposed to modern activities, like adopting technology and renewable energy sources to improve traditional agricultural processes.

However, contrasting findings to the modernization theory were discovered by Nhemachena et al. [20] where authors measured the baseline agriculture related to the Sustainable Development Goals (SDG) Index in the Southern region of Africa to establish that while agriculture-related indicators contribute to the achievement of SDGs, investment in priority areas of each country is required to improve the sustainable development impact of agriculture. Also, Busko & Szafranska [21] contradicts this theory as the conversion of best quality lands in Malopolska Province of Poland to non-agricultural use indicated a permanent degradation which jeopardizes sustainable development. Additionally, Zafeiriou [22] assessed the effect of agriculture on sustainable development through CO_2 emissions and per capita income in the European Union using NARDL cointegration method, the result of which indicates that agriculture is a significant contributor to environmental degradation which threatens sustainable development.

The study of Asmat-campos et al. [23] which investigated the contribution of an endogenous agricultural export, *lucuma* on the sustainable development of Peru also shows that adoption on technology boosts development in line with the modernization theory. The study employed data from the Peruvian Ministry of Agriculture and Irrigation and the National Institute of Statistics and Informatics which were analyzed using a multi-criteria approach of Technical (T), Economic (E), Financial (F), Environmental (E), Social (S), Administrative (A), and Legal (L), (TEFESAL). Due to the economic and export value of the agricultural product, the authors proposed strategies to improve its cultivation, business model, value-addition, and commercialization through the use of a hybrid solar dehydration process. Findings revealed that the utilization of solar dehydration equipment for export boosts sustainable development by mitigating carbon emissions (CO_2) which

were estimated to decrease by 8435,066.5 kg with the use of 18,986 solar equipment in 17 regions of the country. Contrastingly, Khan and Hassan [24] explored the effect of high-technology export among other variables on sustainable development in 141 developing countries from 2000 to 2021. Employing the Method of Moment Quantiles Regression (MMQREG) approach and using CO_2 emission as a proxy for sustainable development, high-tech exports were discovered to harm sustainable development by increasing CO_2 emissions in these countries

The World Systems theory postulates an unbalanced relationship between developed and developing countries through unequal trade relations and resource transfer [25]. Relatedly, the theory of ecologically unequal exchange as hypothesized by Bunker [26] advocates for a more nuanced approach that details the complexity and interrelationships among ecological, demographic, economic and social factors that contribute to uneven development. The theory posits an asymmetric exchange of resources between the core (rich countries) and periphery (poor countries) with the latter bearing the negative consequences of extraction in the form of environmental degradation [27]. In this case, it is argued that the rich countries only enjoy the gains of natural resources without bearing the associated cost of extraction to the environment. Research has shown that even though developed countries consume a larger proportion of natural resources, they experience lower environmental degradation compared to their developing counterparts [28]. Bunker [26] therefore proposes that regions engage in global relationships based on their exchange capacities and available advantageous opportunities. Employing a mixed method of focus group discussion and interview, Dawson et al. [29] follows this theory with finding that the contribution of market-oriented agricultural intensification towards the achievement of sustainable development, particularly through ending hunger and malnutrition in Africa and Asia – Rwanda, Uganda and Laos. The study alluded to the assertion that market-oriented agricultural intensification policies have detrimental social and environmental impacts, thereby causing negative effects on sustainable development. This may be attributed to the negative effects of the exploitation of natural resources for agricultural intensification, which will reduce environmental quality.

Other studies that agree with the ecologically unequal exchange theory is Rivera-Ferre [30] which explores the nexus between development, environmental and social impacts of export-oriented products, with a focus on the shrimp aquaculture industry was examined. It was found that promoting production for export purposes, especially by industrial companies, poses a threat to livelihoods and degrades the environment through deforestation and degradation, which harm sustainable development. Also, Velde et al. [31] examined the impact of agricultural intensification, freshwater resources management and economic development on sustainable development in Small Island Developing States (SIDS) using a case study approach and a combination of environmental and economic data. Agricultural export was found to account for over 40 % of export earnings and about 70 % of the GDP. However, increased agricultural exports were discovered to be linked with increased importation and utilization of agricultural chemicals as well as heightening pressure on freshwater lenses. Economic processes were also found to neglect environmental consequences. The study concludes that the above presents a triple jeopardy that reduces environmental quality and jeopardizes sustainable development. A similar finding is reported by Lie et al. [32] in the investigation of how export diversification influences sustainable development through the environmental dimension in the United Arab Emirates (UAE) using data from 1990 to 2019. In [33] where sustainable development was proxied by economic growth and the quality of the environment, the ratio of exports and imports to GDP and the ratio of exports to GDP were found to wield decremental effects on sustainable development in the long run.

Likewise, studies on the export-natural environment relationship mostly agree with the ecologically unequal exchange theory. Lie et al. [32] in the investigation of how export diversification influences sustainable development through the environmental dimension in the United Arab Emirates (UAE) using data from 1990 to 2019. In [33] where sustainable development was proxied by economic growth and the quality of the environment, the ratio of exports and imports to GDP and the ratio of exports to GDP were found to wield decremental effects on sustainable development in the long run. In addition, is Shandra et al. [34] which examines the applicability of the ecologically unequal exchange in the forestry export of low-income and middle-income countries to China and found that such exports lead to environmental degradation of the exporting countries. A similar outcome was established in Shandra et al. [35] where developing countries were found to suffer high rates of environmental loss from deforestation attributed to export flows from developing to developed economies. The study of Can et al. [36] also supports the assertion of ecologically unequal exchange with the finding that export composition among other variables in Newly Industrialized Countries between 1970 and 2014. For Manga et al. [37] where the quality of export in relation to the climate was examined, a mixed result was found. While better export quality improves the environment in India and China, which concurs with Murshed and Dao [38], it was discovered to worsen the environment in the Philippines and Thailand.

In the traditions of neoclassical growth theories, sustainable development can be linked to the role of savings in capital accumulation [39], since the idea of sustainable development is focused on how countries can manage today's resources without compromising those of the future generation. Phelps [40] introduced the Golden Rule of Capital accumulation which shows the optimum level of capital that maximizes consumption. Chichilnisky, Heal, and Beltratti [41] introduced the Green Golden Rule by including environmental factors in the Golden Rule. Hamilton and Clemens [42] introduced the theory of genuine savings which is an augmented measure of savings and wealth in the national account to conceptualize sustainable development. Genuine savings are estimated by deducting the value of resource depletion and environmental degradation from the national savings and adding the value of investment in human capital. In the study of Liu [43] which included four ASEAN countries, increased agricultural activities were found to positively influence sustainable development by mitigating CO_2 emissions and improving environmental quality, which will improve environmental standards for future generations. Also, Shandra et al. [34] discovered that China is sustainably achieving development by maintaining its forests to meet its own need by balancing responsible consumption with development. Consequently, the neoclassical growth theory serves as the underlying theory of sustainable development. More specifically, the measure of genuine savings is critical for estimating sustainable development. That is, how economies can maximize today's consumption, taking into consideration the consumption of the future generation is crucial in explaining the factors that would determine sustainable development.

From the foregoing review of literature, it can be observed that first, conflicting results are perverse in the studies of sustainable development in relation to agriculture and export. The inconsistencies in mainstream literature may be attributed to different contextual issues, adopted proxies, the methodology employed, agricultural technology and export product and size. This calls for more studies with fresh evidence and insights in a broader study context to ascertain the true effect of agricultural exports on sustainable development. Second, none of the above studies have investigated the size of agricultural exports relative to non-agricultural exports in their analysis of the agricultural effect of sustainable development. Also, most of these studies are carried out for selected agricultural exports (e.g., [23,30]), not the entire agricultural export sector and more so, for individual / selected countries (see [44, 45]). Third, most studies adopt descriptive analysis (e.g. [45]), exploratory analysis (e.g. [46]) and case study approach (e.g. [31]) without employing rigorous econometric analysis. Finally, despite extensive research on ecologically unequal exchange, significant gaps remain in understanding the robust relationship between agricultural exports and sustainable development in Sub-Saharan Africa. While studies like

Austin [28], Manga et al. [37], Jorgenson [27] and Shandra et al. [34, 35] have examined export flows and environmental impacts, there is a limited understanding of how the relative size of agricultural exports specifically influences sustainable development across the region. Therefore, this paper fills these identified lacunas in the literature by conducting a panel analysis on the total agricultural export in 25 countries in the sub Sahara Africa region from 1999 to 2020 using Driscoll-Kraay standard error which will provide for a more robust and generalizable result.

3. Methodology

3.1. Theoretical framework and model specification

To establish a relationship between sustainable development and agricultural export, this study specifies a Cobb-Douglas production function that expresses output as a function of capital and labour, which is augmented with the inclusion of Agricultural export and non-export production and other control factors as follows:

$$Q_{it} = f(K_{it}, L_{it}, AE_{it} NAE_{it} ANE_{it}\ X_{it}) \tag{3.1}$$

$$X_{it} = f(CONF_{it} DEM_{it}) \tag{3.2}$$

$$Q_{it} = K_{it}^{\alpha_1} L_{it}^{\alpha_2} AE_{it}^{\alpha_3} NAE_{it}^{\alpha_4} ANE_{it}^{\alpha_5} CONF_{it}^{\alpha_6} DEM_{it}^{\alpha_7} \tag{3.3}$$

Where *Q,* K, *AE, NAE, ANE, CONF and DEM* denote output, capital, labour agricultural export, non-agricultural export, agricultural non-export production, conflict and democracy respectively. The shares of output with respect to each of the explanatory variables are denoted by α_1-α_7. Log-linearizing Eqs. (3.3) produced Eqs. (3.2) as follows:

$$\ln Q_t = \alpha_0 + \alpha_1 \ln K_{it} + \alpha_2 \ln L_{it} + \alpha_3 \ln AE_{it} + \alpha_4 \ln NAE_{it} + \alpha_5 \ln ANE_{it} + lnCONF_{it} + lnDEM_{it} + \mu_{it} \tag{3.4}$$

Where μ_{it} represents the stochastic error term.

To empirically examine the effect of agricultural export on sustainable development and to understand the differential effects of agricultural export and non-export agricultural production on sustainable development, the study follows the theory of genuine savings of Hamilton and Clemens [42] and the savings equations of [44,47] by substituting output as an augmented measure of savings and wealth in the national account. Output is therefore measured as adjusted net savings or genuine savings (AS) in Eq. (3.3) as follows:

$$\ln AS_t = \alpha_0 + \alpha_1 \ln K_{it} + \alpha_2 \ln L_{it} + \alpha_3 \ln AE_{\ it} + \alpha_4 \ln NAE_{\ it} + \alpha_5 \ln ANE_{\ it} + lnCONF_{it} + lnDEM_{it} + \mu_{it} \tag{3.3a}$$

$$AS = NNS + ED^{exp} - CO_2^E - FK^c - ER^d - MR^d \mp F^d \tag{3.4a}$$

Where $NNS, ED^{exp}, CO_2^E, FK^c, ER^d, MR^d$ *and* F^d represent net national savings, education expenditure, carbon dioxide damage, consumption of fixed capital, energy resources depletion, mineral resources depletion and forest depletion, respectively [42]. Although there are several other measures of sustainable development in literature such as Carbon Intensity of wellbeing (CIWB) and Ecological footprint of wellbeing (EIWB) and the Sustainable Development Index (SDI) this study adopts the adjusted savings measure as it aligns with the role of savings in capital accumulation as explained in the neoclassical economic growth model. Also, for robustness check, Sustainable Development Index (SDI) data is used as a measure of sustainable development.

3.2. Data description and source

The study used a dataset of 25 Sub-Saharan African countries covering the period of 1999 to 2019. AS is sourced from the World Bank's Adjusted Net Savings online database. It is estimated by adding education expenditure to the net national savings and then subtracting energy depletion, mineral depletion, forest depletion and carbon dioxide. SDI is sourced from the SDI database of the United Nations' Sustainable Development Solutions Network (SDSN). SDI is a composite index that measures how ecologically efficient a country is in delivering its human development. Agricultural export is retrieved from the World Integrated Trade Solution (WITS) World Trade Statistics online database, Non-agricultural export is obtained by subtracting agricultural export from total export, while Agricultural non-export production is obtained by deducting Agricultural export from agricultural output. Finally, capital and labour data are sourced from the Penn World table version 10.0 and the World Development Indicators database respectively. Internal conflicts and Political democracy are obtained from Uppsala Conflict Program and the Institute for Economics and Peace Database, respectively as indicated in Table 1.

3.3. Method of data analysis

In panel data analysis, there are several estimation issues that require resolution to ensure the accuracy and reliability of the Eqs. (3.3). These peculiar issues include heteroscedasticity, multicollinearity, endogeneity, and cross-sectional dependence, which are primarily caused by the non-observability of certain variables. Additionally, the presence of the simultaneity problem further exacerbates these issues, particularly in cases where a bi-directional causality exists between dependent and explanatory variables. To address these issues, researchers often utilize the Generalised Method of Moments (GMM). It is important to note that the presence of these issues can result in OLS inconsistency, rendering the coefficients inefficient. In instances where exogeneity is present alongside other issues, the Driscoll-Kraay standard error estimator can be employed. This estimator is particularly useful in accounting for serial correlation, autocorrelation, and heteroscedasticity, while also accommodating an unbalanced panel. Therefore, it is imperative to carefully consider and address these estimation issues when conducting panel data analysis to ensure the reliability and validity of their results [48,49].

4. Presentation of results

Table 2 shows the descriptive statistics of the data used in this study. The mean SDI shows that the average SDI in Africa is 0.50, which implies

Table 1
Data description.

Variables	Description	Unit of measurement	Sources
SDI	Sustainable development Index	Index	
K	Stock of capital	Measured in Millions. 2017 USD	Penn-world Table 10.0
L	Total Labour force	Actual figures in Millions	Penn-world Table 10.0
AE	Agricultural Export	Measured in Million USD	World Integrated Trade Solution
NAE	Non-agricultural export = Total export minus Agricultural export	Measured in Million USD	World Integrated Trade Solution
ANE	Agricultural Non-Export = Agricultural output minus Agricultural export	Measured in Million USD	World Integrated Trade Solution
CONF	Conflict	Actual Estimates in Thousands	Uppsala Conflict Data Program
DEM	Political Democracy	Index Scores	The Institute for Economics and Peace

Source: Authors' computation (2025)

Table 2
Descriptive statistics.

	Std. Dev.	Mean	Obs.	Max	Min
lnSDI	.0913443	.5066981	526	.715	.279
lnANS	1.659073	20.61064	526	25.10066	15.1856
lnL	10.70325	8.161391	526	73.02055	.232817
lnK	693,151.5	301,470.3	526	4,243,349	2836.688
lnAE	1.526431	19.81119	526	23.6175	14.40303
lnNAE	1.486806	21.81448	526	25.30747	17.84999
lnANE	.8617412	2.768565	526	4.104264	.5800674
lnConf.	0.451587	3.626008	526	4.5	2.161
lnDem.	0.72616	3.327089	526	4.76	1.70847

Note: lnSDI, lnANS, lnL, lnK, lnAE, lnNAE, lnANE, lnConf, and lnDem represent the natural logs of Sustainable development Index, Adjusted Net Savings, Labour, Capital, Agricultural exports, Non-Agricultural export, Agricultural Non-exports, Conflicts and Democracy, respectively.
Source: Authors' computation (2025).

that African countries are moving towards achieving sustainable development goals. The average adjusted net savings, including particulate emission damage, is 20.6 billion dollars. The average labour force participation rate and capital stock in the selected countries are 8.1 per cent and 30.14 million dollars, respectively. The average agricultural exports, non-agricultural exports and agricultural non-exports are 19.8, 21.8 and 2.1 million dollars. This implies that on average, the non-agricultural exports are more than agricultural exports and agricultural non-exports in Africa. The standard deviation measures the dispersion of the variables from their respective means. In this case, a standard deviation of 0.0913, 1.659,10.70, 1.526,1.486 and 0.86 for SDI, ANS, L, AE, NAE and ANE, respectively indicate that the values in the dataset are clustered closely around their mean values, with relatively little variation. This implies that the variables are relatively consistent and stable, with most countries falling within a narrow range of values around their mean values. In addition, the variables lnSDI, lnANS, lnAE, lnNAE, and lnANE exhibit no evidence of outliers. The observed ranges for these variables fall within approximately three standard deviations of their respective means, suggesting a consistent and well-distributed dataset. This indicates that the data for these variables are free from extreme deviations. As such, they demonstrate robustness and reliability for analysis.

The pairwise correlation is presented in Table 3. The correlation coefficients show the relationship between the SDI, ANS, L, K, AE, and NAE. The correlation coefficients show that all the variables have significant relationships with one another. Also, the coefficients do not exceed the threshold of 0.80, indicating the absence of multicollinearity among the variables.

Table 4 presents the results of the cross-sectional dependence (CSD) test conducted in this study. The reason for conducting this test is due to the possibility of CSD in the data sets, which can be caused by unobserved components and common shocks, as suggested by (Baltagi, 2008). The results of the Pesaran CSD test in Table 3 indicate the presence of CSD in the data, as the null hypothesis of cross-sectional independence is rejected. Additionally, the p-values obtained from the Breusch-Pagan test in Table 4 suggest the absence of heteroscedasticity in the data series because the p-value is <5 %.

Table 4
Cross-sectional dependence and heteroscedasticity tests.

Tests	Statistics	P-Value
Pesaran's test of cross-sectional independence	9.129	0.0000
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity	4.41	0.0357

Source: Authors' computation (2025).

The estimates of Driscoll-Kraay's standard error are presented in Table 5. The result shows the impact of agricultural exports, agricultural non-exports, and non-agricultural exports on sustainable development in Sub-Sahara Africa. The coefficients of labour and capital produced a positive and significant influence on sustainable development in the adjusted net savings and sustainable development indexes. This implies that capital stock and the rising labour force in Africa are not a hindrance to the attainment of sustainable development. A percentage

Table 5
Estimates of Driscoll-Kraay standard error.

VARIABLES	lnANS	lnSDI
lnK	0.591***	0.00483**
	(0.124)	(0.00061)
lnL	0.0308**	0.000910**
	(0.0119)	(0.000028)
lnAE	0.00610***	0.0181***
	(0.0567)	(0.00216)
lnNAE	−0.1025**	−0.0276***
	(0.015)	(0.00758)
lnANE	0.325*	0.0208***
	(0.106)	(0.00514)
lnConf.	−0.04574**	−1.83288*
	(0.01409)	(0.68899)
lnDem.	−0.006549	.356285
	(0.01093)	(0.25211)
Constant	13.74***	−0.312**
	(2.159)	(0.113)
Observations	408	473
R-squared	0.581	0.4629
Average VIF	2.59	
Number of groups	23	25

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Note: lnSDI, lnANS, lnL, lnK, lnAE, lnNAE, lnANE, lnConf., and lnDem. represent the natural logs of Sustainable development Index, Adjusted Net Savings, Labour, Capital, Agricultural exports, Non-Agricultural exports, Agricultural Non-exports, conflict and democracy respectively.
Source: Authors' computation (2025).

Table 3
Correlation analysis.

	SDI	lnANS	lnL	lnK	lnAE	lnNAE	lnANE
SDI	1						
lnANS	0.207***	1					
lnL	0.211***	0.618***	1				
lnK	0.309***	0.624***	0.817***	1			
lnAE	0.531***	0.294***	0.373***	0.396***	1		
lnNAE	0.598***	0.695***	0.595***	0.655***	0.686***	1	
lnANE	−0.430***	−0.193***	0.109*	−0.191***	−0.207***	−0.468***	1

* $p < 0.05$
** $p < 0.01$.
*** $p < 0.001$
Note: lnSDI, lnANS, lnL, lnK, lnAE, lnNAE and lnANE represent the natural logs of Sustainable development Index, Adjusted Net Savings, Labour, Capital, Agricultural exports, Non-Agricultural exports and Agricultural Non-exports, respectively.
Source: Authors' computation (2025).

increase in K increases sustainable development by 0.591 per cent and 0.00483 per cent for ANS and SDI models, respectively while a percentage increase in L increases sustainable development by 0.0308 per cent and 0.0009 per cent for ANS and SDI models, respectively.

The coefficients of agricultural exports in the two models show that it has a positive and significant impact on the attainment of sustainable development. A percentage increase in AE increases sustainable development by 0.00610 and 0.0181 per cent in the two models. This finding contradicts the study of Jauch [46] and Khan and Hassan [24] which found that Export Processing Zones (EPZs) have a negative impact on the attainment of sustainable development. The positive effect of agricultural exports on sustainable development could be because agricultural exports contribute to economic growth and reduce poverty by creating employment opportunities and increasing income for rural farmers. This, in turn, can lead to a reduction in income inequality and increased access to basic necessities such as food, water, and healthcare. The coefficients of ANE, which is also known as subsistence farming, also have a positive effect on sustainable development. A percentage increase in ANE increases sustainable development by 0.325 and 0.0208 per cent in the two models, respectively. Subsistence farming in most African countries boosts food security by providing local communities with access to fresh and nutritious food, which improves the health and overall well-being of local communities. In terms of magnitude, the result implies that agricultural non-export contributes to sustainable development more than agricultural exports.

The coefficients of non-agricultural exports on sustainable development show that it has a negative effect on sustainable development. A percentage increase in non-agricultural exports reduces sustainable development by 0.102 and 0.027 per cent in the two models. This is in agreement with the findings of Rivera-Ferre [30] and Khan and Hassan [24] which suggests that exploration and importation of some non-agricultural commodities pose threats to livelihoods and degrades the environment through deforestation and degradation which harm the sustainable development of a nation. Some of the primary goods that dominate the export trade in Africa are gold and petroleum. The negative effect of these non-agricultural exports on sustainable development could be attributed to the exploitation of natural resources, such as minerals and oil, which can have negative environmental impacts. Most extractive industries in the region are known for causing soil degradation, deforestation, and water pollution, which can have long-term negative effects on the environment and undermine sustainable development. The differential effect between agricultural exports and non-agricultural exports will be with respect to their signs, while agricultural exports have a positive effect on sustainable development, non-agricultural exports have a negative effect. The coefficients of conflict in the two models show that internal conflict has a negative association with sustainable development as evident in the adjusted net savings model and the sustainable development index. A percentage increase in internal conflict reduces sustainable development by 0.04 and 1.83 percent in ANS and SDI models, respectively. Democracy has a mixed effect on sustainable development in the two models employed in this study. It has a negative effect on ANS, while it has a positive effect on SDI. However, the standard errors of democracy in the two models show that democracy does not have significant effect on sustainable development.

5. Conclusions and policy recommendations

Agricultural exports play a critical role in igniting and sustaining rapid economic development, particularly in African countries. This study investigated the effect of the relative size of agricultural exports on sustainable development across 46 Sub-Saharan African countries between 1999 and 2020. To explain the effects, the study used the Driscoll-Kraay standard error estimation method with data from the World Bank's World Development Indicators and the United Nations' Sustainable Development Solutions Network. The results of Pesaran's test of cross-sectional independence test indicate the presence of cross-sectional dependence, justifying using the Driscroll-Kraay standard error in model estimation.

Using the genuine savings theory and data on adjusted net savings and sustainable development indices, the analysis found that agricultural exports have a positive effect on sustainable development. Specifically, a 1 % increase in agricultural exports was associated with a 0.0058 and 0.017 % increase in sustainable development measures.

Comparing the magnitude of coefficients, agricultural non-export production, referring mainly to subsistence farming, was found to contribute more to sustainable development than agricultural exports. This highlights the importance of smallholder agriculture in supporting livelihoods and food security. Meanwhile, non-agricultural exports had a negative effect, reducing sustainable development measures by 0.02 and 0.18 % in both models. This likely reflects the unsustainable extraction of mineral and oil resources.

Also, the study found that internal conflicts significantly hinder sustainable development, as instability disrupts economic activities, weakens institutional capacity, and deters investment. On the other hand, democracy exhibited a mixed effect positively influencing sustainable development when measured through the Sustainable Development Index (SDI) but showing an insignificant or slightly negative effect when assessed using adjusted net savings (ANS). This suggests that while democratic governance can foster transparency and policy consistency, its effectiveness in driving sustainable development may depend on the quality of institutions and governance structures.

Based on the findings that the relative size of agricultural exports is a positive driver of sustainable development in African countries, policymakers are recommended to pursue pro-agricultural export policies aimed at increasing the size of agricultural exports to promote sustainable development. However, given that agricultural non-export influences sustainable development more than agricultural export, making a policy choice between them would mean that agricultural import substitution is superior to agricultural export promotion development strategy. That is, policymakers should focus on improving smallholder production, food security and rural development. Furthermore, given that agricultural export promotes sustainable development more than non-agricultural exports, implying that countries have a comparative cost advantage in producing agricultural commodities for export, hence, policies should aim to expand agricultural exports, which leverage the region's comparative advantage. Value-added processing, transport links and trade partnerships can grow sustainable agricultural exports. Lastly, with the evidence that capital stock and labour force positively affect sustainable development, it is also recommended that each of these variables be strengthened through investment in infrastructure, human capital, agricultural R&D and technology adoption to improve sustainable development.

Finally, this study used aggregated data for all the relative sizes of agricultural exports and the non-agricultural exports for comparison's sake. A limitation that may arise is that the work has not explored all the different components of all these aggregated exports. This is an area that future research can further explore. Also, the moderating role of political factors, such as the effect of democracy and the quality of institutions on the agricultural export–sustainable development relationship is a good area for studies. Lastly, other welfare measures such as the CIBW and EIBW can be explored in future research.

CRediT authorship contribution statement

Taofeekat Temitope Nofiu: Writing – review & editing, Writing – original draft, Resources, Conceptualization. **Rashidat Sumbola Akande:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Hauwah K.K. Abdulkareem:** Writing – review & editing, Writing – original draft, Conceptualization. **Sodiq Olaiwola Jimoh:** Writing – review & editing, Writing – original draft, Formal analysis.

Declaration of competing interest

Authors have no competing interest(s).

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References

[1] Z.A. Ogutu, Sustainable development in sub-Saharan Africa: what are the alternatives? J. East. Afr. Res. Dev. 23 (1993) 24–39. https://www.jstor.org/stable/24326288.
[2] J.A. Odugbesan, H. Rjoub, Relationship among HIV/AIDS prevalence, human capital, good governance, and sustainable development: empirical evidence from sub-Saharan Africa, Sustainability 11 (5) (2019) 1348.
[3] M.J. De Vries, H. Jochemsen, The Normative Nature of Social Practices and Ethics in Professional Environments, IGI Global, Pennsylvania, 2019.
[4] FAO, Food and Agriculture: Key to Achieving the 2030 Agenda for Sustainable Development, Rome: food and Agriculture Organization, 2016.
[5] S. Kjosev. Agricultural Policy, University of Ss. Cyril and Methodius, Skopje, Macedonia, 2015, pp. 2–6.
[6] E. Tesfaye, Determinants of agricultural export in Sub-Saharan Africa: evidence from panel study, Am. J. Trade Policy 1 (2) (2015) 62–70.
[7] P. Alex, M. Inna, G. Tetiana, S. Ricardo, B. Serhii, Sustainable Development Goals in agriculture and responsible investment: A comparative study of the Czech Republic and Ukraine, Probl. Perspect. Manag. 19 (2) (2021) 65–76, https://doi.org/10.21511/ppm.19(2).2021.06.
[8] R. Edeme, A. Innocent, A. Chigozie, A comparative analysis of the impact of agricultural exports on economic growth of ECOWAS countries, Acta Oeconomica Pragensia 2016 (5) (2016) 31–46, 2016.
[9] D. Sakyi, I. Bonuedi, E.E.O Opoku, Trade facilitation and Social welfare in Africa, J. Afr. Trade 5 (1–2) (2018) 35–53, https://doi.org/10.1016/j.joat.2018.08.001.
[10] D. Sakyi, J. Villaverde, A. Maza, I. Bonuedi, The effects of trade and trade facilitation on economic growth in Africa, Afr. Dev. Rev. 29 (2) (2017) 350–361, https://doi.org/10.1111/1467-8268.12261.
[11] I. Bonuedi, K. Kamasa, E.E.O. Opoku, Enabling Trade across Borders and Food Security in Africa, Food Sec. 12 (5) (2020) 1121–1140, https://doi.org/10.1007/s12571-020-01095-y.
[12] F.M. Charles, The Impact of Trade Facilitation on Agricultural Products Standard Compliance in Relation to Cameroon's Export Performance, J. Food Process. Technol. 7 (2016) 624, https://doi.org/10.4172/2157-7110.1000624.
[13] World Bank, Sub-Saharan Africa Economic Update: Resilience Through Reform, World Bank Group Publications, 2023.
[14] P. Nyambo, P. Nyambo, Z. Mavunganidze, V. Nyambo, Sub-Saharan Africa smallholder farmers agricultural productivity: risks and challenges, in: Food security for African smallholder farmers, Springer Nature Singapore, Singapore, 2022, pp. 47–58.
[15] D. Adeabah, S. Asongu, Agricultural export, growth and the poor in Africa: A meta analysis, in: AGDI Working Paper, No. WP/21/082, African Governance and Development Institute (AGDI), Yaoundé, 2022.
[16] United Nations Conference on Trade and Development (UNCTAD). (2023). Economic development in Africa report 2023. UNCTAD Publications. Retrieved from https://unctad.org/publication/economic-development-africa-report-2023.
[17] J. Mensah, Sustainable development: meaning, history, principles, pillars, and implications for human action: literature review, Cogent. Social. Sci. 5 (1) (2019) 1–21, https://doi.org/10.1080/23311886.2019.1653531.
[18] M.I. Shah, H.K.K. Abdulkareem, Z. Khan, S. Abbas, Examining the agriculture-induced Environmental Kuznets Curve hypothesis in BRICS economies : the role of renewable energy as a moderator, Renew Energy 198 (2022) 343–351, https://doi.org/10.1016/j.renene.2022.08.052. August.
[19] J.A. Dar, M. Asif, Do agriculture-based economies mitigate CO2 emissions? : empirical evidence from five SAARC countries, Int. J. Energy Sect. Manage. 14 (3) (2020) 638–652, https://doi.org/10.1108/IJESM-01-2019-0011.
[20] C. Nhemachena, G. Matchaya, C.R. Nhemachena, S. Karuaihe, B. Muchara, S. Nhlengethwa, Measuring baseline agriculture-related sustainable development goals index for Southern Africa, Sustainability 10 (849) (2018) 1–16, https://doi.org/10.3390/su10030849.
[21] M. Busko, B. Szafranska, Analysis of changes in land use patterns pursuant to the conversion of agricultural land to non-agricultural use in the context of the sustainable development of the Malopolska Region, Sustainability 10 (136) (2018) 1–22, https://doi.org/10.3390/su10010136.
[22] Zafeiriou, E., Mallidis, I., Galanopoulos, K., & Arabatzis, G. (2018). *Greenhouse gas emissions and economic performance in EU agriculture : an empirical study in a non-linear framework*. https://doi.org/10.3390/su10113837.
[23] D. Asmat-campos, Á. Carreño-ortega, M. Diaz-Perez, Recovering-innovation-exportation triangle as an instrument for sustainable development : proposal for Peruvian agro-export development, Sustainability 11 (2019) 1149, https://doi.org/10.3390/su11041149.
[24] Y. Khan, T. Hassan, Promoting sustainable development: evaluating the influence of natural resources, high-tech export and corruption on CO2 emissions in developing economies, Resour. Policy 88 (2024) 104511.
[25] G.E. Reyes, Four main theories of development: modernization, dependency, world systems, and globalization, Nómadas. Revista Crítica de Ciencias Sociales y Jurídicas 4 (2001) 109–124, 2.
[26] S.G. Bunker, (2019). Toward a theory of ecologically unequal exchange. Ecologically unequal exchange: Environmental injustice in comparative and historical perspective, 13-47.
[27] A. Jorgenson, Environment, development, and ecologically unequal exchange, Sustainability 8 (3) (2016) 227, https://doi.org/10.3390/su8030227.
[28] K.F. Austin, Ecologically unequal exchange, in: M.A. Long, M.J. Lynch, P. B. Stretesky (Eds.), Handbook on Inequality and the Environment, Edward Elgar Publishing, 2023, pp. 44–58.
[29] N. Dawson, A. Martin, L. Camfield, N. Dawson, A. Martin, L. Camfield, Can agricultural intensification help attain Sustainable Development Goals ? Evidence from Africa and Asia Development Goals ? Evidence from Africa and Asia, Third World Q 40 (2019) 926–946, https://doi.org/10.1080/01436597.2019.1568190, 5.
[30] M.G. Rivera-Ferre, Can export-oriented aquaculture in developing countries be sustainable and promote sustainable development? The shrimp case, J. Agric. Environ. Ethics 22 (4) (2009) 301–321, https://doi.org/10.1007/s10806-009-9148-7.
[31] M.Van Der Velde, S.R. Green, M. Vanclooster, B.E Clothier, Sustainable development in small island developing states : agricultural intensification, economic development, and freshwater resources management on the coral atoll of Tongatapu, Ecol. Econ. 61 (2007) 456–468, https://doi.org/10.1016/j.ecolecon.2006.03.017.
[32] X. Liu, E.N. Udemba, F. Emir, S. Hussain, N.U. Khan, I. Abdallah, Nexus between resource policy, renewable energy policy and export diversification: asymmetric study of environment quality towards sustainable development, Resour. Policy 88 (2024) 104402.
[33] M. Belloumi, A. Alshehry, The impact of international trade on sustainable development in Saudi Arabia, Sustainability 12 (13) (2020) 5421.
[34] J.M. Shandra, M. Restivo, J.M. Sommer, Do China's environmental gains at home fuel forest loss abroad?: a cross-national analysis, J. World-Systems Res. 25 (1) (2019) 83–110.
[35] J.M. Shandra, C. Leckband, B. London, Ecologically unequal exchange and deforestation: a cross-national analysis of forestry export flows, Organ Environ. 22 (3) (2009) 293–310, https://doi.org/10.1177/1086026609343097.
[36] Can, M., Ahmad, M. & Khan, Z. (2021). The impact of export composition on environment and energy demand: evidence from newly industrialized countries. *Environ. Sci. Pollut. Res.,* 28, 33599–33612. https://doi.org/10.1007/s11356-021-13084-5.
[37] Manga, M., Cengiz, O. & Destek, M.A. (2023). Is export quality a viable option for sustainable development paths of Asian countries?. *Environ. Sci. Pollution Res.,* 30, 50022–50045 (2023). https://doi.org/10.1007/s11356-023-25784-1.
[38] M. Murshed, N.T.T. Dao, Revisiting the CO_2 emission-induced EKC hypothesis in South Asia: the role of export quality improvement, Geo J. 87 (2022) 535–563, https://doi.org/10.1007/s10708-020-10270-9.
[39] R.M. Solow, A contribution to the theory of economic growth, Q. J. Econ. 70 (1) (1956) 65–94.
[40] E. Phelps, The golden rule of accumulation: a fable for growthmen, Am. Econ. Asso 51 (1961) 638–643, https://doi.org/10.4324/9781315199818-34.
[41] G. Chichilnisky, G. Heal, A. Beltratti, The green golden Rule, Econ. Lett. 49 (2) (1995) 175–179, https://doi.org/10.1016/0165-1765(95)00662-Y.
[42] K. Hamilton, M. Clemens, Genuine savings rates in developing countries, World Bank Econ. Rev. 13 (2) (1999) 333–356, https://doi.org/10.1093/wber/13.2.333.
[43] X. Liu, S. Zhang, J. Bae, The impact of renewable energy and agriculture on carbon dioxide emissions: investigating the environmental Kuznets curve in four selected ASEAN countries, J. Clean. Prod. 164 (2017) 1239–1247, https://doi.org/10.1016/j.jclepro.2017.07.086.
[44] L.B. Cui, P. Peng, L. Zhu, Embodied energy, export policy adjustment and China's sustainable development: a multi-regional input-output analysis, Energy 82 (2015) 457–467, https://doi.org/10.1016/j.energy.2015.01.056.
[45] C. Staritz, L. Plank, M. Morris, Global value chains, industrial Policy, and sustainable Development – Ethiopia's apparel export sector, International Centre for Trade and Sustainable Development (ICTSD), Geneva, 2016, p. 44. May.
[46] H. Jauch, Export processing zones and the quest for sustainable development: a Southern African perspective, Environ. Urban 14 (1) (2002) 101–113, https://doi.org/10.1177/095624780201400109.
[47] B.S. Koirala, G. Pradhan, Determinants of sustainable development: evidence from 12 Asian countries, Sustain. Dev. 28 (1) (2020) 39–45, https://doi.org/10.1002/sd.2032.
[48] J.C. Driscoll, A.C. Kraay, Consistent covariance matrix estimation with spatially dependent panel data, Rev. Econ. Statist. 80 (4) (1998) 549–560.
[49] D. Hoechle, Robust standard errors for panel regressions with cross-sectional dependence, Stata J. 7 (3) (2007) 281.