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SHEA TRADE AND ICT NEXUS IMPLICATIONS FOR ECONOMIC DEVELOPMENT IN WEST AFRICA: THE CASE OF GHANA

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ARTICLE INFO	ABSTRACT
	Shea trade openness measures how freely a nation can trade shea with other countries. Information and Communication Technology (ICT) innovation has become a vital force for economic growth, especially in developing nations. However, there is limited data on how the shea trade and ICT impact economic development. We examine how the shea trade and ICT adoption interact to affect economic development using data from 2003 to 2023. Our analysis with the static OLS regression model shows that both the shea trade and ICT significantly boost economic development in West Africa. Additionally, ICT adoption enhances the impact of the shea trade on economic development. Therefore, both the shea trade and ICT serve as pathways to economic growth in shea-producing countries in West Africa. The study concludes that the connection between the shea trade and ICT innovation contributes to economic development, which has important policy implications for these countries. This finding could influence the African Continental Free Trade Agreement by promoting shea trade and the development and spread of ICT innovations.

INTRODUCTION

Shea tree (*Vitellaria paradoxa*) (Hale *et al*., 2021) is a golden tree in West African countries, and its importance to economic development and ecosystem services cannot be overlooked. The tree is an indigenous species, and its nuts serve local economies and traditional cultural practices in semi-arid and sub-humid savannas of West Africa (Ky–Dembele *et al*., 2021). The shea nuts yield a versatile fat which is referred to as shea butter. The shea butter has been recognised globally as a result of its diverse applications in cosmetics, culinary, and pharmaceutical firms (Chalfin, 2004; Glew & Lovett, 2014). Hence, the importance of the shea butter contributes to economic development as firms export it, which earns countries foreign reserves. Shea butter processing also reduces the unemployment rate by creating sustainable jobs in shea-producing countries in West Africa (Alliance Global Shea, 2020). It has been estimated that the global value of shea butter is US$2.75 billion (Choudhury, 2023). The economic value of she a butter is projected to reach US$5.58 billion by 2033 (UNDP, 2024). This intuitively implies that shea nuts and butter trade offer substantial amounts to economic development for shea-producing countries(Kabo-Bah *et al*., 2025). It has been argued that shea products are among the top five non-timber products exported in Ghana (GEPA, 2024). The exportation of shea nuts and butter creates sustainable jobs along the shea value chain actors, hence reducing poverty and enhancing economic development in a country (Opoku–Mensah, 2023).

The income generated through shea nut and butter exportation enhances individuals' and households' welfare through education expenditure, access to healthcare services, and quality food for better nutrition (Ayelazuno & Yaro, 2024). Furthermore, the shea trade enhances the economic diversification portfolio, which helps in macroeconomic stability in developing countries like West African nations. Beyond its quantifiable economic metrics, the shea sector holds profound social significance, particularly as a potent instrument for the empowerment of women. Frequently referred to as "women's gold," the production of shea butter is predominantly spearheaded by women (Beczner*et al*., 2017; Mensa, 2022), who serve as the primary custodians of this tree and processing of the nuts, transmitting traditional knowledge across successive generations. Across 21 West African nations, it has been argued that about 16 million women derive their livelihoods from the shea tree, with approximately 1 million rural women actively participating in this sector within Ghana alone (Enhanced Integrated Framework, 2024; UNDP, 2024). Engagement within the shea enterprise confers upon women crucial financial autonomy, enabling them to generate income, acquire new competencies, and attain enhanced decision-making authority within their matrimonial and community structures(Ayelazuno& Yaro, 2024). Women's cooperatives have emerged as instrumental frameworks, facilitating access to training, ameliorated processing techniques, and collective bargaining capabilities, which in turn aid in securing more equitable prices and improved market access for their produce (Enhanced Integrated Framework, 2024; Green Views

Residential, 2023). Nevertheless, persistent challenges, including constrained access to resources, attenuated incomes, market access impediments, and gender-based discrimination, such as exploitation by intermediaries, continue to hinder the full realization of their economic potential (Ayelazuno& Yaro, 2024; Glubis, 2024; Mohammed *et al*., 2016; UNDP, 2024). The enhancement of these disparities is deemed imperative for unlocking the complete social benefits inherent in the shea industry. Shea trade openness and diffusion of ICT have merged as a pathway for economic empowerment for national development and growth. The trade concept refers to how open a nation is to allowing free trade with other countries in both international and national markets (Keho, 2017; Squalli & Wilson, 2011). Information and Communication Technology (ICT) has become a key driver of economic growth, especially in developing countries, where the spread and adoption of ICT pose significant challenges for value chain participants (Nyagadza *et al*., 2022). ICT can boost global demand for shea products by promoting trade openness and technological progress. It raises global interest in shea butter and its products, which in turn invigorates economic activity within the value chain of a country (Tanzile *et al*., 2023). Thus, studying the individual and combined effects of the shea trade and ICT on economic development is an important research area in West Africa.

The shea trade and ICT nexus holds considerable potential for accelerating sustainable economic development in shea-producing countries in West Africa, particularly in Ghana. The promotion of the shea industry to international markets necessitates enhanced efficiency and competitiveness (Al-hassan, 2012).For instance, ICT tools such as the internet, mobiles, and fixed telephones assist the shea value chain actors to access the international market, which has been a historical constraint as a result of information asymmetries (Bannor *et al*., 2024; Iddrisu & Al-hassan, 2016; Osman *et al*., 2024). Real-time price information empowers value chain actors to negotiate more effectively, thereby increasing their share of the value chain's profits and improving their livelihoods (Lebioda *et al*., 2019; Onyango *et al*., 2014). This translates to a country's economic development. Despite these transformative potentials, challenges persist. These include the prevalent digital divide, limited access to requisite resources and skills among rural producers, and the need for policies that specifically address the unique constraints faced by women and other value chain actors in the shea sector(Glubis, 2024) who export shea nuts and butter. Through concerted efforts to bridge digital divides and implement supportive policies, the shea sector can continue to drive national development, contributing significantly to poverty reduction and improved livelihoods across regions in West Africa. However, the interconnection between the shea trade, ICT adoption, and economic performance has not been well-reported. Investigating the effects of the shea trade and ICT adoption on economic development is vital to formulate relevant policies and interventions. This cannot materialise if there is no empirical evidence to guide policymakers. Hence, this study sought to examine the nexus between the shea trade and the ICT adoption effect on economic development in Ghana.The key variables of interest employed to achieve the study's main objective include Gross Domestic Product (GDP, proxy for economic development), Shea trade (quantity exported in metric tonnes), mobile phone, and fixed telephone subscription (proxies are ICT tools). Following Adeleye *et al.* (2022), the study employed a static (pooled ordinary least squares) model for the estimation. The findings contrast with previous studies that trade openness enhances economic growth, yet the novelty of the study is that ICT promotes the shea trade on economic development. The rest of the paper is divided into four sections. Section 2 provides a brief literature review for the study. Section 3 covers the data source and estimation strategy. Section 4 presents the results and discussion. Finally, Section 5 includes the conclusion and policy implications.

BRIEF LITERATURE REVIEW

Numerous empirical studiesof trade and ICT adoption's contribution to economic development in the global south have been conducted. The studies employed different estimation strategies, specific periods,

and distinct country characteristics for the analysis (Moyo *et al*., 2017). Most of these studies document a significant positive effect of ICT innovation on economic development (Adeleye *et al*., 2021; Awad &Albaity, 2022; Dumor*et al*., 2024; Ganda & Panicker, 2025; Ishnazarov*et al*., 2021; Mazorodze, 2025). However, the impact is time-specific and geographically varies. For instance, Alhassan *et al*. (2025) employs a hypothesized model that was validated by using the technology-organization-environment framework and capability theory. They analysed secondary data from 130 countries using Partial Least Squares-Structural Equation Framework (PLS-SEF). It was revealed that ICT positively influences economic development. That is, ICT adoption significantly regulates a country's economic development. The generalized method of moments of the two-step method was employed to explore the relationship between ICT and economic development in the 36 Sub-Saharan African (SSA) countries, using historical data from 1990 to 2022. It was found that ICT has a direct, significant effect on financial performance, which also moderates economic development (Saeed *et al*., 2025). This finding of the authors suggests that ICT innovation enhancesa country's financial development, which translates into broader economic gains.

A study was conducted in 53 African countries to examine whether ICT adoption and trade influence inclusive economic growth. The study used panel data from 2005 to 2015. Several econometric models showed that trade positively and significantly impacted economic growth in Africa. Regarding inclusive economic growth, the study found that trade's effect on growth varies greatly across Africa's sub-regions. This suggests that a uniform approach to trade policies may not be effective or efficient (Adeleye *et al*., 2021). Another study found a positive link between ICT growth and economic development when the structural gravity model was applied in 27 sub-Saharan African countries from 2000 to 2019 (Dumor*et al*., 2024). The study concluded that ICT innovation and infrastructure growth present many opportunities to boost intra-regional trade. Using the static and dynamic panel models in 29 African countries from 2006 to 2020 revealed that ICT adoption does indeed moderate (strengthen) the positive impact of entrepreneurship on economic growth (Noah & David, 2025). ICT adoption is found to have a positive effect on economic growth, in both the short and long run. In terms of the moderation effect, the study demonstrates that ICT positively moderates the entrepreneurship effect on economic growth in Africa. This implies that when entrepreneurs leverage ICT, their activities have a more pronounced and beneficial effect on the economy. In Asia, a study employs econometric models to analyse innovation adoption, E-commerce, and global value chain nexuses. There was empirical evidence of a positive and robust impact of business-to-consumer e-commerce on GVC exports (Kang & Ramizo, 2022). This suggests that as e-commerce grows within an economy, its participation and exports within GVCs increase. The study further highlighted that the growth of e-commerce and its impact on GVCs are strongly facilitated by robust ICT Infrastructure (access to reliable internet), effective digital payment systems across borders, and effective delivery medium. That is, there is tremendous evidence from studies on leading African economies (and the continent as a whole) that points to a positive and statistically significant relationship between ICT adoption and economic growth (Ejemeyovwi *et al*., 2018; Myovella *et al*., 2020; Solomon & Van Klyton, 2020). While most studies find a positive correlation, others established a bidirectional correlation between ICT diffusion and economic growth, indicating that ICT drives growth and growth, in turn, drives further ICT adoption and investment (Noah & David, 2025).

Despite the extensive studies on ICT innovation adoption, trade performance, and economic growth nexus, there is limited information on the shea trade and ICT adoption nexus effect on economic development in West Africa. This study would expand the debate by estimating the effect of the shea trade and ICT adoption on economic development in West Africa in the context of Ghana. This is a novel since the study is the first of its kind in literature in West Africa in terms of the shea trade and ICT implications for economic development.

Data Source and Estimation Strategy: This section discusses the sources of data and the estimation strategy employed to achieve the study objective.

Study Setting and Data Source: The study took place in West Africa, focusing on Ghana as a case study. Ghana shares many similarities with other West African countries regarding landscape, economic development indicators, and the shea industry. In other words, West African countries are quite alike, and using one country to represent the region is accurate. The study used panel data on the shea trade(quantity of shea nut and butter exported), which was obtained from the Ghana Export Promotion Authority (GEPA) from 2003 to 2023. Similarly, twenty (from 2003 to 2023) data points for the variables of interest were downloaded from the World Bank 2025 World Development Indicators for the same period. These variables are the GDP, ICT innovation (mobile phone and fixed telephone subscriptions), electricity, education spending, labour participation, and Gross Fixed Capital Formation (GFCF). Then the data obtained from each institution were merged to achieve the study objective.

Variables Description and Measurement: Building on previous studies (Adeleye *et al*., 2021), economic development in Ghana was measured using gross domestic product (GDP) in constant 2015 US dollars. The shea trade was quantified as the total quantity of shea nuts and butter exported from Ghana to other countries, measured in metric tonnes. The study utilized two indicators as proxies for information and communication technology (ICT): mobile subscriptions and fixed telephone subscriptions. Additional control variables included annual electricity expenditure (in US dollars), annual education expenditure (in US dollars), the labour participation rate (as a percentage), and gross fixed capital formation (GFCF), which represents the stock of fixed investment and net increases in physical assets over a specific period (Adeleye *et al*., 2021). Interaction terms were created between shea trade openness and mobile subscriptions (trade*mobile) and between shea trade openness and fixed telephone subscriptions (trade*telephone) and were included in the regression analysis to meet the study's objectives. The study concluded that "an increase in shea trade openness is associated with an increase in economic growth when considering the influence of ICT."

Model Integrity Test: The integrity test of the model was conducted using several approaches. The Shapiro–Wilk test for normal ity shows no significant effect ($z = -1.719$; Prob>z $=0.95720$). Also, the result for the Jarque-Bera normality test is not statistically significant (JB value $=0.0116$: Chi (2) 0.9942) at any level. Hence, we failed to reject the null hypothesis for normality. In terms of omitted variable bias, the Ramsey RESET test demonstrated that there is no omitted variable bias ($F=2.12$; Prob > F = 0.1765). The Variance Inflation Factor (VIF) was also conducted, and the VIF value of 8.65 indicated a moderately weak multicollinearity (see Appendix A).

Estimation Strategy: Following past studies (Adeleye *et al*., 2021; Adeleye &Eboagu, 2019; Adeleye & Jamal, 2020), the study examines whether the shea trade has a significant effect on economic growth and if its impact is influenced or hampered by ICT adoption. The individual and interaction of trade and ICT affect economic development can be expressed as:

$$lnGDP_{it} = \delta_0 + \delta_1 lntrade_{it} + \delta_2 lnmobile_{it} + \delta_3 lntelephone_{it} + \delta_4 ln(trade * mobile)_{it} + \delta_5 x_{it} + \delta_6 year_{it} + \varepsilon_{it} \quad [1]$$

$$lnGDP_{it} = \gamma_0 + \gamma_1 lntrade_{it} + \gamma_2 lnmobile_{it} + \gamma_3 lntelephone_{it} + \gamma_4 ln(trade * telephone)_{it} + \gamma_5 x_{it} + \gamma_6 year_{it} + \varepsilon_{it} \quad [2]$$

The $lnGDP_{it}$ represents the logarithm of GDP, $lnmobile_{it}$ and $lntelephone_{it}$ are for the logarithms for ICT adoption, such as mobile and fixed telephone subscriptions, x_{it} denotes the logarithms for the control variables education expenditure, electricity expenditure, labour participation, and gross fixed capital formation (GFCF), and the ε_{it} denotes the stochastic error term. The δ_s and γ_s are the parameters (coefficient) to be estimated. The $\delta_4 and \gamma_4$ assess whether the interaction of ICT adoption indicators on the shea trade distorts the effect of the shea trade on economic development. It is important to note that a positive coefficient implies that ICT adoption enhances the shea trade on economic development and vice versa. The full effect of the shea trade on economic development by mobile subscription can be expressed as:

$$\frac{\partial lnGD}{\partial lnTrade} = \delta_1 + \delta_4 ln\,mobile \quad [3]$$

In terms of the telephone, the full effect of the shea trade on economic development, given fixed telephone subscription, can be expressed as:

$$\frac{\partial lnGDP}{\partial lnTrade} = \gamma_1 + \gamma_4 ln\,telephone \quad [4]$$

It is relevant to know that if the $\delta_4 and \gamma_4 > 0$, then ICT adoption enhances the shea trade on economic development. However, if the $\delta_4 and \gamma_4 If < 0$, then the complete effect of the shea trade on economic development depends on the degree of the negative. For instance, if the negative signs for $\delta_4 and \gamma_4$ overshadows the positive signs for $\delta_1 and \gamma_1$, then the ICT adoption distorts the effect of the shea trade on economic development. On the other hand, if the negative sign for $\delta_4 and \gamma_4$ is less than the positive signs for $\delta_1 and \gamma_1$, then the ICT adoption distorts the effect of the shea trade on economic development. This will mean that the distortion of influence of ICT adoption is not sufficient to impede the positive effect of the shea trade on economic development. Furthermore, if the $\delta_1 and \gamma_1 = 0$, then it means that the shea trade and ICT nexus has no significant effect on economic development.

RESULTS AND DISCUSSIONS

The section presents the estimated results of the trade of shea and the ICT adoption for economic development. It covers descriptive statistics and correlation of all the variables; explanations of the findings are provided.

Descriptive Statistics and Correlation Analysis: Table 1 contains the summary statistics of the variables that were used in the study. The GDP of Ghana for the year range of 2003 to 2023 stands at US$44.04 billion. The total quantity of shea traded to other countries in Ghana is 101217.7MT annually over the same period. Mobile subscriptions are estimated to be about 24.0 billion. The labour force participation rate stands at around 69.5% for the years 2003 to 2023. On average, the GFCF (% of GDP) is about 20%. Cumulatively, the average government expenditure in education and electricity is US$17.9 billion and US$48.8 billion, respectively.

Table 1. Descriptive Statistics

Variable	Mean	Std. dev.	Min	Max
GDP (US$/annum)	4.42e+10	2.32e+10	7.63e+09	7.95e+10
Shea trade (MT/annum)	101217.7	50761.9	6101.34	217833.400
Fixed Telephone	289847	46597.02	143900	376509
Mobile	2.40e+07	1.51e+07	795529	4.09e+07
Electricity (US$/annum)	48.84	20.38372	7.900	74.000
Education expenditure (US$/annum)	1.79e+09	1.06e+09	2.84e+08	3.57e+09
GFCF (% of GDP/annum)	20.007	5.340	11.764	29.002
Labor participation (%)	69.4774	3.162789	63.435	73.593

Source: Authors' Computation, 2025

Furthermore, the results of the pairwise correlation of the variables are presented in Table 2, demonstrating the relative relationship among the dependent variable and the independent variables. All the independent variables were found to have a significant relationship with the dependent variable (GDP), except for telephone and GFCF, but with different signs and magnitudes. For instance, for all the regressors, only labour has a negative relationship with economic growth. By virtual inspection of the results, there is minimal and/or no presence of multicollinearity among the covariates employed for the estimation.

Table 2. Pairwise Correlations Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) GDP	1.000							
(2) shea trade	0.642	1.000						
	(0.002)							
(3) Electricity	0.908	0.718	1.000					
	(0.000)	(0.000)						
(4) Education	0.884	0.833	0.826	1.000				
	(0.000)	(0.000)	(0.000)					
(5) Telephone	-0.051	-0.187	-0.097	-0.122	1.000			
	(0.830)	(0.430)	(0.684)	(0.608)				
(6) GFCF	-0.214	0.212	-0.219	0.049	0.028	1.000		
	(0.365)	(0.370)	(0.353)	(0.839)	(0.907)			
(7) Labor	-0.939	-0.510	-0.877	-0.772	-0.073	0.265	1.000	
	(0.000)	(0.022)	(0.000)	(0.000)	(0.760)	(0.260)		
(8) Mobile	0.967	0.712	0.906	0.885	-0.111	-0.165	-0.914	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.642)	(0.487)	(0.000)	

Note: Figures in the parentheses represent significant levels

Table 3. Estimate ofthe shea trade and ICT effects on economic performance

Variable	Main results				Robustness checks				
	[1]		[2]		[3]		[4]		
	Coefficient	Std. Err.	Coefficient	Std. Err.					
Trade	0.172**	0.067	2.632***	0.571	0.143*	0.075	2.041**	0.915	
Telephone	4.442***	0.717			3.999***	1.154			
Trade*Telephone	-0.233***	0.037			-0.211***	0.060			
Mobile			3.263***	0.628			2.634**	.993	
Shea trade*Mobile			-0.175***	0.039			-0.136**	0.061	
Education	0.342***	0.108	0.142	0.128	0.249	0.158	0.067	0.146	
Electricity	0.216*	0.105	0.224**	0.072	0.170*	0.100	0.183*	0.087	
GFCF	-0.031	0.171	0.085	0.179	-0.100	0.141	0.043	0.137	
Labour	-9.710*	4.893	-2.626	3.927	-4.746	7.837	-.859	5.068	
Inflation					0.085	0.060	0.068	0.058	
Constant	174.152	142.043	-110.590	114.189	23.738	240.851	-135.901	141.214	
Year	Yes		Yes		Yes		Yes		
Observations	20		20		20		20		
F statistics	107.43		1374.40		86.777		119.461		
Prob > F =	0.0000		0.0000		0.0000		0.0000		
R-squared	0.985		0.990		0.987		0.991		

Note: ***, **, &*embodies 1%, 5%, and 10% significance levels
Source: Authors' Estimation

Effects of the Shea Trade and ICT on Economic Development: The results for the effect of the shea trade and ICT adoption on economic development are presented in Table 3. Column 1 and 2 shows the main findings from the regression model using the Pooled OLS estimation strategy, while columns 3 and 4 show the results for robustness checks. The estimation reveals that the proportion of variation in the GDP was determined by the independent variables in a range of 98.5% and 99.0%. The F-statistics for the models are significant at 1% level, indicating that the model is suitable for the analysis and indicates that the independent variables jointly explained economic development. Starting with individual indicators, the shea trade has a positive and significant effect on economic development at the 5% and 1% levels. This implies that the shea trade contributes to economic development, ranging between 2.6 and 0.2 on average, *ceteris paribus*. That is, the shea trade has a positive link to economic performance via GDP, particularly in the shea production and export countries in West Africa. It has been demonstrated that shea exports have contributed substantial incomes to local producers and exporters, which tends to have a multiplier effect on enhanced economic performance. In West Africa, such as Nigeria and Ghana, a study revealed that trade has a positive effect on GDP(Oppong-Baah *et al.*, 2022). This is intuitively correct as the shea trade enhances value chain actors' access to markets, promotes investment, and enhances local economic efficiency. This finding is further supported by other studies in Africa (Abendin & Duan, 2021; Adeleye *et al.*, 2021; Keho, 2017; Onuogu *et al.*, 2024). But other researchers argued that open trade may introduce macroeconomic instability (volatility) depending on the global market ecosystem conditions and market shocks (Koren & Tenreyro, 2007; Ma *et al.*, 2022).

Shea commerce to other countries facilitates governments and private investors to enhance investment in infrastructure development, such as road networks (transportation), shea processing facilities, and efficient supply chain development. These enhance productivity, which contributes directly to the overall economic performance of an economy.The empirical findings from the study verify that ICT subscriptions have a positive and significant linkage to economic development at 1% level. Specifically, mobile is found to have a positive linkage to economic development at 1% level, and an increase of 1 percent in mobile take-up will lead to an increase of 3.3 percent in economic development, ceteris paribus. Furthermore, a 1 percent increase in fixed telephone will lead to a 4.4 percent economic performance (also at 1% level of significance), ceteris paribus. That is, a 1 percent increase in ICT adoption will lead to a 3.3 to 4.4 percent rise in economic development. This finding proves the importance of digital development (ICT) in enhancing the economic performance of a developing nation like Ghana and West Africa. ICT imitates and increases economic productivity by improving its efficiency in the functioning of government and private business, as well as decreasing the production cost, hence increasing business sector efficiency. Digital innovation enhances rapid communication and information exchange between business sectors, and this enhances trade openness and investment, and encourages innovation. Firms that deal in foreign economies, supported by ICT, lead to the creation of employment, more so in technology and online services. Mobile commerce and online marketing enable financial inclusiveness, which is most likely to lead to wider availability of financial services and agricultural commodities. All these go towards the performance of an economy. As remarked, ICT service extremely

boosts economic efficiency and productivity in every industry, including the shea sector, leading to economic growth (Ishnazarov*et al*., 2021; Kurniawati, 2022).The nexus of ICT and the shea trade contribution effect on economic development, the study corroborates that shea trade openness is enhanced or altered by ICT innovation. For instance, column [1], in which the difference of 4.209 (4.442-0.233) indicates the net effect of shea trade on economic development, as telephone subscription, which indicated an inverse relationship interaction, cannot be sufficient to offset the positive effect of shea trade on economic development. Through virtual observation of the interaction between the shea trade and ICT tools, the net effect of the shea trade towards economic development is 3.088 and 4.209, respectively. Thus, the interaction between the shea trade and ICT positively affects the economic development of West Africa. The complementarity between AICT and the shea trade facilitates AICT-facilitated higher productivity, employment generation, and earnings generation, which in turn results in robust economic performance of an economy. The outcome of this finding is consistent with existing literature on developing economies (Adeleye *et al*., 2021; Dossou *et al*., 2024; Dumor *et al*., 2024; Ishnazarov *et al*., 2021; Kurniawati, 2022). This is a crucial finding and contributes to the literature for more openness of the shea trade and economic development in Ghana and West Africa. Turning to the control factors, education has a positive and direct effect on economic development atthe 1% significance level. This implies that a 1 percent increase in education expenditure (proxy as human capital) will increase economic performance by 0.34 percent, *ceteris paribus*. This is plausible as access to quality education empowers people to develop skills that make them productive and innovative, leading to a very strong workforce and a more competitive economy. Similarly, expanding access to quality education helps reduce inequalities and empowers marginalized societies, and this fosters economic inclusivity for economic growth. This finding aligns with other studies (Almutairi, 2024; Hanushek, 2013; Hussin *et al*., 2012) but contradicts others (Ugochukwu & Oruta, 2021). The electricity subscription rate has a positive effect on economic performance, indicating that a 1 percent increase in electricity subscription rate will lead to between 0.216 and 0.224 percent economic development.

Reliable electricity enables factories, businesses, and technology-driven sectors to operate efficiently. This leads to enhanced firms' productivity and economic expansion in general.Studies revealed that electricity is a critical pathway for sustainable economic development in developing economies (Abbasi *et al*., 2021; Byaro*et al*., 2024; Magazzino, 2024). Labour participation has an inverse effect on economic development, which is marginally significant at the 10% level. This indicates that a 1 percent increase in labour will reduce economic performance by 9.7%, *ceteris paribus*. This finding could not meet the study's expectation that labour participation would have a positive effect on economic development. Labour participation is a key indicator in the production function, which is beneficial to economic growth. But the reason for that finding could be that increasing labour participation in an economic activity can have unintended negative effects. For instance, when more people join the workforce but primarily in low-wage or unstable jobs, overall productivity and income levels may not improve significantly. When an economy encounters this situation due to an increase in labour force participation without corresponding job creation or skill development, this can lead to inefficiencies in the economy. Hence, more unskilled labour participation is a drag on economic performance (Adeleye *et al*., 2021; Adeleye &Eboagu, 2019).

Conclusion and Policy Implications:The implications of the shea trade and ICT adoption nexus on economic development in West Africa have not been explored. Drawing on evidence between the years 2003 and 2023 and using a static OLS regression model, the study explores the role of the shea trade and ICT nexus to economic development in West Africa, using Ghana as the case. The study validates the hypothesis that economic development is significantly influenced by the shea trade and whether ICT adoption promotes or impedes the influence of the shea trade on economic development.This study provides evidence that the shea trade and ICT adoption contribute to economic development. Specifically, the shea trade has a significant positive effect on economic development. The study further reveals that ICT adoption significantly increases economic development. Mobile and fixed telephone subscriptions contribute to the shea trade effect on economic development.Based on the key findings of the study, we conclude that the shea trade and ICT have a significant positive effect on economic development. Thus, ICT adoption moderated the shea trade on economic development, and this has policy implications for shea-producing countries in West Africa. Especially, this presents an opportunity for the African Continental Free Trade Agreement (AfCFTA) to enhance economic development in West Africa, particularly in the shea trade and ICT sectors. One of the key benefits of AfCFTA is its potential to enhance trade in the shea industry within the continent and the rest of the world. Through AfCFTA, African nations can streamline trade and ICT policies that will make it easier for shea producers to access international markets. Enhancing ICT adoption can increase the shea trade openness, thereby generating higher revenue for local farmers and processors, ultimately contributing to economic development in West Africa.As the shea trade and ICT are critical pathways to economic development, it is essential to invest in ICT infrastructure and support digital literacy programs along the shea value chain to ensure that businesses can fully leverage AfCFTA's opportunities. Therefore, governments should also focus on strengthening trade policies for shea exports, ensuring sustainable practices, and competitive pricing in global markets.

Declarations: The authors declare that they have no known competing financial interests or personalrelationships that could have appeared to influence the work reported in this paper.

Appendix A. Model normality test: Variance Inflation Factor

Table A. Model integrity test

Variable	VIF	1/VIF
Telephone	22.83	0.043811
Education	10.33	0.096840
labour	9.91	0.100917
shea trade	3.98	0.251393
Electricity	3.56	0.281249
GFCF	1.28	0.780010
Mean VIF	8.65	

REFERENCES

Abbasi, K. R., Abbas, J., & Tufail, M. 2021. Revisiting electricity consumption, price, and real GDP: A modified sectoral level analysis from Pakistan. *Energy Policy*, *149*, 112087.

Abendin, S., & Duan, P. 2021. International trade and economic growth in Africa: The role of the digital economy. *Cogent Economics & Finance*, *9*(1), 1911767.

Adeleye, B. N., Adedoyin, F., & Nathaniel, S. (2021). The criticality of ICT-trade nexus on economic and inclusive growth. *Information Technology for Development*, *27*(2), 293-313.

Adeleye, N., &Eboagu, C. (2019). Evaluation of ICT development and economic growth in Africa. *NETNOMICS: Economic research and electronic networking*, *20*, 31-53.

Adeleye, N., & Jamal, A. (2020). Dynamic analysis of violent crime and income inequality in Africa. *International Journal of Economics, Commerce and Management*, *8*(2), 1-25.

Al-hassan, S. (2012). Market access capacity of women shea processors in Ghana. *European Journal of Business and Management*, *4*(6), 7-17.

Alliance Global Shea. (2020). *Shea value chain as key pro-poor carbon-fixing engine in West Africa*. Food & Agriculture Org.

Almutairi, N. T. (2024). Does investment in human capital via education stimulate economic growth in an oil-rich country? A

case study of Saudi Arabia. *Journal of the Knowledge Economy*, *15*(1), 2933-2955.

Awad, A., &Albaity, M. (2022). ICT and economic growth in Sub-Saharan Africa: Transmission channels and effects. *Telecommunications Policy*, *46*(8), 102381.

Ayelazuno, R. A., & Yaro, J. A. (2024). Shea butter livelihoods and challenges faced by women in the Kassena Nankana districts, Ghana. *SN Social Sciences*, *4*(1), 18.

Bannor, R. K., Oppong-Kyeremeh, H., Boateng, A. O., Kyire, S. K. C., Bold, E., & Nimo, M. A. (2024). Total quality management practices among women shea processors: Implication for job performance and household expenditure. *Cleaner and Circular Bioeconomy*, *9*, 100118.

Beczner, C., Gower, B., &Vizzoni, P. (2017). Women's Gold: Finding a market for Dagara shea butter. In *Corporate Citizenship in Africa* (pp. 224-233). Routledge.

Byaro, M., Mmbaga, N. F., &Mafwolo, G. (2024). Tackling energy poverty: Do clean fuels for cooking and access to electricity improve or worsen health outcomes in sub-Saharan Africa? *World Development Sustainability*, *4*, 100125.

Chalfin, B. (2004). *Shea butter republic: State power, global markets, and the making of an indigenous commodity*. Routledge.

Choudhury, N. (2023). Shea Butter Market. Future Market Insights. https://www.futuremarketinsights.com/reports/shea-butter-market.

Dossou, T. A. M., Asongu, S. A., Dossou, K. P., &Alinsato, A. S. (2024). The role of the internet in moderating the effect of industrialization on income inequality in Africa. *Information Technology for Development*, 1-28.

Dumor, K., Shurong, Z., Dumor, H. K., Ampaw, E. M., Amouzou, E. K., Okae-Adjei, S., & Boadi, E. K. (2024). Evaluating the effect of ICT on trade and economic growth from the perspective of Eastern African belt and road countries. *Information Technology for Development*, *30*(3), 452-471.

Ejemeyovwi, J. O., Osabuohien, E. S., &Osabohien, R. (2018). ICT investments, human capital development and institutions in ECOWAS. *International Journal of Economics and Business Research*, *15*(4), 463-474.

Enhanced Integrated Framework. (2024). Contributing to women's economic empowerment in West Africa: lessons learnt from the shea industry. Trade for Development News. https://trade4devnews.enhancedif.org/en/op-ed/contributing-womens-economic-empowerment-west-africa-lessons-learnt-shea-industry.

Ganda, F., & Panicker, M. (2025). Does access to energy matter? Understanding the complex nexus among energy consumption, ICT, foreign direct investment and economic growth on carbon emissions in Sub-Saharan Africa. *Energy Nexus*, *17*, 100346.

Glew, D., & Lovett, P. N. (2014). Life cycle analysis of shea butter use in cosmetics: from parklands to product, low carbon opportunities. *Journal of Cleaner Production*, *68*, 73-80.

Glubis, J. (2024). Empowering Ghanaian Women Shea Farmers through Diverse Entity Types. Graham Sustainability Institute, University of Michigan. https://graham.umich.edu/media/files/dow/Dow-2023-Nourishing-Change-Justine-Glubis.pdf.

Green Views Residential. (2023). Shea butter from Ghana: importance of cooperatives. Green Views. https://greenviewsresidential.com/shea-butter-from-ghana/.

Hale, I., Ma, X., Melo, A. T., Padi, F. K., Hendre, P. S., Kingan, S. B., Sullivan, S. T., Chen, S., Boffa, J.-M., &Muchugi, A. (2021). Genomic resources to guide improvement of the shea tree. *Frontiers in Plant Science*, *12*, 720670.

Hanushek, E. A. (2013). Economic growth in developing countries: The role of human capital. *Economics of education review*, *37*, 204-212.

Hussin, M. Y. M., Muhammad, F., Hussin, M. F. A., & Razak, A. A. (2012). Education expenditure and economic growth: A causal analysis for Malaysia. *Journal of Economics and Sustainable Development*, *3*(7), 71-81.

Iddrisu, B., & Al-hassan, S. (2016). Adoption of mobile phone use by shea butter processors. *UDS International Journal of Development*, *3*(1), 66-75.

Ishnazarov, A., Kasimova, N., Tosheva, S., & Isaeva, A. (2021). ICT and economic growth: evidence from cross-country growth modeling. Proceedings of the 5th International Conference on Future Networks and Distributed Systems,

Kabo-Bah, A. T., Diji, C., &Sunkari, E. D. (2025). Could Shea be the next gold for Ghana?

Kang, J. W., &Ramizo, D. M. (2022). Nexus of technology adoption, e-commerce, and global value chains: The case of Asia. *Asian Development Review*, *39*(02), 45-73.

Keho, Y. (2017). The impact of trade openness on economic growth: The case of Cote d'Ivoire. *Cogent Economics & Finance*, *5*(1), 1332820.

Koren, M., &Tenreyro, S. (2007). Volatility and development. *The Quarterly Journal of Economics*, *122*(1), 243-287.

Kurniawati, M. A. (2022). Analysis of the impact of information communication technology on economic growth: empirical evidence from Asian countries. *Journal of Asian Business and Economic Studies*, *29*(1), 2-18.

Ky-Dembele, C., Bayala, J., Boffa, J.-M., Kalinganire, A., &Minang, P. A. (2021). Shea Tree Crop Management in West Africa. Tree Commodities and Resilient Green Economies in Africa. Nairobi, Kenya: World Agroforestry (ICRAF).

Lebioda, L., Hahn, I. S., & Martins, A. A. M. (2019). The influence of mobile technology usage behavior on perceived work performance improvement. *International Journal of Development Research*, *9*(02), 25733-25738.

Ma, Y., Jiang, Y., & Yao, C. (2022). Trade openness, financial openness, and macroeconomic volatility. *Economic Systems*, *46*(1), 100934.

Magazzino, C. (2024). Ecological footprint, electricity consumption, and economic growth in China: geopolitical risk and natural resources governance. *Empirical Economics*, *66*(1), 1-25.

Mazorodze, B. T. (2025). The Impact of Trade Openness and ICT on Technical Efficiency of Township Economies in South Africa. *Economies*, *13*(5), 125.

Mensa, N. (2022). Women's Gold: The Shea Butter Industry in Ghana and how Empowerment influences Employment.

Mohammed, A., Baah-Ennumh, T., & Abdulai, A. (2016). Role of the shea industry in the socio-economic lives of women in the West Mamprusi District of Northern Ghana. *Journal of Social Sciences Research*, *10*(1), 1091-2321.

Moyo, C., Kolisi, N., &Khobai, H. (2017). The relationship between trade openness and economic growth: The case of Ghana and Nigeria.

Myovella, G., Karacuka, M., &Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, *44*(2), 101856.

Noah, A., & David, O. (2025). Does ICT adoption moderate the impact of entrepreneurship on economic growth in Africa? *Administrative Sciences*, *15*(3), 88.

Nyagadza, B., Pashapa, R., Chare, A., Mazuruse, G., & Hove, P. (2022). Digital technologies, Fourth Industrial Revolution (4IR) & Global Value Chains (GVCs) nexus with emerging economies' future industrial innovation dynamics. *Cogent Economics & Finance*, *10*(1), 2014654.

Onuogu, I. C., Hassan, A., Akadiri, S. S., Bello, A. A., & Riti, J. S. (2024). Impacts of ICT diffusion, foreign direct investment, trade openness, and globalization on growth in Sub-Saharan Africa. Natural Resources Forum,

Onyango, R. A., Ongus, R. W., Awuor, F. M., &Nyamboga, C. (2014). Impact of adoption and use of mobile phone technology on the performance of micro and small enterprises in Kisii Municipality Kenya. *World Journal of Computer Application and Technology*, *2*(2), 34-42.

Opoku–Mensah, S. (2023). An assessment of the structure of shea global value chain in Ghana and implication for policy development. *Heliyon*, *9*(10).

Oppong-Baah, T., Bo, Y., Twi-Brempong, C., Amoah, E. O., Prempeh, N. A., & Addai, M. (2022). The Impact of trade openness on economic growth: The case of Ghana and Nigeria.

Journal of Human Resource and Sustainability Studies, *10*(1), 142-160.

Osman, R., Shiraz, H., Abdulai, H., &Iddi, F. Y. (2024). Impact of Mobile Money Technology on Sheabutter Marketing in Tolon District, Ghana. *Asian Journal of Agricultural Extension, Economics and Sociology*, *42*(1), 91-99.

Saeed, U. F., Kamil, R., & Wiredu, I. (2025). The roles of ICT and governance quality in the finance-growth nexus of developing countries: a dynamic GMM approach. *Cogent Economics & Finance*, *13*(1), 2448228.

Solomon, E. M., & Van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities policy*, *67*, 101104.

Squalli, J., & Wilson, K. (2011). A new measure of trade openness. *The World Economy*, *34*(10), 1745-1770.

Tanzile, R., Fielmua, N., &Domapielle, M. K. (2023). Contribution of shea-based livelihoods to income of rural women in North-Western Ghana. *Ghana Journal of Development Studies*, *20*(1), 195-212.

Ugochukwu, S. D., & Oruta, L. I. (2021). Government expenditure and economic growth in Nigeria: A disaggregated analysis. *TraektoriaNauki= Path of Science*, *7*(11), 4022-4035.

UNDP. (2024). Ghana's golden resource: How shea is empowering women and preserving savannas. UNDP Climate Promise. https://climatepromise.undp.org/news-and-stories/ghanas-golden-resource-how-shea-empowering-women-and-preserving-savannas.

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