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AGRICULTURAL RAW MATERIALS, INFORMATION AND COMMUNICATIONS TECHNOLOGY AND SERVICE EXPORTS ON ECONOMIC GROWTH IN TWENTY SUB-SAHARAN COUNTRIES: A PANEL VECTOR ERROR CORRECTION MODEL APPROACH

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ABSTRACT
The economies of Sub-Saharan Africa are experiencing significant growth due to increasing populations, rising incomes, and urbanization. However, these factors also bring challenges to trade stability. This study analyses the impact and causality of agricultural raw materials, information and communications technology, and service exports on economic growth in twenty selected countries in the region. The research utilised the Panel Vector Error Correction Model approach and the Canning and Pedroni causality test. The analysis focused on stationarity, long-run and short-term dynamics, and the impact of export variables on economic growth. The results of panel unit root and cointegration tests revealed that all variables are non-stationary at level but became stationary after the first differencing, indicating a long-run relationship. The study conclude and recommend that governments in the region develop and promote efficient policies and institutional frameworks to facilitate technological transformation, which could drive non-oil exports, fuel economic growth, and enhance expertise within Sub-Saharan African economies for greater efficiency.

Keywords*:* Non-oil Export variables used, panel unit root, Panel VECM, Canning and Pedroni causality test, and sub-Saharan Africa.

INTRODUCTION

With more than one billion inhabitants, half of whom will be under the age bracket of twenty-five years by 2050, Sub-Saharan Africa is a diversified continent with abundant natural and human resources that might lead to inclusive growth and eradicating poverty in the area. The continent is forging a whole new path for growth by utilizing the potential of its resources and people. It has the largest free trade area in the world and a market of 1.2 billion people, (World Bank, 2023). The area is made up of 22 fragile or conflict-affected countries with income levels ranging from low to upper middle class to affluent. Africa contains 13 states, each with a modest population, human capital, and area. Sub-Saharan Africa's economic growth varies by sub-region and country. Western and Central Africa's GDP growth is predicted to slow to 3.4% in 2023 from 3.7% in 2022, while Eastern and Southern Africa's GDP growth slows to 3.0% from 3.5% in 2022 (World Bank, 2023). The performance of the region is nevertheless hindered by slow long-term growth in the continent's biggest nations. As the energy crisis worsens, economic activity in South Africa is predicted to contract even more in 2023 (by 0.5%), while the rebound in Nigeria's growth for 2023 (by 2.8%) is still precarious due to low oil production. Eight of the ten economies (Angola, Nigeria, South Africa, Ethiopia, Kenya, Ghana, Tanzania and Côte d'Ivoire) that make up more than three-quarters of the region's GDP are expanding at rates that are lower than their long-term averages, (World Bank, 2023). According to the World Bank (2022), services, followed by agriculture and industry, are the key drivers of economic growth in sub-Saharan Africa. However, the performance of the region's growth varies between nations and sub-regions. The region's largest economies, including those of Nigeria, South Africa, and Angola, rely largely on the sale of oil and minerals, making them susceptible to outside shocks and price instability (Statistica, Africa GDP, 2021). Other nations, like Ethiopia, Kenya, and Rwanda, have more diverse economies that rely on commerce, manufacturing, tourism, and remittances.

The lack of product diversification and competitiveness is one of the issues non-oil exporters in sub-Saharan Africa confront. According to Oxford Business Group, Nigeria, (2023) one of the biggest oil producers in the area, has untapped potential in industries like agriculture and mining that might eventually become important source of export revenue. However, the nation has trouble using its oil revenues to pay for structural reforms and infrastructural expansion (OBG, 2023).

Non-oil exports are crucial for Sub-Saharan Africa's economic development because they can help diversify the region's income sources and lessen reliance on volatile oil prices. Services, agriculture, and manufacturing are examples of non-oil sectors that can boost productivity, stimulate innovation, and add more jobs. Nigeria is one of the nations that has seen a surge in non-oil sector development contributions in recent years, particularly from the financial services, transportation, and telecommunications sectors, according to a report by Oxford Business Group (OBG, 2023). However, the nation continues to deal with issues including oil theft, security worries, and significant fuel subsidies that hurt its prospects for economic growth. According to a report by the World Bank (2021), positive spillovers from a strengthening global economy, improved international COVID-19 control, and robust domestic activity in agricultural commodities, exporters will all contribute to Sub-Saharan Africa's output increasing by 2.8% in 2021 and 3.3% in 2022. Given the effects of the pandemic and the region's sluggish vaccination rate, it is anticipated that the recovery will remain fragile.

The importance of non-oil exports to a nation's economic growth and development cannot be over-emphasized. Hence, this study focuses on the application of the Panel Vector Error Correction

Model (henceforth PVECM) approach to investigate empirically, the contribution of some non-oil exports to economic growth in Sub-Saharan Africa.

Panel data which is often known as longitudinal data, is a type of data that includes observations on various cross-sections over time. Examples of the types of grouping that can make up panel data series are nations, businesses, people, or demographic categories, (Eric, 2021). Panel data can simulate both the typical and unique behaviour of groups. Panel data is more efficient, variable, and informational than cross-sectional or pure time series data. Pure time series or cross-sectional data cannot detect or measure statistical effects, however panel data can. When groups are combined into a single time series, estimate biases may occur. Panel data helps mitigate these biases. (Eric, 2021). Hsiao (1985) and Solon (1989) mentioned numerous benefits of using panel data.

Panel data analysis is the model specification that determines the functional shape and assumptions of your regression equation. Si nce time series data are typically non-stationary, a panel unit root test has to be conducted to ascertain if a time series variable is non-stationary and possesses a unit root, numerous panel data models and time series models need stationary underlying data to be viable. Reliable unit root testing is therefore a crucial step in any time series analysis or panel data analysis (Eric. 2021). Apart from the unit root, another concept is cointegration. Cointegration is a statistical property of a collection of time series variables. Cointegration analysis tests whether variables have stochastic trends- their trend is a random walk-share a common trend (Stern, 2016).
For Panel cointegration, all series are assumed non-stationary and all non-stationary become stationary at first difference (Narujapica, 2018). Even though these series tend to briefly diverge, a test for cointegration tests whether or not there is a long-run relationship between them. Panel Cointegration test is used to determine if the panel time series economic variables are cointegrated before the Panel vector error correction model (VECM) is used to determine the long run and short run relationship Thus, ECMs directly estimate the speed at which a dependent variable returns to equilibrium after a change in other variables.

The panel data will have N x T total observation units if the observation was made at time T periods (t = 1, 2, 3, …, T), where N is the number of persons (i = 1, 2, 3, …, N). And usually consider a balanced panel if each individual's total unit time is equal. If the time units for each member differ, the panel is said to be imbalanced.

It is interesting to study the impact of agricultural raw material exports, Information and Communications Technology (henceforth ICT) exports and service exports on economic growth. In so doing, this paper will examine the impact and causality of agricultural raw materials, ICT, and service exports on economic growth in twenty selected countries in the region using the Panel Vector Error Correction Model approach and the Canning and Pedroni causality test.

Empirically, according to Abogan, Akinola, and Baruwa (2014), the list of non-oil exportable goods is endless and includes things like crops, manufactured goods, solid minerals, entertainment, and tourism services.
Exports of goods other than crude oil (petroleum products) are traded on the world market to generate profit. Akeem (2011) affirms that the non-oil exports sector of Nigeria is divided into four main groups: solid mineral exports, manufactured exports, agricultural exports, and service exports. Non-oil exports, although relatively small presently, contribute to export diversification and serve as a channel for poverty reduction. Agricultural products like palm oil, palm kernels, sesame seeds, and cocoa beans are included in non-petroleum exports, as are some industrial goods like chemicals, corrugated asbestos sheets, and transportation equipment. (Nwachuckwu, 2014).

The understanding of the responsiveness of these non-oil export commodities to changes in price and non-price factors is indispensable in formulating a sound export policy strategy. Where exports respond negatively to price, the price change cannot bring about an increase in export volume; likewise, where the export response is insensitive to supply, increased production cannot bring about an increase in export volume. Consequently, this study is an attempt at a better understanding of the direction and magnitude of response between aggregate non-oil export and its determinants and economic growth of Nigeria (Aladejare and Abdulwahab, 2014) and sub-Saharan Africa.

The Nigerian economy has heavily been dependent on oil export revenues. Economic growth is a key component in determining participation in the organization of powerful countries (Iyoha and Okim, 2017). This means that oil export revenues are of basic importance in the provision of required resources in other sectors. Hence, other sectors either directly or indirectly, depend on crude oil and its export revenues. Increasing reliance on oil revenues has impaired the development, diversification and increase in volume of non-oil exports.
Ethiopia and Kenya to become Sub-Sahara's third and fourth largest economies after Nigeria and South Africa (IMF, 2023).
Sub-Saharan Africa heavily relies on exports of basic commodities including oil, metals, minerals, and agricultural goods. The commodities' unstable prices and demand shocks may impact the region's export and fiscal revenues. For instance, the dramatic decrease in oil prices in 2020 (World Bank, 2023) hurt oil exporters like Angola and Nigeria. However, other exporters of agricultural products, such as Ethiopia and Benin, profited from robust home demand and stable global demand (World Bank, 2021). The region must invest in human capital, innovation, technology, and regional connectivity to increase export potential (IMF 2021 and WEF 2019).

Abogan, Akinola and Baruwa, (2014) used the Johansen Co-integration test, the Error Correction Mechanism, and the Ordinary Least Squares (OLS) methodologies to examine the relationship between non-oil exports and economic growth in Nigeria from 1980 to 2010. According to the study, non-oil exports had a moderate impact on economic growth (26% for the years studied).

Hodey and Senadza (2015) provided evidence of the relationship between export diversification and economic growth using panel data from forty-two (42) SSA countries. Employing the system Generalized Method of Moments (GMM) estimation technique and three different measures of diversification reveal that export diversification has a positive and significant effect on economic

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growth in SSA. Results are robust to the measures of export diversification, however, do not support a hump-shaped (non-linear) relationship between export diversification and economic growth in SSA.

Faustin, Maniraguha, and Ndemezo (2022) researched if financial development in Sub-Saharan Africa may increase the contribution of exports to economic growth and created an interaction index tailored to the region's financial developments and export growth. The results of using econometric methods showed that the level of the interaction index and its impact on growth are country- and region-specific. The interaction index revealed a stronger impact on economic growth. To promote economic growth, policymakers should concentrate on the growth of the financial sector, in particular financial institutions, as well as on financing exports.

Kolawole and Okodua (2013) researched foreign direct investment, non-oil exports and economic growth in Nigeria using the Granger causality test. The finding reveal that in the long-run, foreign direct investment affects economic growth positively in Nigeria.

Terfa and Tarlumun (2019) in their study investigate the relationship between non-oil exports and economic growth in selected African countries. The study employed the Dynamic Panel Data Models and findings reveal that non-oil exports have a positive relationship with economic growth in all the countries except Gabon in the long-run.

The growth impact of export promotion techniques on non-oil output in the sub-Saharan African (SSA) nations is examined by Tolulope and Olalekan (2017). They used panel data and three regression methods (fixed effect, dynamic generalized moment method, and pooled ordinary least squares (OLS) to analyse the data. Results indicate that the non-oil output in SSA is significantly impacted by all of the export promotion policy instruments tested. Additionally, while bank lending to the private sector has a good and considerable impact, the growth-promoting effects of Foreign Direct Investment (FDI), public spending, and exchange rates will be overshadowed.

Jim and Kim (2018) in investigating the relationship between coal use and economic growth for 30 OECD (Organization for Economic Co-operation and Development) nations and 32 non-OECD countries. They conducted the Granger causality test, unit root test, cointegration test, long-run cointegrating vector analysis, and common factor defactorization (which involves decomposing a time series into common factors and idiosyncratic components) method. The findings show that while there is no long-term relationship between coal consumption and economic growth in OECD nations, there is one in non-OECD nations.

Usman (2010) carried out research on non-oil export determinants and economic growth in Nigeria from 1988-2008 using multi-linear regression. The finding show the existence of a positive relationship between GDP and Non-oil exports, consumer price index and exchange rate.

Ceesay and Moussa (2021) examined the impact of commodity price volatility on the economic growth of 35 countries in Sub-Saharan Africa using panel data models. The results indicated statistical significance at 1% level and the coefficients of the variables fluctuated.

While working on Panel cointegration, Kirikkaleli et al. (2018) investigated the long-run relationship between the Internet, electricity consumption and economic growth. To identify any potential long-term and causal relationships between the three variables, panel cointegration, Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Dumitrescu-Hurlin causality tests were undertaken. The results from the FMOLS and DOLS models suggested a long-term relationship between electricity demand, internet demand, and economic growth. Results of the Dumitrescu-Hurlin causality confirm the unidirectional causality from economic growth to energy consumption as well as the feedback causality between internet demand and power consumption.

Enoma and Isedu (2011) digress into the impact of financial sector reforms on non-oil export in Nigeria and empirically examined the impact of current financial sector reforms on non-oil export in Nigeria using VECM, estimated non-oil export supply model. The results obtained both in terms of the time series properties and the estimated error correction model were very impressive and satisfactory. It revealed among other things that the hypothesis of financial liberalization has continued to yield positive results in developing countries and recommended that financial sector reforms should be improved upon and sustained by the authorities to fully optimize the gains so far achieved.

Adenomon and Oyejola (2013) investigated the impact of agriculture and industrialization on GDP in Nigeria, evidence from VAR and SVAR Models. The research utilized the log transform data on agriculture, industry, and GDP along with the ADF test for stationarity, VAR, and SVAR models. The VAR model's results showed that while industry generated about 32% of Nigeria's GDP, agriculture represented roughly 58%. The SVAR models also demonstrated that while both industry and agriculture added to the structural innovations of Nigeria's GDP, agriculture had a bigger impact.

Olowo et al. (2020) in their work titled Sectorial Contributions of Non-oil Revenue to Economic Growth in Nigeria, employed the regression estimation technique of the Autoregressive Distributed Lag Model (ARDL). Their research concluded that the non-oil sector contributed positively and significantly to economic growth in Nigeria.
According to the National Bureau of Statistics (2021), in comparison between 2020 and 2021 revealed that the annual contribution of the non-oil sector increased to 92.76 per cent in 2021 from 91.84 per cent in 2020.

Akpa, Ogbu, and Nwachukwu (2022) investigated non-oil export earnings and Economic Growth in Nigeria. Using the Ordinary Least Square (OLS) method and their result showed a positive and significant relationship between Non-oil Export and GDP (29%) in Nigeria.

Kromotit et al. (2017) opined differently while investigating contribution of non-oil exports to economic growth in Nigeria. Their interest in the given years 1985-2015 was motivated by the sudden fall in international oil prices. The study adopted the Auto-regressive distributed lag (ARDL) model to ascertain the

relationship between non-oil exports and GDP. The ARDL regression result indicated a positive and significant relationship between non-oil exports and GDP. This means non-oil exports contributed significantly to economic growth in Nigeria.

Using random effects and the two-step difference, Pabai (2022), investigated the effects of exchange rate volatility on economic growth for twelve West African nations. In panel data analysis, the generalized method of moment estimation (GMM) techniques were used. In addition to demonstrating that the real effective exchange rate volatility declined have a contractionary impact on economic growth in West African nations. The results also demonstrated that the random effect Ad-hoc methodology and the GMM procedure are robust to cross-section correlation and reverse causality considerations.

Touitou et al. (2018) in their paper titled, the impact of exchange rate regimes on economic growth, examined the impact of exchange rate fluctuations on economic growth for twenty-five countries, using panel data and various econometric techniques. Among their findings was that exchange rate volatility hurts economic growth and that this effect is reduced by financial sector development. The paper also supports the "bipolar view" theory that suggested that developing countries should adopt either fixed or flexible exchange rate regimes, rather than intermediate ones.

Morina et al. (2020) examined the effect of real effective exchange rate volatility on economic growth in Central and Eastern European (henceforth CEE) countries using annual data for fourteen countries to examine the nature and extend the impact of such movements on growth. The empirical findings using the fixed effects estimation for panel data revealed that the volatility of the exchange rate has a significant negative effect on real economic growth and the results appear robust with alternative measures of exchange rate volatility such as standard deviation and z-score.

Akinwolere (2021) used time series data to study the effects of exchange rate volatility on economic growth in Nigeria. To examine the effects of exchange rate volatility on the chosen macroeconomic variables, she employed the Vector Error Correction Mechanism. The findings showed that exchange rate volatility has a considerable impact on economic growth. In particular, it has a beneficial impact on inflation, unemployment, and trade balance, and a negative impact on investment and economic growth.

Theoretically, the idea that exports can spur economic growth by boosting foreign exchange profits, boosting productivity, creating jobs, diversifying the economy, and encouraging technical transfer would serve as the theoretical foundation for export-led growth in sub-Saharan Africa. However, certain empirical research that revealed conflicting or tenuous evidence of a direct relationship between exports and growth in sub-Saharan African countries has called into question this idea. External shocks, trade barriers, exchange rate volatility, insufficient export diversification, inadequate infrastructure, weak institutions, and high external debt are some of the issues that could hinder the effectiveness of export-led growth in this region.

The relationship between exports and growth in 21 sub-Saharan African nations was examined using new evidence from panel data analysis (Odhiambo, 2022), which employed a panel cointegration test and panel Granger-causality model. In both low-income and middle-income nations, the analysis found no evidence of an export-led growth response, although it does find evidence of a bidirectional causal relationship and a neutrality response.

In a study proposed by Chia (2016), it will be determined whether the export-led growth (ELG) hypothesis is true in several Sub-Saharan African (SSA) nations. The empirical results showed that the panel unit root is stationary after the first differencing and presents a cointegration, and there is a long-run relationship between exports and growth based on the results of fully modified ordinary least square (henceforth FMOLS), and Dynamic Ordinary Least Square (henceforth DOLS). A new generation panel data approach was used, including panel unit root, panel cointegration, Fully Modified OLS (FMOLS), and Dynamic Ordinary Least Square (DOLS). Investment, government spending, and exports all had a favourable impact on economic growth, according to FMOLS and DOLS assessments. The results thus demonstrated the viability of an export-oriented growth strategy in SSA nations.

Statistical Theory possesses a set of ideas, presumptions, and rules that direct the analysis of data gathered from the same units throughout several periods and is known as a statistical theoretical framework for panel data. Studying the dynamics of change, the effects of time-invariant variables, the heterogeneity of units, and the causal linkages between variables are all made possible by panel data. Non-random attrition, panel conditioning, endogeneity, measurement error, autocorrelation, heteroskedasticity, and multicollinearity are a few of the difficulties and restrictions that panel data present. The theory of panel data seeks to offer approaches and models that can take into consideration the unique characteristics and difficulties of panel data.
Some of the statistical methods and models that have been developed for panel data analysis are random effects simulations.

Bun, Maurice and Sarafidis, (2015) provides a review of the current dynamic panel data model literature and demonstrated how lagged values of the dependent variable, the covariates or both are frequently included in the specification of time series regression models to address these issues. Many economic dynamic adjustment methods appear to be well characterized by the presence of lags of the dependent variable. However, inference issues, such as small sample bias in coefficient estimates and hypothesis testing, frequently appear to be present in panel data analysis with a limited number of periods. pondering a group of endogenous covariate-allowing linear dynamic panel data models. The covariates may still be influenced by past values of the outcome variable even if one is willing to accept that they are not simultaneously determined.

Kayode, Kelvin, and Olaniyi (2021), investigated on the effect of electronic payment systems on commercial bank profitability in Nigeria. Using the pooled OLS and Panel regression models, fitted on the data gathered from the banks' annual reports, Nigerian interbank settlement scheme, and the Central Bank of Nigeria website, and measured the contribution of the various electronic payment systems under consideration was assessed using the Breusch and Pagan Lagrangian Multiplier (LM) Test and the Hausman Test. The results showed that the random effect model

was more appropriate than the fixed effect model for all of the electronic payment systems studied.

Canning and Pedroni (2008) investigated at the effects of various types of infrastructure supply in a group of countries from 1950 to 1992. Their tests isolate the sign and direction of long-run impacts while accounting for unknown short-run causal linkages. Findings indicate that while infrastructure contributes to long-term economic growth, there is significant variance among countries and shows evidence that each infrastructure type is provided at close to the growth-maximizing level on average globally, but may be under-supplied in some nations and over-supplied in others.

Several panel data unit root tests have been proposed by different researchers. Some of the most commonly used tests are:

The Levin–Lin–Chu (2002) test, assumes a common autoregressive parameter for all panels and requires that the number of periods grow more quickly than the number of panels.

The Im–Pesaran–Shin (2003) test, allows for heterogeneous autoregressive parameters across panels and uses a simple average of the individual panel unit root statistics.
The Fisher-type (Choi 2001) tests, combine the p-values of the individual panel unit root tests based on either the Dickey-Fuller or the Phillips–Perron tests.

Lu (2017) suggest that in the long run, in his research Greenhouse Gas Emissions, Energy Consumption and Economic Growth: A Panel Cointegration Analysis, Granger establishes a bidirectional causal relationship between GDP, greenhouse gas emissions, and energy consumption as well as between GDP, greenhouse gas emissions, and energy consumption. He examines the 22-year co-movement and causality links among greenhouse gas emissions, energy use, and economic growth for 16 Asian nations. For these 16 Asian nations, a non-linear quadratic link between greenhouse gas emissions, energy use, and economic growth is found. This relationship is in line with the environmental Kuznets curve.

Breitung and Pesaran (2008) review Unit Roots and Cointegration in Panels where the time dimension (T) and the cross-section dimension (N) are relatively large. They cover the model and hypotheses to test; first- and second-generation panel unit root tests; cross-unit cointegration; finite sample properties of panel unit root tests; residual-based approaches to panel cointegration; tests for multiple cointegration; and panel cointegration in the presence of cross-section dependence.

Theory of Panel Vector Error Correction Model (PVECM) combines the features of a vector autoregressive (VAR) model and an error correction model (ECM) in a panel data set, where the data consists of multiple cross-sectional units observed over time. A panel VECM can capture both the short-run and long-run effects of the variables on each other, as well as the heterogeneity and commonality across the cross-sectional units.

The theory of panel VECM is based on the following steps:
Firstly, test the stationarity of the variables using unit root tests such as Levin-Lin-Chu, Im-Pesaran-Shin, or Fisher-type tests. If the variables are non-stationary, proceed to the next step. Otherwise, use a panel VAR model instead.
Secondly, test the cointegration of the variables using panel cointegration tests such as Pedroni, Kao (1999), or Westerlund tests. If the variables are cointegrated, proceed to the next step. Otherwise, use a panel VAR model in differences instead.
Thirdly, estimate the cointegrating vectors using panel cointegration methods such as fully modified OLS (FMOLS), dynamic OLS (DOLS), or pooled mean group (PMG) estimators. These methods can account for the endogeneity and serial correlation of the regressors and provide consistent estimates of the long-run coefficients.
Finally, specify and estimate the panel VECM using the estimated cointegrating vectors as error correction terms.
The panel VECM can be estimated by various methods such as pooled OLS, fixed effects, random effects, generalized method of moments (GMM), or maximum likelihood. The choice of method depends on the assumptions and objectives of the analysis.

Summarily, World Bank (2023) revealed that Sub-Saharan Africa heavily relies on exports of basic commodities including oil, metals, minerals, and agricultural goods. Different scholars have taken to refuting or agreeing with this assertion using various statistical methods and different explanatory variables. Findings have shown that there exist both long-run and short-run relationships between non-oil exports (using different variables depending on areas of interest), export diversification and economic growth in Sub-Saharan Africa.

Concerning the empirical works of literature reviewed, it was discovered that few studies have recently adopted the combination of the panel VECM and Canning Pedroni causality test and none have used the selected non-oil export variables (agricultural raw material export, ICT export and service exports) combined as independent variables on economic growth in the 20 selected Sub-Saharan African countries.
Thus, this study seeks to fill these gaps identified in the works of literature. The remaining part of the paper presents the materials and methods, results, conclusion and recommendations.

MATERIALS AND METHODS

The sample for this study selected twenty countries from Sub-Saharan Africa countries. They have been selected based on the top twenty economies (as of 2023) from West Africa, South Africa, Central Africa and East Africa. These selected regions make up the samples from sub-Saharan Africa. They are; Angola, Botswana, Cameroon, Chad, Cote d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Ghana, Kenya, Mali, Namibia, Nigeria, Republic of Congo, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia and some variables in Sub-Saharan Africa; Gross Domestic Product (GDP), Agricultural raw material, Service exports, and information and communications technology exports.

To address the problem of spurious regression, the study employed the LLC, IPS, ADF and PP unit root tests to determine whether variables were stationary. The cointegration was performed using Pedroni, Kao and Johansen Fishe tests to find long-term relationships between variables. Thus, using the Canning-Pedroni long-run cointegration test, we investigated causality to further understand the relationship between Agriculture raw material export, ICT export, Service export and GDP in SSA. The PVECM gives the long-run relationship and the short-run

dynamic as ECT reveals the speed of adjustment to equilibrium. The study used STATA 15.1, Eviews 13.0 and R software to perform the statistical analysis and test of data.

Estimation of panel unit root test

The panel unit root test framework has two generations of tests. A first generation of tests (the Levin, Lin, and Chu test (2002), the Im, Pesaran, and Shin test (2003), and the Fisher type test) that assume cross-sectional independence across units, and a second generation of tests that reject the cross-sectional independence hypothesis.

H_0: Panel data has unit root (assume common unit root)
H_1: Panel data has no unit root.

The unit root test examine the stationarity of time series variables (agriculture raw material export, ICT export, service export, and GDP) in SSA, based on the above hypothesis. To avoid spurious regression, four approaches were used: LLC, IPS, ADF, and PP tests, as well as the unit root test.

Consider a simple panel data model with a first-order autoregressive component

$$Y_{it} = \alpha_i + y_{i,t-1} + X_{it}\delta_i + \varepsilon_{it} \quad (1)$$

where i = 1, . . ., *N* indexes panels; t = 1, . . ., T_i indexes time; Y_{it} is the variable being tested, α_i is the entity-specific intercept term and captures the individual effect for the entity (i) that does not vary over time, $y_{i,t-1}$, is the lagged dependent variable, representing the value of (Y) for entity (i) at time (t-1) and accounts for the influence of past values on the current value of (Y), and ε_{it} is a stationary error term, and $X_{it}\delta_i$ represents panel-specific means and linear time trends. The X'_{it} term represents panel-specific means and a time trend, or nothing, depending on the options specified. By default, X'_{it} = 1, so that the term $X'_{it}\delta_i$ represents panel-specific means (fixed effects). If the trend is specified, $X'_{it} = (1, t)$ so that $X'_{it}\delta_i$represents panel-specific means and linear time trends. For tests that allow it, specifying no-constant omits the $X'_{it}\delta_i$ term. In a regression model, ε_{it} is likely to be plagued by serial correlation, so to mitigate this problem, Levin-Lin-Chu (henceforth LLC) augment the model with additional lags of the dependent variable:

$$\Delta Y_{it} = \varphi y_{i,t-1} + X'_{it}\delta_i + \sum_{j=1}^{p} \Theta_{i\,j}\, \Delta y_{i,t-1} + \varepsilon_{it} \quad (2)$$

Where p denote the number of lags and ε_{it} is the white noise

Levin, Lin, and Chu (2002) recommended using their test with panels of "moderate" size, which they described as having between 10 and 250 panels and 25 to 250 observations per panel. Baltagi (2013) mentioned that the requirement *N/T* → 0 implies that *N* should be small relative to *T*.

Im–Pesaran–Shin test Formula with the model written as

$$\Delta y_{it} = \varphi_i\, y_{i,t-1} + \acute{X}_{it} + \varepsilon_{it} \quad (3)$$

where ε_{it} is independently distributed normally for all *i* and t with panel-specific variance δ_i^2. Denote $\Delta y_i = (\Delta y_{i,2}, \ldots, \Delta y_{i,T})'$ and $y_{i-1} = (y_{i,1}, \ldots, y_{i,T-1})'$.

$$\Delta Y_{ij} = \alpha_i + b_1 y_{t-1} + C_{2i}\bar{y}_{t-1} + \sum_{j=o}^{p} d_{ij}\, \bar{y}_{t-1} + \delta_i \Delta Y_t + \varepsilon_{it} \quad (4)$$

Where i represents each country (i = 1, 2, … 20) and t represents the time index (t = 1, 2, …40)

Panel-data cointegration test

The test statistics are residual-based and derived from the following regressions:

$$Y_{it} = \alpha_i + \delta_{i,t} + \beta_i Y_{1i,j} + \cdots + \beta_{mi} X_{mi,t} + \varepsilon_{it} \quad (5)$$

$$\Delta Y_{it} = \beta_{1i} X_{1i,t} + \cdots + \beta_{mi} X_{mi,t} + \eta_{it} \quad (6)$$

$$\hat{e}_{it} = \hat{Y}\hat{e}_{it-1} + \hat{\mu}_{it} \quad (7)$$

$$Y_{it} = \hat{Y}\hat{e}_{it-1} + \sum_{k=1}^{K} \hat{Y}_{ij}\, \Delta\hat{e}_{it-1} + \hat{V}_{i,t} \quad (8)$$

Johansen (1991, 1995) developed a methodology for testing for cointegration as follows:

Let $Y_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ denote an $(n \times 1)$ vector of non-stationary I(1) time series variables. The basic Vector Autoregressive Model of order p, denoted VAR(p) is defined as:$Y_t = \alpha + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + BX_t + \varepsilon_t$, $t = 1, 2, \ldots, T$ (9)

Where;

α: is an $(n \times 1)$ vector of intercept

ϕ_i $(i = 1, 2, \ldots, p)$: is $(n \times n)$ coefficient matrices

X_t d-vector of deterministic variables

ε_t: is an $(n \times 1)$ vector of unobservable error term with zero mean (white noise).

The Panel Vector Error Correction Model (PVECM)

Cointegrated panel data, or data made up of several cross-sectional units observed across time, can be modelled using the panel VECM approach. Cointegration indicates that, despite the variables' non-stationarity, there is a long-run equilibrium link between them (Eric, 2021).

A formula for panel VECM is given below

$$\Delta Y_t = \alpha_1 + P_1\, e_1 + \sum_{i=1}^{n} \beta_i\, \Delta Y_{t-1} + \sum_{i=1}^{n} \delta_i\, \Delta X_{t-1} + \sum_{i=1}^{n} \gamma_i\, \Delta Z_{t-1} \quad (10)$$

$$\Delta Y X_t = \alpha_2 + P_2\, e_2 + \sum_{i=1}^{n} \beta_i\, \Delta Y_{t-1} + \sum_{i=1}^{n} \delta_i\, \Delta X_{t-1} + \sum_{i=1}^{n} \gamma_i\, \Delta Z_{t-1} \quad (11)$$

With a long-run cointegration model:

$$Y_{it} = \beta_{oi} + \beta_{1i} X_{1,it} + \varepsilon_{it} \quad (12)$$

to obtain residuals.

The lagged residuals are shown below:

$$ECT_{it-1} = Y_{it-1}\ \beta_{oi} + \beta_{1i} X_{1,it} \quad (13)$$

Where:

ECT_{it-1}represents error correction term (lagged OLS residuals from long run model)

The error correction model is:

$$\Delta Y_{it} = \alpha_1 + \sum_{k=1}^{p} \beta_i\, \Delta Y_{it-k} + \sum_{k=0}^{q} \delta_i\, \Delta X_{t-k} + \phi_1 ECT_{it-1} + \mu_{it} \quad (14)$$

ϕ_1 represents the speed of adjustment back to the long-run

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equilibrium
Subscripts i, refer to each subject in the panel and k is the number of lags. There are two parts to the output: the cointegration equation and the error correction model.

Short-run components are:
$\sum_{k=1}^{p} \beta_i \, \Delta Y_{it-k} + \sum_{k=0}^{q} \delta_i \, \Delta X_{t-k}$ (15)

Long-run components are:
$\phi_1 \mathrm{ECT}_{\mathrm{it}-1}$ (16)

α_1 is the constant term or intercept for entity (i).
μ_{it} is the error term for entity (i) at time (t).

RESULT

Table 1: Panel Unit Root Test result

Series	Lags	LLC Test	Im, Pesaran & Shin W-Stat	ADF- Fisher Chi-Sq	PP-Fisher Chi-Sq
LNAEXP	Level	1.0000	1.0000	0.0010	0.2055
Δ LNAEXP	Ist Dif	1.0000	0.0006	0.0000	0.0000
LNGDP	Level	0.4755	1.0000	1.0000	1.0000
Δ GDP	Ist Dif	0.0000	0.0000	0.0000	0.0000
LNICTEXP	Level	0.0000	0.0389	0.0003	0.0104
Δ LNICTEXP	Ist Dif	1.0000	0.0000	0.0000	0.0000
LNSEXP	Level	0.1546	0.9764	0.9988	0.6316
Δ LNSEXP	Ist Dif	0.0000	0.0000	0.0000	0.0000

Table 1 above summarises the result of a Panel unit root test using Levin, Lin, and Chu (LLC), Im, Pesaran and Shin (IPS), Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. LNAEXP(log of agricultural raw materials export) was observed to be stationary at level in ADF same as LNICTEXP(log of information and communications technology export) in all methods. However, the vast majority results with a null hypothesis of unit root indicating non-stationary at level, and the null hypothesis was not rejected due to the majority P-value > 0.05 hence we move to test for stationarity at first difference. The result reveals that after a first difference, the null hypothesis was rejected and then conclude that the variable became stationary at the first difference.

Table 2 Panel Cointegration Test (results)
Table 2 above shows the result of the Pedroni residual

cointegration test, Kao Residual cointegration test and Johansen Fisher Panel cointegration test. Results showed that the null hypothesis of no cointegration was rejected and reported with substantial evidence that cointegration exists among the variables with statistically significant p-values < 0.05 for the method. There is sufficient evidence to show that there is a stable and long-term relationship hence, we proceed with a PVECM to examine the long-run relationship and the short-run and dynamics of the cointegrated series as the series is confirmed to wander together over time.

Furthermore, from Table 3 below, a Durbin-Watson result with a value of 2.04 mirrors the absence of autocorrelation and is in line with the assumptions that errors are normally distributed with mean zero and all errors are stationary as well.

Table 3: Augmented Dickey-Fuller Test Equation results showing Durbin Watson result

R-squared	0.081802	Mean dependent var	112.6647
Adjusted R-squared	0.071944	S.D. dependent var	748.3376
S.E. of regression	720.9161	Akaike info criterion	16.01097
Sum squared resid	3.39E+08	Schwarz criterion	16.06542
Log likelihood	-5275.620	Hannan-Quinn criterion	16.03208
Durbin-Watson stat	2.044134		

Table 4: Long run cointegrated vector estimated by Group Mean DOLS for GDP

	Coefficient	t-statistics
Drift	-0.5496312	-4.959409
lnaexp_cross		
lnictexp_cross	0.2694764	-5.81508
lnsexp_cross		
	-0.1492500	-3.026407
	0.3782513	11.924564

Table 4 demonstrates that GDP has a statistically significant long-run cointegrated relationship between the variables.
The equation below is the long-run cointegration equation:

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$$LNGDP = -0.5496312 + 0.2694764LNAEXP - 0.1492500LNICTEXP + 0.3782513LNSEXP \quad (17)$$

Table 5 ECM with the difference of lngdp, lnaexp, lnictexp and lnsexp as dependent variables at lag 1

LAG 1	Estimate	p-value	LAG 2	Estimate	p-value
LNGDP as DV			**LNGDP as DV**		
Intercept	-0.003	0.4437	Intercept	-0.004	0.2507
Lag(**Δ**(lngdp_cross),1	0.192	0.0001	Lag(**Δ**(lngdp_cross),2	0.0188	0.5712
Lag(**Δ**(lnaexp_cross),1	0.004	0.8561	Lag(**Δ**(lnaexp_cross),2	0.0029	0.8352
Lag(**Δ**(lnictexp_cross),1	-0.002	0.9175	Lag(**Δ**(lnictexp_cross),2	-0.0424	0.0579
Lag(**Δ**(lnsexp_cross),1	0.021	0.2245	Lag(**Δ**(lnsexp_cross),2	0.0491	0.0443
Lag(ECT)	-0.54	0.0000	Lag(ECT)	-0.53	0.0003
Multiple R^2	0.320		Multiple R^2	0.41	
LNAEXP as DV			**LNAEXP as DV**		
Intercept	0.007	0.5244	Intercept	0.0082	0.4995
Lag(**Δ**(lngdp_cross),1	-0.055	0.6619	Lag(**Δ**(lngdp_cross),2	0.0065	0.0972
Lag(**Δ**(lnaexp_cross),1	-0.149	0.0042	Lag(**Δ**(lnaexp_cross),2	-0.0968	0.0382
Lag(**Δ**(lnictexp_cross),1	-0.051	0.5240	Lag(**Δ**(lnictexp_cross),2	-0.0090	0.8513
Lag(**Δ**(lnsexp_cross),1	-0.011	0.8357	Lag(**Δ**(lnsexp_cross),2	-0.0001	0.9987
Lag(ECT)	0.05	0.5274	Lag(ECT)	-0.02	0.8434
Multiple R^2	0.19		Multiple R^2	0.31	
LNICTEXP as DV			**LNICTEXP as DV**		
Intercept	-0.001	0.9381	Intercept	-0.002	0.9082
Lag(**Δ**(lngdp_cross),1	-0.202	0.3799	Lag(**Δ**(lngdp_cross),2	0.0282	0.9315
Lag(**Δ**(lnaexp_cross),1	-0.038	0.6723	Lag(**Δ**(lnaexp_cross),2	-0.0641	0.5349
Lag(**Δ**(lnictexp_cross),1	-0.014	0.8091	Lag(**Δ**(lnictexp_cross),2	-0.1235	0.0032
Lag(**Δ**(lnsexp_cross),1	0.035	0.8077	Lag(**Δ**(lnsexp_cross),2	0.0540	0.6482
Lag(ECT)	0.11	0.6656	Lag(ECT)	0.16	0.5840
Multiple R^2	0.16		Multiple R^2	0.30	
LNSEXP as DV			**LNSEXP as DV**		
Intercept	0.001	0.8974	Intercept	0.008	0.4451
Lag(**Δ**(lngdp_cross),1	0.036	0.6075	Lag(**Δ**(lngdp_cross),2	-0.011	0.9105
Lag(**Δ**(lnaexp_cross),1	0.065	0.3254	Lag(**Δ**(lnaexp_cross),2	0.050	0.3856
Lag(**Δ**(lnictexp_cross),1	0.055	0.1044	Lag(**Δ**(lnictexp_cross),2	0.009	0.7925
Lag(**Δ**(lnsexp_cross),1	-0.110	0.0207	Lag(**Δ**(lnsexp_cross),2	-0.079	0.0565
Lag(ECT)	-0.049	0.5239	Lag(ECT)	-0.090	0.5383
Multiple R^2	0.17		Multiple R^2	0.18	

$$\Delta LNGDP\_CROSS_t = -0.0025635+0.1924945\Delta LNGDP_{t-1} + 0.0042064\Delta LN\text{AEXP}_{t-1} -0.0023868\Delta LN\text{ICTEXP}_{t-1}+0.0210660\Delta LN\text{SEXP}_{t-1}+\varepsilon_t \quad (18)$$

Table 5 shows the short-run dynamics of GDP, agricultural export, and service export at lag 1 as captured in equation (18). lngdp, lnaexp, and lnsexp are positively related to lngdp at lag 1, whereas lnictexp is negatively related to lngdp at lag 1. Additionally, the ECT of lngdp at lag 1 have fulfilled the two attributes at any conventional level of being negative (-0.54) and has a p-value<0.05. This indicates that the estimated PVECM (1) model for GDP is statistically significant (p<0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run is that about 54% of this disequilibrium is corrected every period. The study established that there is a long-run and short-term relationship between independent variables and the dependent variable, with GDP being a function of aexpt, ictexp, and sexpt in the 20 selected sub-Saharan countries.

The Multiple R-square result confirmed that 32% of GDP is explained by agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With GDP as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexpt, and sexpt have no cross-sectional dependence on GDP.

From Table 5, the model below shows the PVECM at lag 1 for lnaexp:

$$\Delta LN\text{AEXPT}\_CROSS_t = 0.0074809-0.0552691\Delta LNGDP_{t-1} - 0.1490757\Delta LN\text{AEXPT}_{t-1} -0.0509154\Delta LNI\text{CTEXP}_{t-1}-$$

$$0.0111749\Delta LN\text{SEXP}_{t-1}+\varepsilon_{t-1} \quad (19)$$

the result shows that lnaexp, lngdp, lnictexp, and lnsexp all turned in negative values and p-values >0.05. at lag 1, whereas the ECT of PVECM at lag 1 is positive (0.05). With the values of lnaexp as an independent variable, lnaexp is statistically significant and it is desirable to sustain growth in SSA as it has a feedback impact on itself in the short-run and validates the ingenuity of the equations estimated. The Multiple R-square result shows that 19% of lnaexp is explained by GDP, agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With lnaexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexpt, and sexpt have no cross-sectional dependence on lngdp. (See Appendix 1). Furthermore, as agricultural raw material exports in Sub-Saharan African countries rise or fall, so do lngdp, lnictexp, and lnsexp.

From table 5, the model below shows the PVECM at lag 1 for lnictexp

$$\Delta LNI\text{CTEXP}\_CROSS_t = -0.0011287 - 0.202372216343\Delta LNGDP_{t-1} - .0384403\Delta LN\text{AEXPT}_{t-1} - 0.0135415\Delta LNI\text{CTEXPT}_{t-1} + 0.350486\Delta LN\text{SEXPT}_{t-1} + \varepsilon_{t-1} \quad (20)$$

Table 5 shows the short-run dynamics of GDP, agricultural export, and service export at lag 1 as captured in equation (20). lngdp, lnaexp, and lnictexp are negatively related to lngdp at lag 1, whereas lnsexp is positively related to lngdp at lag 1. However, the ECT of lngdp at lag 1 have failed to fulfil the two attributes at any conventional level of being negative (0.11) and has a p-value>0.05. This indicates that the estimated PVECM (1) model for GDP is statistically insignificant (p>0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run cannot be corrected in the long run. Hence lnictexp in the short run is not a good predictor on GDP. The Multiple R-square result confirmed that 16% of lnictexp is explained by agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value less than 0.05, we reject the null hypothesis. With lnictexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexp, and sexpt have cross-sectional dependence on GDP.

From table 5, the model below shows the PVECM at lag 1 for lnsexp.

$$\Delta LN\text{SEXPT}\_CROSS_t = 0.0013763 + 0.0360480\Delta LNGDP_{t-1} + 0.0648271\Delta LN\text{AEXPT}_{t-1} + 0.0554230\Delta LN\text{ICTEXPT}_{t-1} - 0.1101062\Delta LN\text{SEXPT}_{t-1} + \varepsilon_{t-1} \quad (21)$$

Table 5 reveals that GDP, aexpt and ictexp are positively related to sexpt at lag 1. sexpt is negatively and statistically significant. The ECT of lnsexp at lag 1 have fulfilled the two attributes at any conventional level of being negative (-0.54) and has a p-value<0.05. This indicates that the estimated PVECM (1) model for GDP is statistically significant (p<0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run is that about 4.9% of this disequilibrium is corrected every period. The study established that there is a long-run and short-term relationship between independent variables and the dependent variable, with GDP being a function of aexpt, ictexp, and sexpt in the 20 selected sub-Saharan countries. The Multiple R-square result confirmed that 17% of lnsexp is explained by GDP, agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With lnsexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexpt, and sexpt have no cross-sectional dependence on GDP. Chi-statistics show that lngdp, lnaexp, lnictexp, and lnsexp are positively related using the lambda Pearson test. Additionally, the P-value for GDP is less than 0.05, indicating that GDP as the dependent variable is statistically significant to independent variables in the Canning Pedroni long-run Causality and Lambda-Pearson tests. Therefore, we reject the null hypothesis and accept the alternative. We infer that Gross Domestic Product (GDP) is a function of aexpt, ictexp, and sexpt, indicating that there is a long-run relationship between aexpt, ictexp, and sexpt and GDP. Though aexpt, ictexp, and sexpt are positively connected, neither is statistically significant using the Canning Pedroni long-run Causality (Lambda-Pearson) tests. Although GDP is our primary focus, it is a function of three (3) independent variables.

DISCUSSION

The tests conducted indicated that the series are non-stationary at level, but stationary at first difference. The coefficients had a negative sign and were statistically significant with P-values less than 0.05, meaning they are stationary and can be used for the panel cointegration test.

In this study, three different panel cointegration tests were conducted and results are seen in Table 2. Three test statistics indicated cointegration from all the tests conducted. while eight showed no cointegration. Deciding based on ADF; we conclude that cointegration exists. Again, considering the Kao residual cointegration just as a p-value <0.05 (0.0001) is substantial evidence to reject the null hypothesis and conclude that there is evidence of cointegration among the variables. There is sufficient evidence from the results to show that there is a stable and long-term relationship hence, we proceed with a PVECM to examine the short-run and long-run dynamics of the cointegrated series as the series is confirmed to wander together over time. Furthermore, a Durbin-Watson result with a value 2 mirrors the absence of autocorrelation and is in line with the assumptions that errors are normally distributed with mean zero and all errors are stationary as well. Unlike the Kao test, the Johansen Fisher panel cointegration test shows from the trace test and max-eigen test that; firstly, None and at most one demonstrated the existence of a long-run cointegration while at most 2, 3 and 4 resulted otherwise. This study concluded that there is substantial evidence to show that cointegration is present with statistical evidence of a long-run cointegration among the variables under study.

The panel long-run cointegrated vector estimated group mean DOLS demonstrates that ictexp is adversely associated with GDP, but aexpt and sexpt are positively related to GDP. Additionally, GDP has a statistically significant long-run cointegrated relationship between the variables.

The short-run dynamics of GDP, agricultural export, and service export at lag 1 as captured in equation (4). lngdp, lnaexp, and lnsexp are positively related to lngdp at lag 1, whereas lnictexp is negatively related to lngdp at lag 1. Additionally, the ECT of lngdp at lag 1 have fulfilled the two attributes at any conventional level of being negative (-0.54) and has a p-value<0.05. This indicates that the estimated PVECM (1) model for GDP is statistically significant (p<0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run is that about 54% of this disequilibrium is corrected every period. The study established that there is a long-run and short-term relationship between independent variables and the dependent variable, with GDP being a function of aexpt, ictexp, and sexpt in the 20 selected sub-Saharan countries as supported by the work of Ağca, Çakmak and Ergül (2017) and Nkalu et al (2020) who used the same method and also employed the pane ARDL and the same result was validated by Ali, Yusop, and Law (2015) using panel ARDL approach.

The Multiple R-square result confirmed that 32% of GDP is explained by agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With GDP as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexp, and sexpt have no cross-sectional dependence on GDP.

With the values of lnaexp as an independent variable, lnaexp is statistically significant and it is desirable to sustain growth in SSA as it has a feedback impact on itself in the short-run and validates the ingenuity of the equations estimated. This is because when lnaexp increases by one unit, it will have a significant impact on GDP in SSA. ECT value (0.05) and a p-value >0.05 show that any disequilibrium cannot be corrected in the long-run. The Multiple R-square result shows that 19% of lnaexp is explained by GDP, agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With lnaexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexp, and sexpt have no cross-sectional dependence on lngdp. Furthermore, as agricultural raw material exports in Sub-Saharan African countries rise or fall, so do lngdp, lnictexp, and lnsexp.

The short-run dynamics with lnictexp as the independent variable at lag 1 shows lngdp, lnaexp, and lnictexp are negatively related to lngdp at lag 1, whereas lnsexp is positively related to lngdp at lag 1. However, the ECT of lnictexp at lag 1 have failed to fulfil the two attributes at any conventional level of being negative (0.11) and has a p-value>0.05. This indicates that the estimated PVECM (1) model for GDP is statistically insignificant (p>0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run cannot be corrected in the long run. Hence lnictexp in the short run is not a good predictor of GDP. The Multiple R-square result confirmed that 16% of lnictexp is explained by agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value less than 0.05, we reject the null hypothesis. With lnictexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexp, and sexpt have cross-sectional dependence on GDP.

The PVECM at lag 1 for lnsexp reveals that GDP, aexpt and ictexp are positively related to sexpt at lag 1. sexpt has a negatively and statistically significant. The ECT of lnsexp at lag 1 has fulfilled one attribute at any conventional level of being negative (-0.54) but has a p-value>0.05. This indicates that the estimated PVECM (1) model for GDP is not statistically significant (p>0.05). As a result, the estimated coefficient revealed that any disequilibrium in the short-run is that about 5.0% of this disequilibrium is not corrected every period. The Multiple R-square result confirmed that 17% of lnsexp is explained by GDP, agricultural raw material export, ICT export and service export. A Cross-sectional Dependence (CD) Test was carried out and with results showing a P-value greater than 0.05, we do not reject the null hypothesis. With lnsexp as a dependent variable, PVECM (1), reveals that at lag 1, aexpt, ictexpt, and sexpt have no cross-sectional dependence on GDP.

Chi-statistics show that lngdp, lnaexp, lnictexp, and lnsexp are positively related using the lambda Pearson test. Additionally, the P-value for GDP is less than 0.05, indicating that GDP as the dependent variable is statistically significant to independent variables in the Canning Pedroni long-run Causality and Lambda-Pearson tests. Therefore, we reject the null hypothesis and accept the alternative.

The study established that there is a long-run and short-term relationship between independent variables and the dependent variable, in the 20 selected sub-Saharan countries. Canning Pedroni's long-run Causality is not interested in the sign nor the direction but established that there is a causality between the dependent variable (GDP) and the independent variables (agricultural raw material export, ICT export and service export.

Panel VECM at lag 2 revealed that Since ECT of lngdp maintained the status quo as seen in lag 1 negative (-0.53) and p-value 0.0003. The result revealed that the estimated PVECM (2) model for GDP shows that lnictexp at lag 2 is not statistically significant about GDP. At the same time, AEXPT, GDP and SEXPT INF are positively associated with GDP. A cross-sectional dependence (CD) test was carried out with a null hypothesis of no cross-sectional dependence. A p-value > 0.05 (0.1) confirmed that we do not reject the null hypothesis and concluded that there is no cross-sectional dependence.

Chi-statistics show that GDP, aexpt, ictexpt, and sexpt are positively related using the Canning-Pedroni long-run causality test. Additionally, the P-value for GDP is less than 0.05, indicating that there exists a long-run causality between GDP as the dependent variable and all independent variables. This is in agreement with the works of Apergis and Danuletiu (2014) as stated by the Canning-Pedroni (2008) long-run Causality which is neither concerned with the sign nor the direction of the causality. Therefore, we reject the null hypothesis and accept the alternative. We conclude that Gross Domestic Product (GDP) is a function of aexpt, ictexp, and sexpt, indicating that there is a long-run relationship between aexpt, ictexp, and sexpt and GDP.

Summarily, our results show that GDP, AEXPT, ICTEXPT, and SEXPT were non-stationary at level but stationary at first difference. This was deduced using a panel unit root test. A panel cointegration test by Pedroni, Kao and Johansen Fisher cointegration tests mirrored sufficient evidence of a long-run relationship while the PVECM revealed the short-term dynamics as well as the long-run relationship between agricultural raw material export, ICT export, service export and GDP in the 20 selected sub-Saharan African countries though not statistically significant and

this is supported by Terfa and Tarlumun (2019). The Canning-Pedroni long causality test revealed that there is a positive and significant causality between GDP and the independent variables. The test result isolates the sign and direction of long-run impacts while accounting for unknown short-run causal linkages with GDP and with this, objectives two and three have been achieved successfully unlike Özşahin (2017), whose results capture a bidirectional causality though signs were of no consideration.

Conclusively, because growth is an important economic indicator, this study examined the relationship between some non-oil export factors and GDP. This study spans 1982 to 2022 in 20 sub-Saharan African countries. After determining that all variables were non-stationary at the level, panel unit root tests were performed, with the results indicating that they became stationary at the first difference. Panel cointegration tests revealed evidence of cointegration between variables. As a result, the model has demonstrated that agricultural raw material exports, ICT exports, and service exports all have a major long-term impact on GDP. A panel Vector Error Correction Model (PVECM) framework was used to examine the long-run and short-run effects of agricultural raw material exports, ICT exports, and service exports on economic growth (GDP) in sub-Saharan Africa. The findings revealed that there are both long-run and short-run relationships between some non-oil export factors and GDP. The long-term influence on GDP suggests that several non-oil export variables increase GDP. This is consistent with the findings of Ajao, Adenomon, and Adehi (2023) in ECOWAS countries. It also aligns with the findings of Terfa and Terlumun (2019), who found that there is a favourable influence of non-oil exports on the economic growth of various sub-Saharan African countries. The short-term impact of variables has been determined using the Canning-Pedroni Causality tests focused on identifying causality. Economic policymakers in sub-Saharan African countries need to recognize that a growing economy leads to increased GDP in both the short and long term. This includes agricultural raw materials, ICT, and service exports. Governments in these countries should promote the development of policies and institutional frameworks for technological transformation to drive effective non-oil exports and economic growth. Investing in research and development (R&D) is essential to increase human resource capital and drive knowledge in SSA economies for efficiency in both GDP and non-oil export sectors.

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