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PANEL REGRESSION INVESTIGATION ON THE IMPACT OF SERVICE EXPORT AND AGRICULTURAL RAW MATERIALS ON ECONOMIC GROWTH IN 5 SUB-SAHARAN COUNTRIES

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ABSTRACT

Population expansion, rising incomes, and increasing urbanization characterize Sub-Saharan Africa's economies, indicating potential market development but also posing trade stability problems. Poor economic performance and dependency on oil exports in the region have necessitated additional research and talks. This study will look into the impact of service exports and agricultural raw materials on the economic growth of five Sub-Saharan African countries between 2012 and 2022. The study will examine the impact of service exports (sexp) and agricultural raw materials (aexp) on GDP using several regression models, to determine the most appropriate model using the Hausman test. The research seeks to establish the relationship between service exports, agricultural raw material exports, and economic growth in these countries, chosen based on their GDP performance as of 2023. The study used three different estimators to ensure robust results. The Hausman test revealed that the fixed effects model is most suitable for addressing challenges related to independent variables with a positive but negligible impact on GDP. Overall, the research found that while service exports have a positive impact, it is statistically insignificant for GDP. The findings are also applicable to agricultural raw materials. The consistent and large value shows that an increase in service exports and agricultural raw materials will increase the selected Sub-Saharan African countries' GDP. According to the findings, authorities in these countries should develop policies to establish conditions that promote the productive and advantageous roles of agricultural raw materials and service exports in driving economic expansion across Sub-Saharan Africa.

Keywords: Service export, Agricultural raw material, Fixed Effect, Random Effect, Panel Data, Sub-Saharan Africa

INTRODUCTION

A time series is a series of data points indexed in time order. It is an ordered sequence of observations, (Adenomom, 2017). 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). Researchers can explore the relationships between variables across several cross-sections and historical periods employing this panel data collection, and they can additionally assess the outcomes of different economies' policy decisions, (Davies, 2000). 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 equ ation. Panel data models can be classified into two types: fix ed effects and random effects. (Vijayamohanan, 2016).

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.

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 (Africa GDP, 2021). Other nations, like Ethiopia, Kenya, and Rwanda, have more diverse economies that rely on commerce, manufacturing, tourism, and remittances.

Thus, it is interesting to study the impact of service exports and agricultural raw materials on economic growth. In so doing, this study aims to evaluate a Panel Regression Investigation on The Impact of Service Export and Agricultural Raw Materials on Economic Growth In 5 sub-Saharan countries by comparing the three models (pooled regression, fixed effect regression and random effect regression respectively).

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. Iyoha & Okim (2017).

Kayode *et al* (2021) examined the impact of electronic payment systems on the profitability of commercial banks in Nigeria. Pooled OLS and Panel regression models were applied to data gathered from the bank's annual reports, the Nigerian interbank settlement scheme, and the Central Bank of Nigeria website.

The contribution of the various electronic payment systems under consideration was evaluated using the Breusch and Pagan Lagrangian Multiplier (LM) Test, the Hausman Test, the Stationarity Test, the Schwarz Criterion, and the Akaike Information Criterion. The results revealed that the random effect model was more appropriate than the fixed effect model for all of the electronic payment systems examined in this study. Furthermore, it was determined that there is a favorable correlation between electronic payment systems and commercial bank profitability in Nigeria.

Ajao *et al* (2023) Modeled panel data with no first-order autocorrelation using three estimate models: Pool Regression, Fixed Effect, and Random Effect. The analysis was based on simulation data. The study's findings demonstrated that the fixed effect model was chosen for small sample panel structures, regardless of autocorrelation degree. However, the random effect model outperformed the moderate and large sample panel structure.

Abdulazeez (2022) investigates how government capital expenditure and the implicit price deflator affect economic growth in Nigeria. Multiple regression analysis was utilized to develop a model for predicting GDP growth, authenticate and validate the model for use, and ultimately predict GDP given revenue and implicit price deflator (IPD). The findings demonstrated that IPD was the only variable adding to GDP during the time.

Abogan et al. (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).

Abubakar et al. (2022) looked at the direction of a causal relationship between government revenue and expenditure in Nigeria. They employed an Engle Cointegration test to validate the existence of long-run and short-run linkages, as well as short-run dynamics of the variables. The findings suggest the existence of a revenue-to-spending feedback mechanism in Nigeria, indicating that both revenue and expenditure levels influence each other in the Nigerian budgeting process.

Concerning the empirical works of literature reviewed, it was discovered that few studies have recently adopted panel regression, as well as no specific study that has adopted a panel regression model to investigate the impact of service export and agricultural raw material (combined as independent variables) on economic growth in the 5 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 research utilized data sourced from the World Bank Database spanning from 2012 to 2022. This dataset includes information on service exports, agricultural raw materials, and the economic growth of five specifically chosen Sub-Saharan African countries. The research employed various models, such as pooled regression, fixed-effect regression, and random-effect regression.

Estimation of Panel Data Regression

The techniques that follow can be used to estimate the regression model of panel data:

Pooled Ordinary Least Square

The Pooled OLS model is widely employed with panel data sets. It assumes that there are no entity-specific effects (such as fixed or random effects). It is represented by the equation below:

$$Y_{it} = \beta_o + \beta_1 X_{1,it} + \varepsilon_{it} \quad (1)$$

$$For\ i = 1, 2, \dots, N\ and\ t = 1, 2, \dots, T$$

Estimation entails applying OLS regression to the pooled data, considering all observations as if they were from a single cross-sectional dataset. It has the following assumptions;

Regression coefficients are the same for all observations, regressors are non-stochastic i.e errors not correlated with explanatory variables Cov $(X_{it}, \varepsilon_{it})$= 0, and Error term, $\varepsilon_{it} \sim i.i.d\ (0, \delta_v^2)$.

Fixed Effect Model

In a fixed effects model, group means (such as group averages) are regarded as fixed (non-random) rather than random variables. This is in contrast to random effects models and mixed models, which have part or all of its parameters as random variables. Fixed effects models can assist correct for omitted variable bias caused by unobserved heterogeneity that remains constant over time. The fixed effects estimator (also known as the within estimator) calculates coefficients in the regression model, incorporating fixed effects, and accounts for individual-specific effects by taking variances from the group mean for each subject.

It is represented by the equation below:

$$Y_{it} = \beta_{oi} + \beta_1 X_{1,it} + \omega_i + \varepsilon_{it} \quad (2)$$

$$For\ i = 1, 2, \dots, N\ and\ t = 1, 2, \dots, T$$

The LSDV model allows for heterogeneity by permitting several intercepts, one for each country in the pooled data, which are achieved by dummy variables. Differences in intercept reflect the countries' distinct characteristics. The phrase "fixed effect" refers to the fact that the intercept β_{oi} varies among countries but remains constant across time. It is time-invariant, therefore there is no t subscript. It has the assumptions of Homoscedasticity: assume the error term has an equal variance across all cross-sectional units, No autocorrelation: assume that the error terms have no correlation over time and assumes there is no correlation between the error term and the unobserved fixed effects for every individual.

Random Effect Model

A random effects model, also called a variance components model posits that the model parameters are random variables. It is a sort of hierarchical linear model that takes into account data from multiple populations with relevant differences. Random effects models are used to compensate for unobserved heterogeneity, which is constant across time and is not connected with independent variables.

From equation (2), Random effect replaces β_{oi} with $\beta_o + \omega_i$, and then a new equation arises as shown below:

$$Y_{it} = \beta_o + \beta_3 X_{1,it} + \beta_4 X_{2,it} + (\omega_i + V_{it}) \quad (3)$$

Where $(\omega_i + V_{it}) = \varepsilon_{it}$, equation (3) becomes;

$$Y_{it} = \beta_o + \beta_3 X_{1,it} + \beta_4 X_{2,it} + \varepsilon_{it} \quad (4)$$

The error term ε_{it}, has two components: Country-specific error term (ω_i) and idiosyncratic i.i.d error (V_{it}). Unlike in the fixed error model where each country has its own (fixed) intercept value, in random effect model, the common intercept (β_o) is the average of all the countries' intercepts. The country-specific error component (ω_i) measures the random deviation of each country's intercept from the common intercept (β_o). The random effect model assumes that the individual-specific effects are uncorrelated with the independent variables.

RESULTS AND DISCUSSION

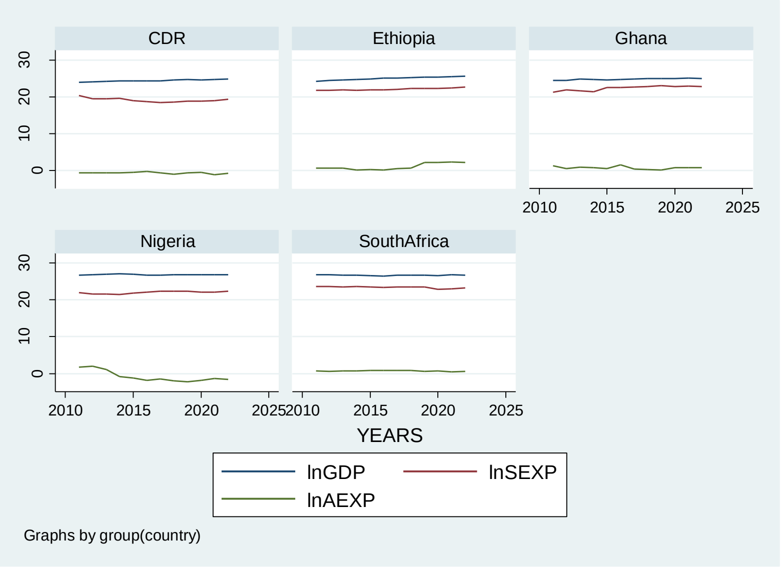

Figure 1: Line graph of lnGDP, lnSEXP and lnAEXP

Figure 1 above shows the panel line plots for the log of three variables in each of the selected five sub-Saharan countries. The variables used include GDP, Service export and Agricultural raw material export (lngdp, lnsexp and lnaexp respectively) while Congo Democratic Republic (CDR), Ethiopia, Ghana, Nigeria and South Africa are the selected countries. The graphs show that all the variables moved through the years under consideration, 2012-2022. It is seen that the five countries share similarities in their performance in general. lngdp is seen to maintain a high level as it is a function of lnsexp and lnaexp except for minor fluctuations. The group graph shows that in all five countries, service export (lnsexp) thrives and contributes more to the GDP (lngdp) than agricultural raw material export (lnaexp). Ethiopia is seen to have had an upward trend along the line, unlike the other four countries. Nigeria recorded the poorest performance in agricultural raw material export followed by CDR.

Table 1: Summary Descriptive Statistic

Variables	Statistic	Mean	Std Dev.	Min	Max	Observations	
lngdp	Overall	25.5498	1.0470	23.9752	27.0762	N	60
	Between		1.1281	24.4286	26.8424	n	5
	Within		0.2467	24.7452	26.1234	T	12
lnsexp	Overall	21.7894	1.4986	18.4989	23.6076	N	60
	Between		1.5950	19.1209	23.4060	n	5
	Within		0.4196	20.7486	23.0891	T	12
lnaexp	Overall	0.2148	1.1064	-2.1681	2.2989	N	60
	Between		0.8602	-0.7764	1.0422	n	5
	Within		0.7888	-1.1768	2.9748	T	12

Source: obtained from STATA output

Table 1 above shows that the total number of observations for each variable is 60. This is consistent with the sample size of five Sub-Saharan African countries and the study period (2012-2022). The lngdp, lnsexp, and lnasexp have mean values of 25.5498, 21.7894, and 0.7888, respectively. The lngdp, lnsexp, and lnasexp have Std. Dev. values 1.0470, 1.4986, and 1.1064, respectively. This summarises the variability within the dataset. The overall minimum and maximum lngdp were 23.9752 and 27.0762; lnsexp were 18.4989 and 23.6076; and lnasexp were -2.1681 and 2.2989, respectively.

Table 2: Pooled OLS regression for lngdp, lnsexp and lnaexp.

lngdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnsexp	0.5218	0.0736	7.09	0.000	0.3744	0.6693
lnaexp	-0.3488	0.0997	-3.50	0.001	-0.5485	-0.1490
Cons	14.2546	1.5991	8.91	0.000	11.0525	17.4568
F(2, 57) =	25.34,	P. Value =	0.0000			

Source: Extract from STATA output

Table 2 above shows the pooled regression results on the impact of service export and agricultural raw material export on gross domestic product. The results from Table 2 for the pooled regression model show that the adjusted coefficient of determination (Adj. R-squared), which represents the proportion or percentage of the total variation in the dependent variable explained by the independent variables combined, is 0.4521. This indicates that the models' independent variables (lnsexp and lnaexp) account for approximately 45.21% of the variations in lngdp of the five selected Sub-Saharan African countries under study. Similarly, the pooled regression F-statistic and P-values were 25,34 and 0.0000, respectively, indicating that the model was significant at 5% (0.05).

Below is a pooled regression equation showing the relationship between the variables:

$$lngdp = 14.2546 + 0.5218X_{1,it} - 0.3488X_{2,it} \quad (5)$$

The regression results show that the coefficient of ln*sexp* has a positive and significant impact on lngdp ($\beta_i = 0.5218$, $p < 0.05$) while the coefficient of ln*aexp* is a negative but significant impact on lngdp ($\beta_2 = -0.3488$, $p<0.05$). This implies that an increase in service export will also increase the gross domestic product of the selected Sub-Saharan African countries while an increase in agricultural raw material export will bring about a decrease in the gross domestic product of the selected SSA countries significantly for the period under study. It is important to state that irrespective of the negative coefficient obtained, the variable lnaexp remains statistically significant with a p-value of 0.001 at a 5% (0.05) level of significance.

A test for the presence of heteroscedasticity using Breush-Pagan/Weisberg with a null hypothesis of not present was conducted and results indicated (Prob > Chi^2 =0.6130) that we do not reject the null hypothesis and concluded that heteroscedasticity is absent. (see results in Appendix 1).

A further diagnostic test was conducted using the Ramsey RESET test to check for omitted variables and access the functional form of the model. Results obtained following a null hypothesis, stating that the model has no omitted variable problem. The null hypothesis was rejected as a p-value of 0.0019 (P >F = 0.0019) which indicates potential misspecification.

Table 3: Diagnostic test for Multicollinearity using Variance Inflation Factor

Variable	VIF	$1/_{VIF}$
lnsexp	1.20	0.8359
lnaexp	1.20	0.8359

Source: Extracted from STATA output

Table 3 shows the result of the diagnostic test for multicollinearity conducted using the Variance Inflation Factor (VIF). This study used the variance inflation factor (VIF) to determine the presence of multicollinearity in the estimated OLS model. If multicollinearity is present, it is difficult to distinguish between the individual effects of explanatory variables and OLS estimators may be biased and have significant variances (Murray, 2006). With a result of 1.2, which lies between 1 and 5, it only shows a moderate correlation and it is usually acceptable, this is because a VIF value above 10 suggests a high correlation and a cause for concern (Gujarati, 2003).

Table 4: Fixed Effect Model

lngdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval
lnsexp	0.1258	0.0770	1.63	0.108	-0.0287	0.6280
lnaexp	0.0789	0.0410	1.92	0.060	-0.0033	0.1611
Cons	22.7919	1.6800	13.57	0.000	19.4224	26.1614
F(2, 57) =	**126.87,**	**P > F =**	**0.0000**			

Source: Extract from STATA output.

Table 4 above shows the Fixed Effect Model results on the impact of service export and agricultural raw material export on gross domestic product.

Below is a FE model regression equation showing the relationship between the variables:

$$lngdp = 22.7919 + 0.1258lnsexp + 0.0789lnaexp \quad (5)$$

The FE results show that the coefficient of ln*sexp* has a positive impact but an insignificant impact on lngdp ($\beta_1 = 0.1258$, $p > 0.05$) also, the coefficient of ln*aexp* has a positive but insignificant impact on lngdp ($\beta_2 = 0.0789$, $p>0.05$). The constant value is both positive and significant with 22.7119 and p <0.05. This implies that an increase in service export will also increase the gross domestic product of the selected Sub-Saharan African countries. Similarly, an increase in agricultural raw material export will bring about an increase in the gross domestic product of the selected SSA countries significantly for the period under study.

A test for the presence of serial correlation (autocorrelation) was conducted using the Wooldridge test with a null hypothesis of no first-order autocorrelation. Results indicated (Prob > F =0.0136) meaning that we do not reject the null hypothesis and concluded that there is no first-order autocorrelation problem.

Furthermore, another diagnostic test was conducted using the Modified Wald test for assessing groupwise heteroscedasticity in the residuals of an FE regression model. The null hypothesis was rejected as a p-value of 0.0000 (P >F = 0.0000) which gives a conclusion that indicates that heteroscedasticity is present and means there are varying variances across groups.

To test for the suitability of the FE Model, parameters for each year were tested and results show that each year was significant except the year 2012 with a p-value of 0.260. Generally, a p-value of 0.0000 obtained from the model led to rejecting the null hypothesis and a conclusion that the FE model is suitable for the panel data.

Table 5: Random Effect Model

lngdp	Coef.	Std. Err.	z	P>|t|	[95% Conf.	Interval]
lnsexp	0.1782	0.0760	2.34	0.019	0.0291	0.0327
lnaexp	0.0728	0.0443	1.64	0.101	0.0141	0.1596
Cons	21.6516	1.6770	12.91	0.000	18.3647	24.9385

Source: Extract from STATA output.

Table 5 above shows the Random Effect Model results on the impact of service export and agricultural raw material export on gross domestic product.

Below is a RE model regression equation showing the relationship between the variables:

$$lngdp = 21.6516 + 0.1782 lnsexp + 0.0728 lnaexp \quad (6)$$

The RE results show that the coefficient of ln*sexp* has a positive impact and significant impact on lngdp (β_1 = 0.11782, p < 0.05) also, the coefficient of ln*aexp* has a positive but insignificant impact on lngdp (β_2 = 0.0728, p>0.05). the constant value is both positive and significant with 21.6516 and p <0.05. This implies that an increase in service export will also increase the gross domestic product of the selected Sub-Saharan African countries. Similarly, an increase in agricultural raw material export will bring about an increase in the gross domestic product of the selected SSA countries significantly for the period under study.

A test for the presence of serial correlation (autocorrelation) was conducted using the Wooldridge test with a null hypothesis of no first-order autocorrelation. Results indicated (Prob > F =0.0136) meaning that we do not reject the null hypothesis and concluded that there is no first-order autocorrelation problem. Furthermore, another diagnostic test was conducted using the Breush and Pagan Lagrangian Multiplier (LM) test for random effects. In the same vein, the null hypothesis was rejected as a p-value of 0.0000 (P >Chi^2 = 0.0000) which gives a conclusion that indicates that heteroscedasticity is present.

Table 6: Hausman Fixed Random, Sigmamore

	Coefficients			
	(b) fixed	**(B) random**	**(b-B) Difference**	**Sqrt(diag (V_b-V_B) S.E.**
lnsexp	0.1258	0.1782	-0.0524	0.0365
lnaexp	0.0789	0.0728	0.0061	0.0071

Source: Extract from STATA output.
Note: Prob>Chi^2 = 0,0038.

The Hausman test also known as the Durbin-Wu-Hausman test is appropriate when it is intended to choose between the FE model and the RE model. The null hypothesis states that the RE model is appropriate against the alternative hypothesis of FE model being appropriate. Table 6 above shows the result of the Hausman test and a p-value of 0.0038 and is less than 0.05, (Prob>Chi^2 = 0,0038), the null hypothesis is rejected and this concludes that the Fixed effect model is more appropriate hence, a better model for the panel data used in this study

Discussion

Based on the results of the analysis we can draw the following discussions and conclusions: Performance of Selected Sub-Saharan African Countries: Graphically as discussed Wiggins and Poi (2024), the study analyses the economic performance of five Sub-Saharan African countries; Congo Democratic Republic, Ethiopia, Ghana, Nigeria, and South Africa over the period 2012-2022. It observes that these countries share similarities in their economic performance, with service exports significantly contributing to GDP compared to agricultural raw material exports as against results from Adenugba and Dipo (2 013), whose results reveal that agriculture contributed more to GDP than Solid minerals as seen in the graphical presentations. Notably, Ethiopia showed an upward trend compared to the other countries.

Regression Analysis Findings: The pooled regression model used by Vijayamohanan (2016) elucidated the essence of using the selected models, the result reveals that service exports and agricultural raw material exports significantly impact the gross domestic product of the selected countries. An increase in service exports positively influences GDP, while an increase in agricultural raw material exports has a negative effect on GDP as supported by works done by Adenugba & Dipo (2013) and Ajao et al (2023).

Fixed Effect Model: The fixed effect model indicates that while service exports positively impact GDP, agricultural raw material exports also contribute positively to GDP growth. However, these impacts were found to be statistically insignificant. The model was found to be more appropriate based on the results of the Hausman test as supported by works done by Ajao et al (2023) and Ceesay & Moussa (2022) who empirically revealed that fixed effects models work better for small sample panel data.

Random Effect Model: In the random effect model, service exports were found to have a significant positive impact on GDP, whereas the impact of agricultural raw material exports was statistically insignificant. The model suggests that an increase in service exports leads to an increase in GDP. This is true from the results obtained which show the presence of heteroscedasticity disqualifies the model for the panel data used and is supported by Vijayamohanan (2016) confirming that the random effects model was better for considering his large data size.

Diagnostic Testing: Multicollinearity: The study used the Variance Inflation Factor (VIF) to test for multicollinearity in the estimated regression models. The results indicated a moderate level of correlation among the variables, which is acceptable.

Heteroscedasticity: The presence of heteroscedasticity was tested using diagnostic tests like the Breush-Pagan/Weisberg test and the Modified Wald test. The results suggested the presence of heteroscedasticity in the models.

Serial Correlation: Tests for serial correlation using the Wooldridge test showed no first-order autocorrelation in the models.

In summary, the study provides valuable insights into the economic dynamics of Sub-Saharan African countries, highlighting the importance of service exports in driving economic growth. The Hausman test also known as the Durbin-Wu-Hausman test is appropriate when it is intended to choose between the FE model and the RE model. The null hypothesis states that the RE model is appropriate against the alternative hypothesis of the FE model being appropriate. hence, a better model for the panel data used in this study and this agreement with Ajao et al (2023).

CONCLUSION

The study employed a panel regression model in determining the influence of agricultural raw material export, ICT export and service export on the GDP of 5 selected SSA countries. A graphical illustration was used to depict the economic performance of five Sub-Saharan African countries over a given time. The pooled regression model, Random effect model and Fixed effect models were adopted in the analysis while the Hausman test aided the choice between the FE model and the RE model. Findings displayed graphically that these countries share similarities in their economic performance, with service exports significantly contributing to GDP compared to agricultural raw material exports with Ethiopia showing an upward trend compared to the other countries. Findings from the pooled regression model reveal that service exports and agricultural raw material exports significantly (with p-values of 0.000 and 0.001 respectively) impact the gross domestic product of the selected countries. An increase in service exports positively increases a unit in GDP, while an increase in agricultural raw material exports hurts GDP. The Hausman test aided the choice between the FE model and the RE model as the null hypothesis was rejected and proved that the FE model was more appropriate Findings demonstrated that, although both independent variables (Service export and Agricultural raw material exports) turned in positive values (0.1258 and 0.0789 respectively) indicating that an increase in each is associated with an increase in unit in GDP, they were both statistically insignificant as p-values>0.05. the Wooldridge test confirmed no first-order autocorrelation is present. The study concluded that, in as much as the FE model remains the most appropriate choice for addressing challenges related to independent variables with a positive but negligible impact on GDP. However, service exports and agricultural raw material exports have a positive impact on GDP.

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