OPEN ACCESS

GRS Journal of Multidisciplinary Research and Studies
Abbriviate Tittle- GRS J Mul Res Stud
ISSN *(Online)- 3049-0561*
https://grspublisher.com/journal-details/GRSJMRS
Vol-2, Iss-4 (Apr- 2025)

The Impact of Blue Economy Factors On Economic Growth in Sierra Leone: A Granger Causality Test Analysis

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Received: 21.03.2025 **Accepted: 16.04.2025** **Published: 22.04.2025**

Abstract: *T*his study investigates the impact of blue economy factors on Sierra Leone's economic growth from 1990 to 2023, using GDP as the dependent variable. It examines the contributions of Ocean Trade, Fisheries, Aquaculture, and Agriculture, emphasizing the importance of sustainable marine resource management in alignment with Goal 14 of the United Nations Sustainable Development Goals (SDGs), which advocates for the sustainable use of ocean resources. The analysis employs an econometric time series approach, utilizing secondary data collected between 1990 and 2023. The Granger Causality Test was conducted to determine the causal relationships between the independent variables and GDP growth. Findings reveal that blue economy factors significantly contribute to Sierra Leone's economic progress. Ocean Trade enhances economic activity through increased maritime commerce and revenue generation. Fisheries play a pivotal role in ensuring food security and providing employment opportunities. Aquaculture supports economic diversification by complementing traditional fisheries, while Agriculture is a critical control variable in understanding broader economic dynamics

The study underscores the need for sustainable management and strategic investment in the blue economy to ensure long-term economic growth. Key recommendations include prioritizing Ocean Trade, Fisheries, and Aquaculture investments, fostering international partnerships, and implementing policies promoting sustainable practices. These measures aim to harness the untapped potential of Sierra Leone's ocean resources, foster economic transformation, and advance the nation's development agenda. The findings affirm the blue economy as vital to Sierra Leone's sustainable growth, offering valuable perspectives for policymakers to drive development.

Keywords: *Blue Economy; Economic Growth; Granger Causality Test*.

JEL Classification: *Q56; Q22; QC32;Q44*

Introduction

A blue economy is a long-term approach to managing ocean and coastal resources that aims to sustain ocean ecosystems, improve livelihoods, create jobs, and promote economic growth. It includes all environments found around lakes, rivers, and seas. The blue economy preserves "blue" resources to lessen the adverse effects on the ocean and coastal regions while promoting ocean-related businesses, endeavours, and economic expansion. (Cattaneo, M. 2024) It enables more effective land and ocean management, better governance of marine ecosystems, reduced greenhouse gas emissions, and supports human well-being, social equity and inclusion, environmental protection (CO_2 reduction and carbon sequestration), resilience and health of ocean and coastal ecosystems, and community empowerment. Since Professor Gunter Pauli launched the Blue Economy concept at the United Nations University in 1994 it has been the topic of heated debate. It gained prominence at the third Blue Economy Summit (Rio+20) in Rio de Janeiro, Brazil in 2012 because the concept of "blue growth" connects sustainable principles to unlocking the potential of seas and oceans in reconciling food security with ecosystem services and marine resource conservation (FAO, 2014). Achieving macroeconomic outcomes such as price stability, reducing unemployment, and economic growth over a long period through the formulation and application of prudent macroeconomic policies arguably, are the major goals of an economy (Fernandez-Macho et al. 2016). This goal is congruent with the blue economy's objectives of full employment and GDP growth. According to the World Bank (2018), the Blue Economy specifically creates over 260 million employments and approximately €500 billion in gross added value yearly. The African Union estimates that the Blue Economy currently generates approximately $300 billion for the continent, supporting 49 million jobs. Sierra Leone's blue economy is a little-known source of untapped wealth, but it has the potential to become the country's largest export sector. A blue economy has the potential to boost the provision of jobs, livelihood, energy, and economic growth because the region is one of the world's richest fishing grounds, with a 506-kilometer coastline. Because the ocean serves as the foundation for the worldwide network of cities and governments, coastal and small island developing states account for 38% (and growing) of the world's population, benefiting from seaborne trade and other economic activities. Submarine telecommunication cables can be placed on ocean floors to supply 90% of the electronic traffic we rely on for communication (UN, 2016). In addition, the blue economy helps strengthen the foreign sector, especially emerging nations, as it generates new markets and increases jobs and local investment opportunities (Blue Economy Department, 2018). For instance, in South Africa, a blue economy is estimated to create 1 million new jobs by 2033 while generating USD13 billion in revenue (Ebarvia, 2016). Considering its numerous opportunities, it has also been embraced by Seychelles as a nation and has become its main economic sector for revenue generation through fishery exportation (Blue Economy Department, 2018). Despite these advantages, the world's population is expected to grow, economies and trade are developing, alternative energy sources are being sought, and technology is rapidly evolving, all of which will cause significant changes in the ocean space in the coming decades (Kamanlioglu, 2011; Visbeck et al., 2014). Furthermore, human activity has a significant negative impact on the environment and ocean ecosystems, threatening the survival and economic prospects of several countries, including Sierra Leone (Patil et al., 2016). Pollution, overexploitation, declining biodiversity, and climate change are some of the problems that are currently preventing the ocean from providing significant benefits (Barbier et al., 2009; Visbeck et al., 2014). The ocean's full potential can only be realised by adopting sustainable methods and considering ecological wellbeing. As such, achieving the ocean's full potential necessitates a change to sustainable practices and taking ecosystem welfare into account. It is widely acknowledged that sustainable improvements in human interactions and economic activities with the environment are necessary, but opinions on the most crucial elements to accomplish this goal are divided (Park and Kidow, 2014). Since the Rio+20 summit, many countries have been poised to ensure that they increase the contribution of ocean trade to GDP; Sierra Leone is no exception. In this respect, the Government of Sierra Leone has over the years formulated a series of sectorial policies, institutional frameworks, and regulations that directly deal with the judicious use of our natural resources and the environment in particular. They include; mineral Acts, forestry, wildlife, fisheries, marine, biodiversity, etc. With these developments, it is expected that the outputs and trade from the blue economy may have increased and consequently increase its contribution to GDP. However, from the scatter plot below, it is obvious that ocean trade as one of the blue economy factors still lags comparatively.

See figure 1 below.

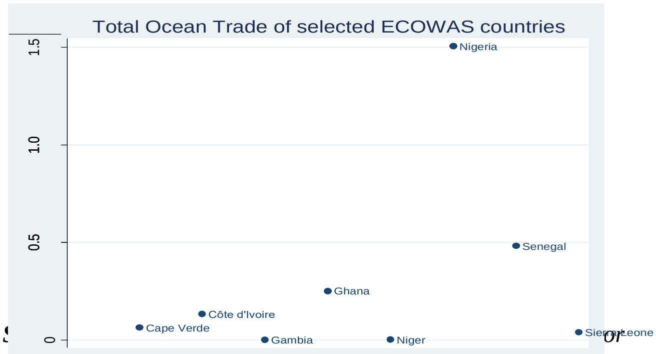

Figure 1 shows that the entire ocean product exports for 2018 were less than half a billion US dollars, except Nigeria, which exported more than US$ 1.5 billion worth of ocean products. This suggests that while Sierra Leone has taken steps to increase its GDP through the blue economy, it has not gone far enough to equal the volume of maritime trade produced by Nigeria. The essential question is why Sierra Leone's ocean commerce volume has lagged behind other countries in the ECOWAS sub-region.

Literature Review

The blue economy, which encompasses marine-based sectors such as aquaculture and fisheries, has gained recognition as a source of economic growth in coastal and island countries. Resource management and the incorporation of blue economy sectors into national economic strategy are prioritized by researchers in order to achieve sustainable growth.

Empirical Review of Literature

Empirical analysis is an evidence-based approach that relies on observation, experimentation, and real-world data to test theories and hypotheses. Empirical studies on the relationship between blue economy factors such as ocean trade, fisheries, aquaculture, and economic growth often employ quantitative techniques like the Granger Causality Test to determine cause-and-effect relationships. The concept of ocean trade's impact on economic growth is relatively new and has been examined in a few empirical studies. One notable study by Osadume & Blessing (2020) focused on maritime trade and economic development, employing a Granger Causality Test and ARDL Bound test using data from Nigeria. The study discovered that maritime trade had a considerable positive impact on economic development, with a bidirectional causal relationship and strong co-integration between maritime trade and economic growth. Similarly, Saeed et al. (2021) investigated the links between maritime connectivity, trade, and GDP per capita using non-recursive models and path analysis. Their study found a complex relationship between these variables, confirming that maritime connectivity positively affects economic growth, though the gravity variables (such as distance and economic size) showed no significant effect on bilateral trade. While these studies contribute valuable insights, they were conducted outside Sierra Leone and are focused more broadly on maritime trade rather than the specific context of ocean trade in Sierra Leone. Thus, they offer limited direct relevance to the local context. Fisheries form a crucial part of many economies, especially in coastal regions. Numerous studies across different regions have evaluated the impact of fisheries on GDP and economic development. For instance, Gillett et al. (2001) found that fisheries positively contributed to GDP in most Pacific Island countries. Similarly, Richard et al. (2009), in their assessment of the macroeconomic impact of the Lake Victoria Fishing Industry in East Africa, demonstrated that fisheries significantly positively impacted employment and rural economic growth. Hara M. (2022) found that fisheries positively influenced GDP growth in South Africa, while the UNCTAD (2014) study on The Gambia emphasized the sector's role in poverty alleviation and GDP growth. Neiland et al. (2016) focused on Sierra Leone and concluded that fisheries positively impacted the country's GDP in the post-Ebola period. This study is one of the few focused on Sierra Leone, making it particularly relevant. However, the review also highlights divergent findings.

Conceptual Framework

The conceptual framework of this research focuses on the blue economy's impact on Sierra Leone's economic growth. The exogenous variables include ocean trade, which supports foreign trade and national revenue through maritime transport and fisheries**,** which are vital for food security, employment, and exports; aquaculture, which enhances livelihoods through the farming of aquatic species; and coastal/marine-related agriculture**,** which supports local economies through activities like salt production. The endogenous variable, Gross Domestic Product (GDP)**,** measures the total economic output of these sectors, reflecting their contribution to Sierra Leone's overall economic growth.

Theoretical Literature

- **Hirschman's unbalanced growth theory**

This research is based on Hirschman's theory of uneven growth since it considers the forward and backward connections associated with industrial interconnections and blue economy aspects. Hirschman (1958) proposes an unbalanced growth theory in response to certain characteristics shared by developing countries, such as low gross national income (GNI) per capita, slow GNI per capita growth, inequality, technological backwardness, and the presence of both traditional and modern sectors (dualism). Furthermore, there is insufficient infrastructure to utilize the resources available, as well as a scarcity of investors and entrepreneurs to spread the necessary capital across the many sectors for equitable economic expansion.

Hirschman, therefore, suggested complementarity, foreign economies, and induced investment as part of a purposefully uneven economic development strategy to preserve the current structural imbalance. The situation in Sierra Leone may be tied to Hirschman's uneven growth theory since it is predicated on the particular need for investment in key economic sectors. Investments should be prioritized according to comparative advantage, potential yield, and percentage contribution to national revenue rather than aiming for growth in every industry at once. The industrial sector may be fueled for sustainable growth and development by the Blue Economy's promise to provide higher levels of productivity and profits. Finally, Hirschman's backward and forward linkage theory is particularly relevant because it suggests that sectors will organically increase due to the interconnections effect. According to this theory, the industrial sector's backward linkage with Blue Economy variables, such as the provision of inputs and technology, is required for Blue Economy productivity growth. The Blue economy will maintain a forward relationship with the industrial sector by providing raw materials for manufacturing and processing.

Theory of Endogenous Growth

The blue economy is now driving all countries' long-term economic growth. The sustainable expansion of ocean space by nations to support economic progress is the foundation for both promoting blue growth and benefiting monetarily from the blue economy. According to the endogenous growth theory, internal rather than external forces are the main drivers of economic growth. Endogenous growth theory underlines the role of human capital, creativity, and knowledge in supporting sustainable economic growth, in contrast to classic growth theories that assign economic growth to external processes like labour and capital accumulation. This theoretical approach provides an engaging lens through which to assess the possibility for growth in developing economies like Sierra Leone.

Human capital is a crucial engine of economic growth, including education, skills, and worker expertise. Investments in education and vocational training improve individuals' capacities, resulting in improved production and innovation. In Sierra Leone, boosting educational outcomes and technical skills in blue economy sectors, such as aquaculture and fisheries, might result in a more skilled workforce capable of adopting and implementing current practices. For Sierra Leone, adopting innovative practices in aquaculture and fisheries, such as sustainable farming techniques and advanced resource management, can significantly increase output and profitability. Studies have shown that technological advancements in the fishing industry can lead to more sustainable practices, which not only boost economic growth but also preserve marine ecosystems. The endogenous growth theory also highlights the importance of knowledge spillovers, where the benefits of knowledge creation extend beyond the original innovator. In Sierra Leone, collaboration between academia, government, and private sector stakeholders can facilitate the sharing of best practices and innovative solutions within the blue economy. Such partnerships can lead to collective advancements that enhance economic performance and drive growth across various sectors. Investments in public goods, such as education and infrastructure, can further amplify these knowledge spillovers and contribute to sustained economic growth.

Methodology

Data Source

The World Bank Open Data portal, which has a credible and large collection of global development indicators, provided the majority of the data used in this study. This platform provides high-quality, publicly available datasets, which are vital for policy analysis and economic research. The study utilises time series to investigate the relationship impact of the blue. Data was collected so that an estimate might correctly depict the series' true value. The study is dependent on the sufficiency of the secondary data gathered from the aforementioned institutional sources on the impact of the blue economy factor and the economic growth of Sierra Leone during the period 1990 to 2023.

Specification of Model

As the theoretical foundations for modelling economic growth, the literature examines the Endogenous Growth Theory and Hirschman's theory of imbalanced growth. According to this theory, economic growth and balance are gauged by the production function.

The function's definition is as follows:

$$Y = Af(K,L)$$

Where Y is the GDP of an economy, L is the percentage of unskilled labour in an economy, K is the capital share of the economy, and A is a specific level of technology. Fisheries, aquaculture, agriculture, and marine trade all have an impact on technology.

$$\mathrm{A = f(OT, F, A\ and\ Ag)} \quad (1)$$

In which OT stands for maritime trade, F for fishing, A for aquaculture, and Ag for farming;

Substituting (3.2) into (3.1) yields;

$$\mathrm{Y = f(OT, F, A , Ag, K, L)} \quad (2)$$

The model's functional form can be expressed mathematically as follows:

$$Y_{it} = \beta_0 + \beta_1 \mathrm{OT}_{it} + \beta_2 \mathrm{F}_{it} + \beta_3 \mathrm{A}_{it} + \beta_4 \mathrm{Ag}_{it} + \beta_5 \mathrm{K}_{it} + \beta_6 \mathrm{L}_{it} + \varepsilon_{it} \quad (3)$$

The model's output from taking the logarithm on both sides is:

$$\mathrm{In}Y_t = \beta_0 + \beta_1 \mathrm{InOT}_t + \beta_2 \mathrm{InF}_t + \beta_3 \mathrm{InA}_t + \beta_4 \mathrm{InAg}_t + \beta_5 \mathrm{InK}_t + \beta_6 \mathrm{InL}_t + \varepsilon_t \quad (4)$$

Justification of Variables

The variables used in The Impact of Blue Economy Factors on Economic Growth in Sierra Leone were carefully selected to highlight major components of the blue economy and their contribution to growth. The dependent variable, economic development, reflects Sierra Leone's overall performance and trends. Ocean trade captures the role of maritime trade in exports, foreign exchange, and financial activities. Fisheries production contributes to livelihoods, food security, and export revenue, while aquaculture development highlights the potential of fish farming to create jobs, reduce poverty, and supplement wild fish stocks. These variables provide a framework for investigating the link between blue economy activities and economic growth.

Estimation Techniques

- **The Unit Root Test**

The Unit Root Test is a critical stage in the estimate technique, especially when determining the data's stationarity. The Augmented Dickey-Fuller (ADF) test is used in this study to look for unit roots in time-series data for Sierra Leone's blue economy elements (ocean trade, fisheries, and aquaculture) and economic growth. Stationarity is required to ensure that the Granger Causality Test produces accurate and valid results, as non-stationary data can result in false regression outputs.

The ADF test examines whether the variables exhibit constant mean, variance, and auto-covariance over time. The null hypothesis of the test presupposes the presence of a unit root (i.e., the data is non-stationary), whereas the alternative hypothesis implies that the series is stationary. If the null hypothesis is rejected, the data is considered stationary, and further analysis can proceed. In cases where the data is non-stationary, the variables are differenced until they achieve stationarity, ensuring the accuracy of the causality analysis.

The ADF test is conducted using the following models:

$$(Delta\ y - t = alpha - y[t-1] + sum - \{n = 1\}\Lambda\{N\}\ alpha - n\ Delta\ y - t\{t-n\} \pm t) \quad (5)$$

$$(Delta\ y - t = alpha - 1 - \{t-1\} + sum - \{n = 1\}\ \Lambda\ \{N\}\ alpha\ n\ Delta\ + delta\ t + e\ t) \quad (6)$$

Where:

(y_t) is the data series being tested,

(t) denotes the linear time trend,

(Delta) is the initial difference operator,

(alpha_0) is the constant term,

(N) is the optimum number of lags in the model, and

(e_t) is the stochastic error term.

- **Cointegration Test**

The second estimation procedure involves using the Johansen Cointegration test to determine the level of cointegration between data series of the same order. The implication is that if two or more series move closely together over time, regardless of whether the series is trending, the difference between them remains constant. In theory, they can wander arbitrarily far away from each other. Achieving empirical results amounts to constructing a maximum-likelihood test process. The Johansen Cointegration model is given below.

$$\lambda\ \mathrm{trace(r)} = -\mathrm{T}\sum_{\mathrm{i=r+1}}^{\mathrm{n}} \mathrm{In}(1 - \lambda_\mathrm{t})$$

- **The Granger Causality Test**

The Granger Causality Test is used in this study to determine if blue economy characteristics cause economic growth or whether economic growth drives blue economy sector development. This aids in understanding the nature of the link between the blue economy and economic growth, thereby providing policymakers in Sierra Leone with valuable information. The Granger causality test can be described in the model which tests if the blue economy factors Granger-cause economic growth.

Thus, the model is defined as:

$$\mathrm{In}Y_t = \beta_0 + \sum \beta_{1t}\mathrm{InOT}_{t-1} + \sum \beta_{2t}\mathrm{InF}_{t-1} + \sum \beta_{3t}\mathrm{InA}_{t-1} + \sum \beta_4 \mathrm{InAg}_{t-1} + \sum \beta_5 \mathrm{InK}_{t-1} + \sum \beta_6 \mathrm{InL}_{t-1} + \varepsilon_{1t}$$

$$\mathrm{InOT}_t = \beta_0 + \sum \beta_{1t}\mathrm{In}Y_{t-1} + \sum \beta_{2t}\mathrm{InF}_{t-1} + \sum \beta_{3t}\mathrm{InA}_{t-1} + \sum \beta_4 \mathrm{InAg}_{t-1} + \sum \beta_5 \mathrm{InK}_{t-1} + \sum \beta_6 \mathrm{InL}_{t-1} + \varepsilon_{1t}$$

The lag period is denoted by t-1, the current by t, and the error term by ε_(t). In both models, t−1t-1t−1 represents the lagged period, and ε varepsilon tεt is the stochastic error term, capturing any unexplained variation. The lagged values are included to account for the time-dependent relationship between the variables.

- **Diagnostic Tests**

Diagnostic tests such as serial correlation (LM test), Ramsey's RESET test, and heteroscedasticity (ARCH test) will be performed to ensure the model's strength, functionality, and stability.

Results

This section presents an econometric analysis and interpretation of empirical findings. It provides a comprehensive analysis of relationships between variables, causality, and impacts. The section confirms the robustness of the model through diagnostic testing and draws insights based on observed patterns. It also assesses the relevance of the results in the broader economic context.

Descriptive Statistics Results

This section illustrates the distribution of the variables used in the study. It provides an overview of the features of the variables, such as the mean, which represents the average value of the series.

Table 1. *Descriptive summary statistics*

Source: *Author*

	LGDP	LT	LF	LAP	LAGRIC
Mean	3.915062	21.31938	11.66183	3.743973	3.997280
Median	3.951059	21.29080	11.82027	3.401197	3.941535
Maximum	5.253746	22.98765	12.76543	4.753485	5.675432
Minimum	1.096849	20.27051	10.76543	2.708050	3.583519
Std. Dev.	0.639230	0.797424	0.556773	0.560345	0.426422
Skewness	-2.448807	0.273294	0.043304	0.087282	2.908692
Kurtosis	13.34680	1.931096	1.576005	1.704833	11.41803
Jarque-Bera	174.7238	1.921751	2.713684	2.277240	139.6069
Probability	0.000000	0.382558	0.257473	0.320261	0.000000
Sum	125.2820	682.2203	373.1784	119.8071	127.9129
Sum Sq. Dev.	12.66706	19.71246	9.609872	9.733587	5.636919
Observations	32	32	32	32	32

Table 1. Provides the descriptive statistics for the variables utilized in the study. The data presents key statistics for variables related to economic and agricultural indicators. LGDP, with a mean of 3.92, shows significant variation as indicated by its high skewness (-2.45) and kurtosis (13.35), pointing to a left-skewed distribution with extremely lower values and showing outliers in GDP. LAGRIC, on the other hand, demonstrates positive skewness (2.91) and kurtosis (11.42), suggesting that agricultural output is influenced by a few high outliers. Meanwhile, LT, LF, and LAP are more normally distributed with minimal skewness and moderate variation. The Jarque-Bera test confirms non-normality in LGDP and LAGRIC, indicating potential issues with data distribution that may need further consideration in regression models or statistical analysis. Despite this, the standard deviations for most variables are relatively small, pointing to a degree of consistency in the sample. Overall, while the data for LT, LF, and LAP appear stable, LGDP and LAGRIC exhibit substantial outliers, warranting closer inspection for robust analysis.

The Test of the Unit Root

The Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) criteria were applied to the unit root test. Since it appeared that all of the variables were stationary at the initial difference, the Granger Causality Test was appropriate in this study. The Unit Root Test findings are shown in Tables 2 and 3 below

Table 2 *Augmented Dickey-Fuller Tests*

Variables	Level		First difference		Order of Integration
	Constant	Constant & Linear Trend	Constant	Constant & Linear Trend	
Log of Gross Domestic Product	-0.75	-2.39	-4.356***	-4.273**	I(1)
Log of Agricultural Output	-2.68*	-3.45*	-5.155***	-4.722***	I(1)
Log of Aquaculture Production	-0.69	-2.52	-6.837***	-6.697***	I(1)
Log of Fisheries	-0.84	-1.35	-4.776***	-4.677***	I(1)
Log of Trade	-2.18	-2.56	-6.900***	-6.786***	I(1)

***Table 3**. Phillips - Perron Test*

Log of Gross Domestic Product	-2.15	-2.506	-6.525***	-6.472***	I(1)
Log of Agricultural Output	-1.581	-2.196	-4.434***	-4.315**	I(1)
Log of Aquaculture Production	-0.624	-2.484	-6.700***	-6.571***	I(1)
Log of Fisheries	-0.857	-1.464	-4.778***	-4.68***	I(1)
Log of Trade	-0.525	-2.026	-4.125***	-4.050**	I(1)

***Note:** ***1% level of significance ** 5% level of significance*

In order to eliminate false regression difficulties caused by unstable time series models. Following the unit root test, the long-term relationship between variables, known as co-integration, was explored. Tables 1 and 2 show the test results for each time series variable used in the estimation for the Philips-Perron and Augmented Dickey-Fuller statistics. LBDP, LAGRIC, LAP, LF, and LT were all non-stationary in their level forms. However, the ADF and PP test statistics demonstrated that they remained stationary after the initial difference.

The null hypothesis that the unit root existed in the series was rejected since the estimated ADF and PP (in absolute terms) statistics were greater than their critical values at the first difference, and their probability values were less than 0.05. In this scenario, the data series are known as integrated of order one, or 1(1).

Test of Johansen Co-Integration

The fact that each variable is integrated of order one, or I (1), validates the importance of utilising the Johansen technique to search for a long-term link (cointegration). The test findings are as follows: The co-integration test results, reported in Tables 4 and 5, allow the study to analyse the long-term connection between the variables

***Table 4.** Showing test for Johansen co-integration using trace statistics.*

Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistics**	**Critical Value**	**Pro Prob****
None*	0.766874	39.31673	33.87687	0.0102
At most 1	0.573841	23.02944	27.58434	0.1722
At most 2	0.325060	10.61455	21.13162	0.6856
At most 3	0.228411	7.001179	14.26460	0.4890
At most 4	0.052775	1.463893	3.841466	0.2263

***Source:** Researcher's computation from E-views 10.*

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level; *denotes rejection of the hypothesis at the 0.05 level; **MacKinnon Haug-Michelis (1999) p-values.

***Table 5.** Showing test for Johansen co-integration using max-eigenvalue*

Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistics**	**Critical Value**	**Pro Prob****
None*	0.666874	39.31673	13.87687	0.0102
At most 1	0.473841	23.02944	7.58434	0.1722
At most 2	0.125060	10.61455	11.13162	0.6856
At most 3	0.128411	7.001179	4.26460	0.4890
At most 4	0.352775	1.463893	1.841466	0.2263

***Source:** Researcher's computation from E-views 10.*

The max-eigenvalue test indicates 3 coin-integrating eqn(s) at the 0.05 level; *denotes rejection of the hypothesis at the 0.05 level; ** MacKinnon-Haug-Michelis (1999) p-values.

Tables 4 and 5 supplement the findings of the trace statistic and Eigenvalue multivariate co-integration test. The Max-Eigen and Trace statistics at the 0.05 level revealed three co-integrating equations, as shown in Tables 4 and 5. The previously described

Johansen Co-integration tests decisively rejected the null hypothesis that there was no co-integration or long-term link between the dependent and independent variables, instead supporting at least three co-integrating ones. This implies that there may be a long-term relationship between the dependent variable and the explanatory factors.

The Johansen co-integration test results show a strong long-term link between the dependent variable and explanatory factors, as indicated by three co-integrating equations at the 5% significant level. The trace and max-eigenvalue statistics both reject the null hypothesis of no co-integration for the first equation ("None"), with test statistics (39.31673) exceeding critical values and p-values less than 0.05. Subsequent hypotheses fail to reject the null, showing that there are no further co-integrating equations beyond the three identified. These findings support the use of an error correction model to represent short-term dynamics while maintaining a long-term equilibrium link among the variables.

Optimal Lag Length Selection Criteria

After establishing the variables' stationarity, the Granger Causality Test technique requires figuring out the variables' largest lag order. Using the Akaike Information Criterion, the maximum lag duration was calculated. The unrestricted VAR is used to determine this since its power attribute is superior than the other criteria. Thus, the maximum VAR length is 2. The maximum VAR length based on the Akaike Information Criterion (AIC) is displayed in Table 6 below.

Table 6. *VAR Lag Oder Selection Criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	16.27144	NA	2.99e-07	-0.834921	-0.594952	-0.763566
1	113.1990	150.7763*	1.50e-09	-6.162891	-4.723073*	-5.734758
2	144.0902	36.61174	1.20e-09*	-6.599273*	-3.959606	-5.814362*

Source: *Computed by the Researcher   * indicates lag order selected by the criterion*

Granger Causality Test

Granger causality was used to demonstrate one variable's capacity to accurately predict another. Granger-cause refers to the situation in which one variable helps predict another; failure to Granger-cause refers to the situation in which it does not. Below, in Table 7, is the Granger Causality Test.

Table 7. *Result of the LGDP model in Sierra Leone.*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.320619	4.468314	1.190744	0.2454
LAGRIC	-1.257486	0.508699	-2.471965	0.0209
LF	-0.132250	0.348773	-0.379187	0.7079
LT	0.168055	0.305525	0.550054	0.5874
LAP	0.412616	0.299651	1.376989	0.1812
R-squared	0.445534			
Adjusted R-squared	0.353123			
S.E. of regression	0.256121			
Sum squared resid	1.574348			
Log-likelihood	1.095876			
F-statistic	4.821218			
Prob(F-statistic)	0.005358			

Source: *Researcher's Computation from E-views 10.*

Discussion of the Regression Results

The regression study of the LGDP model in Sierra Leone investigates the link between GDP and important variables such as agricultural production (LAGRIC), fisheries sector output (LF), trade (LT), and aquaculture productivity (LAP). The findings reveal both major findings and limits.

Agricultural output (LAGRIC) is the only statistically significant variable at the 5% level, with a negative coefficient (-1.2575) indicating that a 1% increase in agricultural output results in a 1.257% decrease in GDP. This reflects inefficiencies or structural issues in the agricultural industry. The other variables (LF, LT, and LAP) are statistically insignificant, implying a little or ambiguous direct influence on GDP in this model.

The model explains 44.55% of the variation in GDP (R-squared), but the adjusted R-squared of 35.31% highlights the need for additional explanatory variables. Despite its limitations, the model is statistically significant overall, as evidenced by the F-statistic (4.8212, p = 0.0054).

The results imply that although agriculture has a negative impact on GDP, more research may be necessary to fully understand other aspects, including trade, finance, and agricultural production. The model's explanatory power might be increased, and a more thorough understanding of the factors influencing GDP in Sierra Leone could be obtained by including further variables like infrastructure, education, or institutional quality.

Diagnostic Tests

Diagnostic tests are required to ensure the robustness and reliability of the econometric model used in this study. After estimating the model, numerous tests are run to confirm that the classical linear regression model's assumptions are not violated. These diagnostic tests helped in examining the model's functional form, error term characteristics, and general stability. This study's primary diagnostic tests include the Breusch-Godfrey Serial Correlation LM Test, White's Test for Heteroscedasticity, the Jarque-Bera Normality Test, and the Cumulative Sum of Recursive Residuals (CUSUM) Test for Stability.

Table 8. *Showing Diagnostics Test Result*

Residual Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistics	3.449898	Prob. F(1,23)	0.0761
Obs*R-squared	3.782511	Prob. Chi-Squared(1)	0.0518

Normality Test

Jarque-Bera	0.800752	**Probability**	0.670068

Heteroscedasticity Test: Breusch-Pagan-Godfrey

F-statistics	1.016848	**Prob. F(4,24)**	0.4185
Obs*R-squared	4.202540	**Prob. Chi-Squared (4)**	0.3793

Heteroscedasticity Test: ARCH

F-statistics	0.807651	**Prob. F(1,26)**	0.3771
Obs*R-squared	0.843573	**Prob. Chi-Squared (1)**	0.3584

Stability Test

Ramsey RESET Test			
	Value	**Df**	**Probability**
T-statistics	1.730985	23	0.0969
F-statistics	2.996308	(1,23)	0.0969

Source: *Computed by the researcher*

Note: Significant level at 1, 5, and 10%

Conclusions

A blue economy can contribute significantly to economic growth provided a country's blue resources are effectively mapped and integrated within a strong institutional framework based on concrete policies and research. As a result, there is an opportunity for infrastructure development. This will also create jobs and aid in the eradication of poverty by allowing coastal residents to integrate into society. This study suggests that Sierra Leone can adopt a blue economy that will lead to economic progress; however, overturning these findings will require strong governmental commitments, concrete research, societal knowledge, and positive attitudes. As a result, if Sierra Leone makes effective use of its resources, it will progress more quickly.

In short, this study concludes that Sierra Leone, in general, has the potential and scope to implement the blue economy concept. To achieve long-term success, compact political duties, extensive examinations, cultural sensitivity, and a positive frame of mind are essential to increase reliance on the blue economy. The sustainable management of ocean resources necessitates national collaboration, which will aid in understanding the blue economy and its relevance in supporting economic growth, reaching SDG 14, and improving people's livelihoods by providing food security.

The study suggests that Sierra Leone citizens be sufficiently sensitized and mobilized about the importance of the blue economy to Sierra Leone's development. An initial step would be to educate the community on the value of the blue economy in political and environmental development, which is critical in promoting sustainable development.

The government and private sector should ensure that the people involved in the small-scale fisheries get to the decision-making table where they can help in developing policies that enhance their welfare. After including the locals in the decision-making, the government should provide financial assistance to the local fisheries so they can engage in deep-sea fishing. Similarly, the government should have fisheries' resources to boost the local supply of fish. In streamlining the Aquaculture activities, investors should collaborate with the government to enhance the Aquaculture sector. Investors and the government should acknowledge the significance of social responsibility, which would help the communities realize self-sustenance.

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