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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

The impact of blue economy components on economic growth: Evidence from fisheries and aquaculture in ASEAN-5 countries

Mavi ekonomi bileşenlerinin ekonomik büyüme üzerindeki etkisi: ASEAN-5 ülkelerinde balıkçılık ve su ürünleri yetiştiriciliğinden kanıtlar

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Abstract: This study investigates the effects of the fisheries and aquaculture sectors, two key components of the blue economy, on economic performance in ASEAN-5 countries over the period 2000–2023 using panel data methods. The existence of a long-run relationship among the variables is examined through the Westerlund and Edgerton panel LM bootstrap cointegration test, while long-run coefficients are estimated using the Common Correlated Effects (CCE) estimator developed by Pesaran (2006). The empirical findings reveal that fisheries production exerts a positive and statistically significant impact on economic growth. In contrast, aquaculture production does not exhibit a statistically significant effect at the panel level. Furthermore, gross fixed capital formation is identified as an important driver of long-run economic development. The results indicate that fisheries activities and capital accumulation make a substantial contribution to growth dynamics within the blue economy framework. By providing sector specific evidence for ASEAN-5 countries, the study contributes to the literature on the blue economy and offers policy-relevant insights for promoting sustainable fisheries development and regional prosperity.

Keywords: Blue economy, fisheries sector, aquaculture production, ASEAN-5 countries, cointegration analysis

Öz: Bu çalışma, mavi ekonominin iki temel bileşeni olan balıkçılık ve su ürünleri yetiştiriciliği sektörlerinin ASEAN-5 ülkelerinde ekonomik performans üzerindeki etkilerini 2000–2023 dönemi için panel veri yöntemleri kullanarak incelemektedir. Değişkenler arasındaki uzun dönemli ilişkinin varlığı Westerlund ve Edgerton panel LM bootstrap eşbütünleşme testi ile araştırılmış, uzun dönem katsayıları ise Pesaran (2006) tarafından geliştirilen Ortak İlişkili Etkiler (CCE) tahmincisi kullanılarak tahmin edilmiştir. Ampirik bulgular, balıkçılık üretiminin ekonomik büyüme üzerinde pozitif ve istatistiksel olarak anlamlı bir etkiye sahip olduğunu göstermektedir. Buna karşılık, su ürünleri yetiştiriciliği üretiminin panel düzeyinde istatistiksel olarak anlamlı bir etkisinin bulunmadığı tespit edilmiştir. Ayrıca, brüt sabit sermaye oluşumunun uzun dönemli ekonomik kalkınmayı destekleyen önemli bir unsur olduğu belirlenmiştir. Sonuçlar, mavi ekonomi çerçevesinde balıkçılık faaliyetleri ile sermaye birikiminin büyüme dinamiklerine önemli katkılar sağladığını ortaya koymaktadır. ASEAN-5 ülkelerine yönelik sektör bazlı kanıtlar sunan çalışma, mavi ekonomi literatürüne katkıda bulunmakta ve sürdürülebilir balıkçılık politikalarının geliştirilmesi ile bölgesel refahın desteklenmesine yönelik politika çıkarımları sunmaktadır.

Anahtar kelimeler: Mavi ekonomi, balıkçılık sektörü, su ürünleri yetiştiriciliği, ASEAN-5 ülkeleri, eşbütünleşme analizi

INTRODUCTION

In recent years, the blue economy has emerged as a prominent concept in both academic and policy discussions, emphasizing the relationship between the sustainable use of marine and ocean resources and economic development (Silver et al., 2015). Although its conceptual origins can be traced back to the sustainable development agenda that gained prominence following the 1992 Rio Summit, the concept has attracted increasing attention, particularly after the Rio+20 Conference held in 2012 (Voyer et al., 2018). At its core, the blue economy seeks to establish a balance between economic growth and environmental sustainability through the responsible and sustainable use of marine resources. This approach is closely aligned with Sustainable Development Goal 14, which aims to conserve and sustainably use oceans, seas, and marine resources (UN, 2015; Morgan et al., 2022). Given that oceans cover more than two-thirds of the Earth's surface and provide substantial ecological, social, and economic benefits, blue economy activities have become a strategic development priority for many countries (WWF, 2018; Bennett et al., 2019).

The blue economy encompasses a wide range of marine- and ocean-based activities, including fisheries, aquaculture, maritime transport, coastal tourism, marine biotechnology, shipbuilding, and marine energy production (Alharthi and Hanif, 2020; Toplu Yılmaz, 2021). Among these sectors, fisheries and aquaculture occupy a particularly important position due to their contributions to employment generation, income creation, food security, and export revenues. Accordingly, the sustainable development of these sectors is increasingly recognized as an important component of the blue economy, contributing to economic growth while supporting the sustainable management of marine resources (Nham and Ha, 2023). Although there is no universally accepted definition of the blue economy, a broad consensus exists that economic development objectives should be pursued alongside environmental sustainability and ecosystem conservation (World Bank, 2017; European Commission, 2018; Keen et al., 2018; Yuan and Failler, 2025).

Recent studies have increasingly emphasized the importance of effective governance mechanisms, sustainable

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resource management, and supportive policy frameworks for achieving the objectives of the blue economy. In this context, governance structures, marine spatial planning, technological innovation, effective regulatory frameworks, and conservation-oriented management strategies play a critical role in ensuring the long-term sustainability of marine resources while supporting economic development (Hamaguchi and Thakur, 2024; Yang et al., 2026; Gerou and Pantouvakis, 2025; González-Cancelas et al., 2025). Furthermore, Saygı (2024) notes that the development of fisheries and aquaculture within the blue economy framework is important for ensuring long-term environmental and economic sustainability, promoting innovation, and supporting responsible practices. Therefore, fisheries and aquaculture should be regarded not only as productive economic activities but also as strategic sectors that contribute to sustainable economic growth.

From a theoretical perspective, fisheries and aquaculture can influence economic growth through several channels. These sectors generate employment opportunities, increase household incomes, contribute to export revenues, strengthen food security, and stimulate investments in related industries. Furthermore, productivity improvements and technological advancements in fisheries and aquaculture can enhance economic efficiency and support long-term development (Qi et al., 2020; Qi, 2022). Therefore, understanding the economic contributions of these sectors is essential for evaluating the growth implications of the blue economy.

The empirical literature examining the relationship between blue economy activities and economic growth can generally be classified into three strands. The first strand focuses on fisheries and provides evidence that fisheries production contributes positively to economic performance. For example, Abila (2003) demonstrates that the fisheries sector makes significant contributions to GDP and foreign exchange earnings in the Lake Victoria region of Kenya, while Eyüboğlu and Akmermer (2023) find that fisheries production has a positive and statistically significant effect on economic growth in Türkiye in the long run. The second strand concentrates on aquaculture and highlights its potential to promote economic growth and development. Empirical studies conducted for the European Union, China, and BRICS countries indicate that aquaculture constitutes an important sector within the blue economy framework and contributes to economic and developmental outcomes (Alsaleh and Wang, 2024; Ahammed et al., 2025; Mohanty and Lenka, 2026). The third strand adopts a broader perspective and examines blue economy activities as a whole. Silver et al. (2015) discuss the growing importance of the blue economy as a framework linking marine resources and activities to economic development and sustainability. Similarly, Alharthi and Hanif (2020) report that blue economy components support economic growth in SAARC countries, particularly in the long run. Ahammed et al. (2025) and Chakila et al. (2025) provide time-series evidence indicating that blue economy sectors contribute positively to economic growth and sustainable development. Likewise, Imran et al. (2025), using a panel of NEXT-11 countries, find that fisheries and aquaculture positively affect economic growth. Furthermore, Rafiq et al. (2025) reveal that trade openness is an important driver of economic growth in Southeast Asian countries, while the effects of fisheries and aquaculture vary across countries. Nevertheless, previous studies suggest that the effects of blue economy components are not homogeneous across countries and sectors, reflecting differences in economic structures, institutional characteristics, and sectoral development levels (Bennett et al., 2019; Bădîrcea et al., 2021; Alsaleh and Wang, 2024). For instance, Soyu Yıldırım (2025) finds that aquaculture has an insignificant effect on economic growth in Türkiye, whereas fisheries production and capital accumulation significantly support growth. These findings imply that the contribution of blue economy components depends largely on country-specific conditions and development dynamics. In addition, several studies emphasize that the economic benefits generated by blue economy activities should be evaluated alongside environmental sustainability objectives and effective marine resource management policies (Toplu Yılmaz, 2021; Suluk, 2022).

Despite the rapid expansion of the blue economy literature, several important research gaps remain. First, a considerable proportion of existing studies are conceptual in nature and focus primarily on single-country cases. Second, many empirical studies employ aggregated blue economy indicators, making it difficult to identify the separate effects of fisheries and aquaculture on economic growth. Third, comparative panel data studies focusing specifically on these production-based sectors remain relatively limited. This issue is particularly relevant for ASEAN-5 countries, which are among the world's leading producers of fisheries and aquaculture products and rely heavily on marine resources for employment, food security, and export revenues.

Accordingly, this study investigates the impact of fisheries and aquaculture on economic growth in ASEAN-5 countries over the period 2000–2023. Unlike previous studies, aggregated blue economy indicators are not employed; instead, fisheries and aquaculture are examined separately in order to identify their individual contributions to economic growth. In addition, the relationship is assessed using contemporary panel data techniques that account for cross-sectional dependence and heterogeneity. In this regard, the study contributes to the existing literature by providing sector-specific evidence on the effects of fisheries and aquaculture on economic growth in ASEAN-5 countries and offers policy implications for the development of sustainable blue economy strategies.

MATERIALS AND METHODS

Dataset and model

This study analyzes the effects of fisheries and aquaculture sectors on economic growth in ASEAN-5 countries over the period 2000–2023. The ASEAN-5 countries (Indonesia, Malaysia, Philippines, Thailand, and Vietnam) were selected

because they represent some of the largest economies in the region and because fisheries and aquaculture constitute significant sectors within their economic structures. Furthermore, the availability of long-term and comparable data for these countries enables a more reliable empirical assessment. Economic growth is measured by gross domestic product per capita (constant 2015 US dollars). Aquaculture production (metric tons), fisheries production (metric tons), and the annual growth rate of gross fixed capital formation are included as explanatory variables. All data are obtained from the World Development Indicators (WDI) database of the World Bank (2025). The analysis period is restricted to 2000–2023 due to data availability and consistency considerations across the sample countries.

The model is specified in its functional form as follows:

$$\mathrm{GDP} = \mathrm{AP}, \mathrm{TP}, \mathrm{GFCF} \quad (1)$$

The econometric specification of the model is presented as follows:

$$\mathrm{LnGDP}_{2it}=\alpha_i+\beta_{1i}\mathrm{LnAP}_{it}+\beta_{2i}\mathrm{LnTP}_{it}+\beta_{3i}\mathrm{LnGFCF}_{it}+\varepsilon_{it} \quad (2)$$

In the model, GDP represents gross domestic product per capita, AP denotes aquaculture production, TP refers to fisheries production, and GFCF indicates gross fixed capital formation. The index *i* denotes countries), $(i = 1, \dots, 5)$, while t represents the time dimension $(t = 2000, \dots, 2023)$. The coefficients β_1 , β_2 and β_3 reflect the long-run elasticities associated with the AP, TP, and LGFCF variables, respectively. Table 1 provides an overview of the variables by presenting their summary statistics along with correlation coefficients.

Table 1. Descriptive statistics and correlation matrix

	GDP	AP	TP	GFCF
Mean	0.840	8.771	3.688	1.675
Median	0.932	9.020	3.787	1.687
Max.	1.259	9.266	4.062	1.783
Min.	0.237	7.884	2.878	1.510
Std. Dev.	0.297	0.477	0.328	0.056
Skewness	-0.617	-0.917	-1.127	-0.812
Kurtosis	2.271	2.397	2.970	3.656
Jarque–Bera	9.842	17.886	24.383	14.706
P-value	0.007	0.000	0.000	0.000
Obs.	115	115	115	115
Correlation Matrix				
	GDP	**AP**	**TP**	**GFCF**
GDP	1.000	0.557	-0.550	-0.133
AP	0.557	1.000	0.741	0.578
TP	-0.550	0.741	1.000	0.115
GFCF	-0.133	0.578	0.115	1.000

Note: GDP, AP, TP, and GFCF represent gross domestic product per capita, aquaculture production, fisheries production, and gross fixed capital formation, respectively.

The Jarque–Bera test results reported in Table 1 indicate that the p-values for all variables are below the 1% significance level, implying that the series GDP, AP, TP, and GFCF do not satisfy the normality assumption. The correlation matrix reveals a positive association between GDP and AP (0.557) as well as between GDP and TP (-0.550). Moreover, the correlation coefficient between AP and TP (0.741) suggests a relatively strong relationship between these two variables. In contrast, the correlation between GDP and GFCF is negative (−0.133), indicating a weak inverse relationship between the variables.

Method

Panel data methodologies have expanded in line with the increasing complexity of economic datasets, offering a variety of techniques tailored to different data structures. Nevertheless, selecting an econometric approach that is consistent with the theoretical framework remains essential for ensuring reliable empirical findings. In this context, identifying the presence of cross-sectional dependence represents a fundamental step in determining the appropriate estimation strategy. When cross-sectional dependence is detected, second-generation panel data methods should be employed, whereas first-generation techniques are sufficient in its absence. To assess cross-sectional dependence, several established testing procedures are applied, namely the "LM test of Breusch and Pagan (1980), the CDlm and CD tests proposed by Pesaran (2004), and the bias-adjusted LM test developed by Pesaran et al. (2008).

$$\mathrm{LM}= \mathrm{T}\sum_{\mathrm{i}=1}^{\mathrm{N}-1}\sum_{\mathrm{j}=\mathrm{i}+1}^{\mathrm{N}}\hat{\mathrm{P}}_{\mathrm{ij}}^{2}, \ \sim \mathrm{X}^{2}\mathrm{N}(\mathrm{N}-1) \quad (3)$$

$$\mathrm{CD}_{\mathrm{LM}} = \sqrt{\frac{1\mathrm{T}}{\mathrm{N}(\mathrm{N}-1)}}\sum_{\mathrm{i}-1}^{\mathrm{N}-1}\sum_{\mathrm{j}=\mathrm{i}+1}^{\mathrm{N}}\left(\mathrm{T}-\hat{\rho}_{\mathrm{ij}}^{2}+1\right) \quad (4)$$

$$\mathrm{CD}= \sqrt{\frac{2\mathrm{T}}{\mathrm{N}(\mathrm{N}-1)}}\left(\sum_{\mathrm{i}=1}^{\mathrm{N}-1}\sum_{\mathrm{j}=\mathrm{i}+1}^{\mathrm{N}}\hat{\rho}_{\mathrm{ij}}\right) \quad (5)$$

$$\mathrm{LM}_{\mathrm{adj}} = \sqrt{\left(\frac{2}{\mathrm{N}(\mathrm{N}-1)}\right)}\sum_{\mathrm{i}=1}^{\mathrm{N}-1}\sum_{\mathrm{j}=\mathrm{i}+1}^{\mathrm{N}}\frac{(\mathrm{T}-\mathrm{k})\hat{\rho}^{2}{}_{\mathrm{ij}}-\mu_{\mathrm{Tij}}}{\sqrt{2\nu_{\mathrm{Tij}}}} \sim \mathcal{N}(0,1) \quad (6)$$

These tests are designed to evaluate whether error terms are correlated across cross-sectional units within the panel structure. Although the choice of test may vary depending on the relative sizes of the cross-section (N) and time dimension (T), all test results are reported together to ensure methodological consistency. Across all tests, the null hypothesis refers to cross-sectional independence, while the alternative implies the existence of dependence across panel units. In addition, evaluating slope homogeneity prior to further analysis is essential for selecting appropriate cointegration methods and long-run estimators. To evaluate slope homogeneity, the Delta tests proposed by Pesaran and Yamagata (2008), building on the approach of Swamy (1970), are applied. In these tests, the null hypothesis indicates that slope coefficients are identical across panel units. The statistical formulations of these tests are presented below.

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}\right) \quad (7)$$

$$\hat{\Delta}_{adj}= \sqrt{N}\left(\frac{N^{-1}\tilde{S}-E(\tilde{Z}_{iT})}{\sqrt{Var(\tilde{Z}_{iT})}}\right) \quad (8)$$

Equation (7) represents the standard Delta test, which is based on the slope heterogeneity test developed by Swamy (1970). This test is obtained by normalizing the Swamy statistic and measures the dispersion of slope coefficients around their mean by taking into account the number of parameters in the model and the cross-sectional dimension. Equation (8), on the other hand, presents the bias-adjusted Delta test, denoted as $\hat{\Delta}_{adj}$ which is designed to provide more reliable results, particularly in small samples. For both tests, slope homogeneity is taken as the null hypothesis, implying that coefficients are identical across cross-sectional units. A rejection of this hypothesis points to the existence of heterogeneity within the panel structure.

The Fourier LM unit root test proposed by Nazlıoğlu and Karul (2007) is employed to examine the stationarity properties of the series. Compared to conventional unit root approaches, this method offers a more flexible structure by incorporating nonlinear patterns and potential structural changes into the analysis. A key advantage of this approach is that it does not require prior specification of the number, timing, or form of structural breaks (Enders and Lee, 2012). Given the difficulty of accurately identifying structural break points across countries, the Fourier approach provides a more practical and adaptable alternative. Within this framework, the null hypothesis assumes that the series contains a unit root. The corresponding test statistic is presented below.

$$z_{LM}(k)=\frac{\sqrt{N}(Pt(K)-\xi(\kappa))}{\zeta(\kappa)} \sim N(0,1) \quad (9)$$

In the equation, ξ(k) represents the mean at frequency k, while ζ(κ) denotes the average of the variances. The presence of a long-run relationship among the variables is examined using the panel LM bootstrap cointegration test introduced by Westerlund and Edgerton (2007). This approach relies on the Lagrange Multiplier framework of McCoskey and Kao (1998) and enables the incorporation of cross-sectional dependence into panel data analysis. When cross-sectional dependence is detected, bootstrap critical values are utilized to enhance the reliability of the estimation results. In contrast, when cross-sectional independence holds, asymptotic critical values are considered for inference. This methodological flexibility ensures the validity of the test under different data structures and improves the robustness of the empirical findings. Within this testing framework, the null hypothesis indicates the presence of a cointegration relationship, whereas the alternative suggests its absence. The corresponding model equation for the panel cointegration test is presented below.

$$\gamma_{it} = a_i + \acute{\chi}_{it}\beta_{it} + Z_{it} \quad (10)$$

$$Z_{it} = \mu_{it} + V_{it}V_{it} = \sum_{j=1}^{t} n_{ij} \quad (11)$$

In the model specification, t denotes the time dimension, i represents cross-sectional units, and Zit corresponds to the error term. The LM test statistic is presented below.

$$LM_N^+=\frac{1}{NT^2}\sum_{i=1}^{N}\sum_{t=1}^{t}\bar{\omega}^{-2}\, s_{it}^2 \quad (12)$$

Once the existence of a long-run relationship is established, long-run coefficients are obtained through the Common Correlated Effects (CCE) estimator proposed by Pesaran (2006). By accounting for unobserved common factors, this approach produces reliable estimates in the presence of cross-sectional dependence and slope heterogeneity. By accounting for these common factors, the CCE approach captures the dependence structure across cross-sectional units more effectively. The corresponding test statistic for the estimation method is presented below.

$$\hat{b}_{CCEMG} = (1/N)\sum_{i=1}^{N}\hat{b}_i \quad (13)$$

$$\hat{b}_{CCEMG} = \left(\sum_{i=1}^{N}\theta_i X_i'\bar{M}_w X_i\right)^{-1}\sum_{i=1}^{N}\theta_i X_i'\bar{M}_w y_i \quad (14)$$

Under this estimation approach, the null hypothesis indicates that the estimated coefficients are statistically insignificant. In addition, the method enables the assessment of results at both the panel level and the country-specific level.

The CCE estimator is preferred because it effectively accounts for cross-sectional dependence and slope heterogeneity, which are common issues in panel data analysis. The economic and sectoral interdependencies among ASEAN-5 countries suggest that these economies may be exposed to similar external shocks and unobserved common factors. By controlling for the effects of such common factors, the CCE approach enables the estimation of consistent and reliable long-run coefficients. Accordingly, the empirical framework adopted in this study is illustrated in Figure 1.

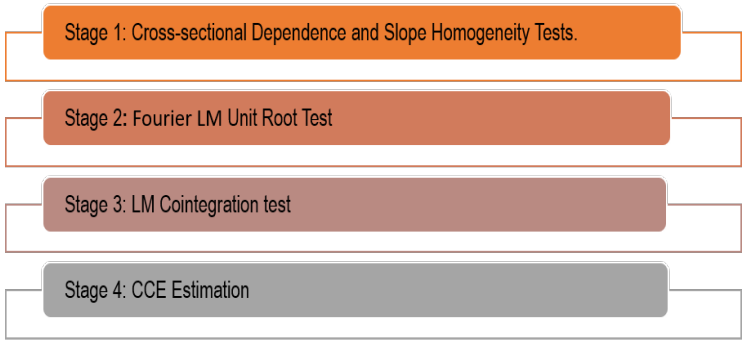

Figure 1. Empirical implementation framework

RESULTS

A systematic empirical modeling strategy comprising four stages is adopted, and the findings are presented in this sequence. In this context, Table 2 first reports the results of the cross-sectional dependence and slope homogeneity tests.

The empirical results reveal cross-sectional dependence in the model at the 1% significance level. This outcome implies that shocks affecting one country are likely to spill over to other countries within the panel. In contrast, the slope homogeneity tests reveal that the coefficients are heterogeneous at the 1% level, implying that the impacts of the analyzed variables differ across countries and vary according to country-specific economic and structural conditions.

Given the existence of cross-sectional dependence, second-generation unit root methods are required; therefore, the Panel Fourier LM unit root test is applied. The corresponding unit root results for the variables are presented in Table 3.

The Fourier LM unit root test results reported in Table 3 are computed for each country using harmonic frequency values of k =1, k =2, and k =3, respectively. The frequency parameter (k) indicates the number of oscillations through which potential structural break patterns in the series are approximated by a Fourier function. Specifically, k=1 captures a low-frequency structural transformation, whereas k=2 and k=3 represent more complex dynamics characterized by multiple structural breaks. Accordingly, implementing the test under different frequency specifications enables the stationarity properties of the series to be assessed from alternative perspectives that account for structural changes (Enders and Lee, 2012). Based on this approach, the panel-level Z_{LM} test statistics and their associated p-values suggest that the series contain unit roots and are therefore non-stationary. The presence of unit root processes in the series justifies the application of cointegration analysis to examine whether a long-run relationship exists among the variables. In this context, the findings of the cointegration test are presented in detail in Table 4.

Table 2. Test results

Cross-Sectional Dependence				
Tests	**LnGDP**	**LnAP**	**LnTP**	**LnGFCF**
	Statistic p-value	**Statistic p-value**	**Statistic p-value**	**Statistic p-value**
LM	27.377***(0.002)	30.653***(0.000)	23.538***(0.009)	25.277***(0.005)
CD_{lm}	3.886***(0.000)	4.614*** (0.000)	3.027***(0.001)	3.405***(0.000)
CD	-3.151***(0.001)	-3.186*** (0.001)	-2.899***(0.002)	-2.509***(0.006)
LM_{adj}	4.809***(0.002)	4.501*** (0.008)	1.372**(0.045)	2.529***(0.000)
Model				
	Test Statistic		**p-value**	
LM	27.377***		0.002	
CD_{lm}	3.886***		0.000	
CD	-3.151***		0.001	
LM_{adj}	4.809***		0.000	
Slope Homogeneity				
Δ	7.787***		0.000	
Δ_{adj}	8.530***		0.000	

Note: ***p<0.01, **p<0.05.

Table 3. Unit root test findings

Countries	**Fourier tau LM_1 k=1**	**Fourier tau LM_2 k=2**	**Fourier tau LM_3 k=3**
LnGDP			
Indonesia	-0.842	-0.479	-1.882
Vietnam	1.331	0.602	0.335
Thailand	0.085	-0.113	0.218
Philippines	-1.313	-1.678	0.717
Malaysia	-0.776	0.651	-0.253
Findings			
Z_{LM} (Stat.)	8.981	5.457	5.831
P-value	1.000	1.000	1.000
LnAP			
Indonesia	-3.400	-1.141	-0.416
Vietnam	0.178	-0.156	0.386
Thailand	-2.343	-0.308	-1.462
Philippines	-3.102	-2.539	-1.520
Malaysia	-2.282	0.420	0.568
Findings			
Z_{LM} (Stat.)	2.830	4.482	5.773
P-value	0.997	1.000	1.000
LnTP			
Indonesia	-1.497	-2.024	-2.164
Vietnam	-1.570	-0.790	-0.297
Thailand	-1.985	-0.560	-0.538
Philippines	-3.618	-3.770	-3.076
Malaysia	-3.297	-1.174	-3.557
Findings			
Z_{LM} (Stat.)	1.990	2.815	1.638
P-value	0.976	0.997	0.949
LnGFCF			
Indonesia	-5.575	-5.966	-5.952
Vietnam	-0.982	-1.553	-1.168
Thailand	-2.595	-2.991	-3.040
Philippines	-3.669	-2.479	-2.293
Malaysia	-3.971	-2.584	-2.748
Findings			
Z_{LM} (Stat.)	0.353	0.879	0.794
P-value	0.638	0.546	0.385

Table 4. Cointegration test findings

	LM Statistic	**Asymptotic p-value**	**Bootstrap p-value**
Constant	4.355	0.000	0.548
Constant and trend	5.293	0.000	0.959

Note: The analysis is conducted using one lag and a distribution generated through 1,000 replications.

In the LM cointegration test, the lag length is set to one based on the Schwarz Information Criterion (SIC), as this lag order yields the lowest information criterion value. This choice allows the model to be estimated with an optimal dynamic structure while avoiding over parameterization. Within this framework, taking into account the presence of cross-sectional dependence, the bootstrap-based p-values indicate that a statistically significant and long-run cointegration relationship exists among the variables in both the constant-only model and the constant-and-trend specification.

Following the identification of this relationship, the estimation results for the cointegration coefficients are reported in detail in Table 5 in the final section of the study.

Table 5 reports the CCE-based long-run coefficient estimates, which reflect the elasticity relationships among the variables. At the panel level, the coefficient of aquaculture production (AP) is positive; however, it does not reach

statistical significance. By contrast, the coefficient associated with fisheries production (TP) is estimated at 0.109 and is statistically significant at the 5% level. This finding implies that a 1% increase in fisheries production is associated with approximately a 0.11% rise in per capita income in the long run. Similarly, the coefficient of gross fixed capital formation (GFCF) is calculated as 0.081 and is statistically significant at the 5% level. This result indicates that a 1% increase in capital formation contributes to economic growth by nearly 0.08% in the long term.

Table 5. Cointegration coefficient estimator results

CCE-Countries	β_1			β_2			β_3		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Country Results									
Indonesia	0.040***	0.013	0.003	0.099***	0.011	0.000	0.178***	0.035	0.000
Vietnam	0.146**	0.060	0.015	0.277***	0.093	0.003	0.008	0.046	0.862
Thailand	0.048	0.030	0.121	0.149***	0.039	0.000	0.047	0.054	0.386
Philippines	-0.034	0.044	0.446	0.013	0.245	0.585	0.154***	0.054	0.005
Malaysia	0.003	0.020	0.874	0.034	0.061	0.578	0.021	0.042	0.612
Panel	0.040	0.030	0.176	0.109**	0.050	0.030	0.081**	0.035	0.020

Note: ***p<0.01, **p<0.05, *p<0.10 "β_1" LnAP, "β_2" LnTP and "β_3" LnGFCF represents.

The country-specific CCE estimation results indicate that the long-run effects of fisheries and aquaculture sectors on economic growth differ substantially across ASEAN-5 countries. The findings for Indonesia reveal that all explanatory variables (LnAP, LnTP, and LnGFCF) have positive and statistically significant effects on LnGDP. Accordingly, a 1% increase in LnAP increases LnGDP by 0.04%, a 1% increase in LnTP increases it by 0.10%, and a 1% increase in LnGFCF raises it by 0.18%. For Vietnam, the results indicate that LnAP and LnTP have positive and statistically significant effects on LnGDP, whereas LnGFCF is statistically insignificant. In the case of Thailand, only LnTP is found to have a positive and statistically significant effect on LnGDP, while the coefficients of LnAP and LnGFCF are not statistically significant. For the Philippines, LnGFCF is positive and statistically significant, whereas LnAP and LnTP are insignificant. Finally, the findings for Malaysia indicate that LnAP, LnTP, and LnGFCF do not have a statistically significant long-run effect on LnGDP.

Figure 2 presents a visual summary of the CCE estimation results. The figure illustrates the long-run effects of the explanatory variables on economic growth. The results indicate that fisheries production and gross fixed capital formation positively affect economic growth, whereas aquaculture production does not exhibit a statistically significant effect.

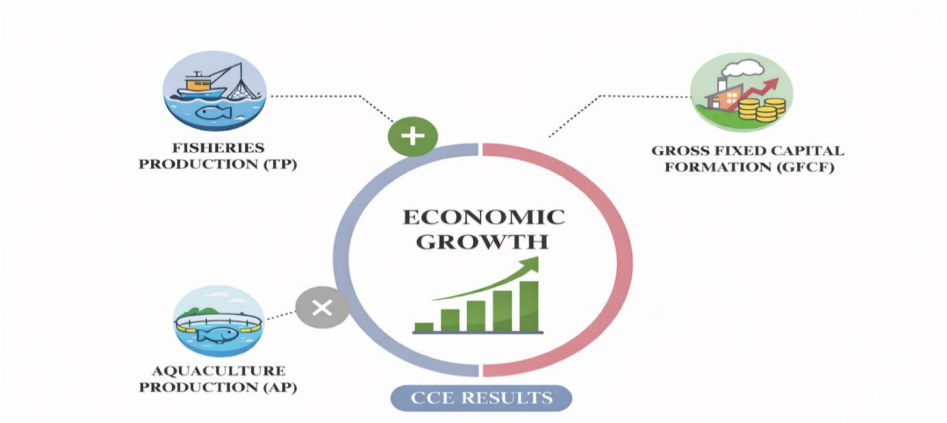

Figure 2. CCE Estimation Results

DISCUSSION

The findings suggest that the economic effects of blue economy components differ considerably across ASEAN-5 countries. At the panel level, fisheries production exerts a positive and statistically significant effect on economic growth, whereas aquaculture production does not exhibit a statistically significant impact. In addition, gross fixed capital formation emerges as an important determinant of long-run economic growth.

The positive contribution of fisheries production to economic growth may be explained by the sector's significant role in employment generation, food security, export earnings, and income creation across ASEAN economies. Fisheries activities not only provide direct economic benefits through production and trade but also generate indirect effects through processing industries, transportation services, and related supply chains. Given the strategic importance of marine

resources in ASEAN-5 countries, particularly in coastal regions, fisheries production can contribute substantially to economic performance by stimulating both domestic and external economic activities. This finding is consistent with previous studies emphasizing the growth-enhancing role of fisheries activities (Abila, 2003; Eyüboğlu and Akmermer, 2023; Imran et al., 2025; Alharthi and Hanif, 2020).

In contrast, the statistically insignificant effect of aquaculture production at the panel level suggests that the growth effects of aquaculture may not be homogeneous across ASEAN countries. Although aquaculture has experienced rapid expansion in many developing economies, its economic contribution may depend on factors such as technological capabilities, production efficiency, investment intensity, institutional support, and market integration. Differences in these factors across ASEAN-5 countries may limit the ability of aquaculture production to generate a statistically significant impact on aggregate economic growth at the panel level. This result is consistent with Soyu Yıldırım (2025), who also reports an insignificant effect of aquaculture production on economic growth in Türkiye.

From a theoretical perspective, the findings support the blue economy framework, which emphasizes the contribution of marine resource-based activities to economic growth through employment generation, increased income and export revenues, and enhanced food security. In the ASEAN-5 context, the fisheries sector occupies a strategic position not only as a major source of livelihood, particularly in coastal areas, but also in terms of export earnings and food supply. By contrast, the insignificant effect of aquaculture production may be associated with disparities in technological development, production capacity, investment intensity, and sectoral scale across ASEAN economies. These findings suggest that the growth effects of blue economy components are conditioned by country-specific structural and sectoral characteristics.

The country-specific estimation results further reveal substantial heterogeneity across ASEAN-5 countries. The stronger positive effects observed in Indonesia and Vietnam may be associated with the relatively larger scale of fisheries and aquaculture production, higher export orientation, and stronger integration of marine-based activities into national development strategies. In contrast, the insignificant findings reported for Malaysia and the more limited effects identified in Thailand and the Philippines may reflect differences in economic structures, sectoral specialization, and policy priorities. These results reinforce the argument that the economic contribution of blue economy sectors depends not only on the availability of marine resources but also on the effectiveness of supporting institutions, investments, and sectoral development policies.

Furthermore, the positive and statistically significant effect of gross fixed capital formation is consistent with the predictions of neoclassical growth theory, which emphasizes the importance of capital accumulation in expanding productive capacity and improving productivity. Investments in infrastructure, logistics networks, port facilities, processing industries, and production technologies may enhance the efficiency of fisheries and aquaculture sectors, thereby contributing to long-run economic growth. This finding supports both the theoretical and empirical literature highlighting the crucial role of capital investment in promoting sustainable economic development.

CONCLUSION

This study examined the effects of fisheries and aquaculture production on economic performance in ASEAN-5 countries over the period 2000–2023 using panel data techniques. The empirical findings reveal that fisheries production has a positive and statistically significant effect on long-run economic growth, whereas aquaculture production does not exhibit a statistically significant impact at the panel level. In addition, gross fixed capital formation was found to be an important determinant of economic growth. These results indicate that the growth effects of blue economy components are heterogeneous and depend on sector-specific as well as country-specific characteristics. By examining fisheries and aquaculture separately rather than relying on aggregated blue economy indicators, this study contributes to the literature by providing sector-specific empirical evidence on the relationship between blue economy activities and economic growth in ASEAN-5 countries.

The findings suggest that supporting the fisheries sector through sustainable production policies and increasing investments in marine-based industries may represent an effective strategy for promoting long-term economic development. In particular, improving production infrastructure, strengthening technological capabilities, enhancing productivity, and developing a skilled labor force may increase the economic contribution of fisheries and aquaculture sectors. Furthermore, integrating environmental sustainability considerations into blue economy policies and ensuring the effective management of marine resources are essential for achieving long-term economic and ecological benefits.

From a policy perspective, ASEAN member states should strengthen sustainable fisheries management through effective monitoring, regulatory frameworks, and conservation-oriented practices to prevent the overexploitation of marine resources. In addition, greater support for technological innovation, infrastructure development, and investment in aquaculture may enhance the sectors contribution to economic performance. Integrating blue economy objectives into national development strategies and promoting regional cooperation in marine resource management, environmental protection, and knowledge sharing could further support sustainable economic development across the region.

Nevertheless, the findings should be interpreted in light of certain limitations. The analysis focuses specifically on fisheries and aquaculture and does not incorporate other important blue economy sectors such as maritime transport, marine tourism, marine biotechnology, and marine renewable

energy. Therefore, the reported findings reflect only part of the broader relationship between blue economy activities and economic growth.

Future research may contribute to the literature by examining the effects of different blue economy sectors on development outcomes in greater detail. In particular, incorporating additional blue economy components such as marine tourism, maritime transport, marine biotechnology, and marine-based energy activities would provide a more comprehensive understanding of the blue economy-growth nexus. Furthermore, comparative analyses across different country groups, such as developed and developing economies or coastal and island countries, may provide additional insights into how the economic effects of blue economy activities vary according to country-specific characteristics. Finally, the inclusion of environmental indicators and the application of more advanced econometric techniques may contribute to a deeper understanding of the relationship between the blue economy and sustainable economic development.

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AUTHORSHIP CONTRIBUTIONS

Dilek Atılgan: Conceptualization, methodology, data collection, formal analysis, writing-original draft, writing-review and editing.

CONFLICT OF INTEREST

There is no conflict of interest.

ETHICAL APPROVAL

No specific ethical approval was necessary for the study.

DECLARATION OF AI USE

We have not used AI-assisted technologies in creating this article.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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