Investigating the Role of Fisheries Production on Indonesia's Economic Growth: Long-Run and Short-Run Analysis

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Abstract

The purpose of this study is to determine the short and long-term effects of seafood production variables, including capture fisheries production, aquaculture production and trade in the fisheries sector on Indonesia's economic growth. This is necessary because seafood products have great benefits, especially in fulfilling the nutritional needs for the population. This research was based on the time series data of uses an explanatory quantitative approach with the vector error correction model (VECM) analysis technique. The data used in this study is secondary data obtained from BPS, World Bank, FAO, and OECD. Through the Johansen Cointegration Test in the VECM analysis technique, it is shown the long-term and short-term effects of seafood production variables on Indonesia's economic growth. The results showed that the variable capture fisheries production and aquaculture production had short-term and long-term effects on Indonesia's economic growth. However, the international trade variable in the fisheries sector only has a short-term effect on Indonesia's economic growth. Government needs to increase expenditure to build better infrastructure and fishing technology can be achieved through better facilities and greater financial support for Indonesian fishermen to improve the fishing industry. Recommendations for improvements in these areas have been made.

Keywords: capture fisheries production, aquaculture production, international trade, economic growth

Introduction

The sea provides a large part of the global population with food and livelihoods and is the means of transportation for 80 % of global trade. Oceans cover 72 % of surface our blue planet and comprise over 95 % of the biosphere. Life originates in the oceans and continues to support all life by producing oxygen, absorbing carbon dioxide, recycling nutrients, and regulating global climate and temperature (Plan Bleu, 2020) . The large sea potential owned by several countries in the world encourages the formation of a concept and implementation of sustainable development by exploiting sea potential through the blue economy. The blue economy concept then becomes an alternative for countries with large territorial waters and minimal implementation of Green Economy (Smith-Godfrey, 2016) .

To realise the implementation of the blue economy, the fisheries and aquaculture sectors play a significant role in contributing to food security and nutrition, as well as being a livelihood for hundreds of millions of people worldwide (FAO, 2021). Indonesia is the second country with the highest seafood production after China. Even in the field of aquaculture, China, India, and Indonesia were the largest contributors, accounting for 75 % of the total global aquaculture production in 2016 (FAO, 2021) . The expansion of Indonesia's maritime economy has contributed to the country's strong economic dynamism recorded since the aftermath of the 1997 Asian financial crisis, which made Indonesia the largest economy in Southeast Asia and an upper middle-income country since 2019 (OECD, 2021). It is validated that Indonesia has enormous potential in the marine and fisheries sector.

According to data published by the Ministry of Marine Affairs and Fisheries (Fig. 1) the national aquaculture production is far superior to marine capture fisheries or inland public waters capture fisheries. The production figure has increased significantly, in 2011 capture fisheries production reached 7.94 million tonnes and increased significantly every year to 15.79 million tonnes in 2018. Marine fisheries production also experienced a fairly constant increase where in 2010 data amounted to 5.04 million tonnes to 6.70 million tonnes. Based on figure above, it can be seen that Indonesia's fisheries production growth has increased quite well, namely by 32.88 % in the 2010–2018 period in marine capture fisheries production, and aquaculture production growth by 98.83 %, although in 2018 it tends to decrease (Badan Pusat Statistik, 2020).

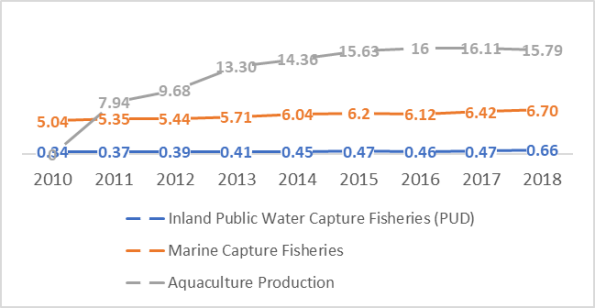

Fig. 1. Marine capture fisheries production, aquaculture and inland public water capture fisheries (million tonnes) 2010-2018. Source: Indonesian Ministry of Marine and Fisheries (2020).

Based on the data, it proved the magnitude of marine and fisheries potential owned by Indonesia. However, the enormous potential of the sea and fisheries affects climate change which then, as is likely in the future fisheries production can decrease. If over-fishing occurs, this can disrupt the climate, environment, and life of both marine biotas, to the chain of impact on humans (Cámara and Santero-Sánchez, 2019) . Central Bureau of Statistics (known as Badan Pusat Statistik Indonesia BPS) stated, although overfishing is considered to cause a decrease in fisheries production potential, natural factors such as extreme weather and changing sea conditions are also unavoidable (Badan Pusat Statistik, 2020) . Therefore, the Indonesian government stipulates the establishment of the State Fisheries Management Area of the Republic of Indonesia or abbreviated as WPPNRI into 11 areas carried out with the stipulation of the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia No. 18/Kepmen-KP/2014. The Ministry of Marine Affairs and Fisheries in determining the 11 WPPNRI refers to the concept of fishing area set by FAO. The establishment of WPPNRI was carried out to achieve the objectives of fisheries management in Fisheries Law No. 31 of 2004 and the Amendment of Law No. 45 of 2009 concerning Fisheries. The establishment of WPPNRI also aims to maintain the stability of marine life, so that fisheries production can take place sustainably (Kementerian Kelautan dan Perikanan, 2020) .

Regulations as described above should be implemented by the community, especially fishermen, concerning how they can utilise marine resources sustainably, particularly in capture fish production (CFP). Therefore, based on the WPPNRI regulations, the government's efforts aim to limit CFP and increase aquaculture production (AP). In addition to regional regulations, a pivotal regulation in maintaining the balance of marine resource exploitation is Law No. 31 of 2004 concerning Fisheries. This law comprehensively manages fisheries in Indonesia, including capture fisheries, aquaculture, and the marketing of fishery products. Specifically, overseeing capture fisheries production is governed by Minister of Marine Affairs and Fisheries Regulation No. 12/PERMEN-KP/2020 on capture fisheries operations. This regulation is the latest derivative of Government Regulation No. 54 of 2002 on Fisheries Operations. Furthermore, to enhance trade in the fisheries sector, regulations are governed by the Ministry of Trade Regulation No. 13/M-DAG/PER/3/2012 concerning the provisions of export and import of fishery products. This regulation sets standards for the quality and certification of fishery products exported to and imported into Indonesia (BAPPENAS and OECD, 2021). Regulations implemented by the government to support fisheries management in Indonesia, as mentioned earlier, have shown quite positive impacts. This is illustrated in Figure 2, which depicts the linearity of economic growth through international trade in the fisheries sector in Indonesia. In the initial period (1975–1990), international trade in the fisheries sector in Indonesia showed relatively stable but slow growth. Since the 2000s, trade in the fisheries sector has experienced significant increases, evidenced by the rise in fishery product exports supported by increased investment in fisheries infrastructure. The government has also begun to focus on the potential of its marine resources, leading to the implementation of regulations governing the fisheries sector, including WPPNRI, which regulates the areas for capture fisheries production. Subsequently, the increase in fisheries sector trade has continued to rise. One of the factors driving this trend is the high global demand for fishery products to ensure food security, particularly in achieving SDG 2 (Zero Hunger) (Latifah, 2024). Indonesia primarily targets major global markets (Ningsih, 2018) such as Japan (Sahara et al., 2022; Osmaleli et al., 2023), the European Union (Leal et al., 2016; Wiranthi et al., 2019; Nurkhasanah and Puspita, 2022), and the United States (Hartanto and Ramli, 2018; Sitompul et al., 2018; Nurkhasanah and Puspita, 2022; Sahara et al., 2022) for its fisheries exports.

As shown in Figure 2, in the early years (1976–1990), fishery trade (TRD) was relatively low and stable while Indonesian economic growth (GDP) was slowly increasing. This is also indicated by FAO data in the Fisheries and Aquaculture Statistic report, where the

production of capture fisheries (CFP) and aquaculture production (AP) were still very low. The contributing factors were the use of simple technology, and the Indonesian community at that time was still quite unfamiliar with aquaculture management. The correlation between fishery trade and economic growth experienced significant fluctuations from the early 1990s to the early 2000s. This was due to economic instability caused by external factors, such as the depreciation of the Rupiah against the US Dollar. Additionally, global demand for fishery products also declined due to very high export costs, resulting in higher selling prices that were not accompanied by an increase in market demand.

The rapid increase in both TRD and GDP post-2005 suggests improved economic conditions, technological advancements, better policies, or increased global demand for fishery products. This rising trend in TRD and GDP underscores the potential for fisheries trade to significantly contribute to economic growth. Advances in fishing technology, such as improved gear, vessels, and methods, can increase efficiency and catch volumes, thereby boosting the sector. Additionally, the availability and skills of the workforce in the fishing industry directly impact productivity. Traditional fishing practices and community management systems also play a crucial role in the sustainability of fisheries, ensuring long-term viability and economic benefits. Together, these factors highlight the intricate relationship between fisheries trade and economic development, emphasising the importance of sustainable practices, technological innovation, and skilled labour in enhancing the sector's contribution to the overall economy.

However, as in Figure 2, it can also be observed that the international trade graph in the fisheries sector and Indonesia's economic growth exhibit similar trends. Unfortunately, the contribution of the fisheries sector to Indonesia's economic growth remains relatively small compared to its marine potential. Nevertheless, the utilisation of Indonesia's marine resources, which are a potential source of wealth, must be balanced with efforts to preserve its ecosystems. This can be achieved through the implementation of the blue economy in managing Indonesia's seafood production. It is expected to enhance seafood production itself, as well as in aquaculture and international trade within the fisheries sector, thereby boosting the country's economic growth in both the short and long terms. Therefore, the concept of the blue economy should be applied to create an increasingly advanced national economy by leveraging its marine potential, without compromising the sustainability of its ecosystems.

The essence of the blue economy concept is to work in line with all the things that nature has provided to the maximum, without reducing but enriching the entities in it. The blue economy becomes one form of business

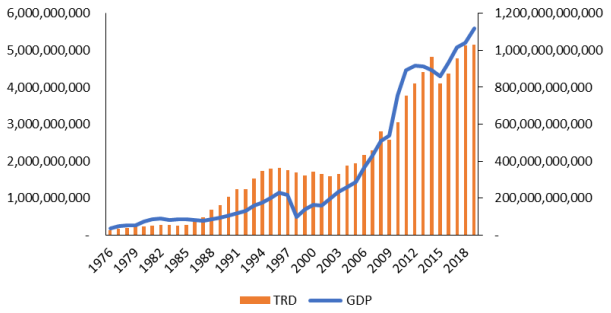

Fig. 2. Comparison of international trade in the fisheries sector on economic growth in Indonesia (1976–2019). Source: World Bank and OECD (2022).

to encourage productivity activities in aquaculture fisheries and reduce the production rate of capture fisheries. Why is that? These efforts are necessary to be implemented to preserve the environment, natural resources, and ecosystem life in the sea. Protecting natural resources and ecosystems in the sea is a thing that later became one of the same elements in the concept of the blue economy.

When discussing the blue economy, there are numerous components that must be achieved to attain the concept itself. These include sectors such as capture fisheries production, aquaculture production, marine-based industries, tourism, trade, transportation, logistics, and renewable energy (BAPPENAS and OECD, 2021). However, this study focuses on capture fisheries production, aquaculture production, and trade. The researcher aims to understand the balance that Indonesia, with its vast potential in marine resources, can achieve with the economy measured by GDP. Furthermore, the essence of the blue economy is also known for efforts to enhance societal awareness and care for the environment and marine ecosystems (Smith-Godfrey, 2016; Shahzad, 2022). This concept may appear contradictory to efforts aimed at economic growth through marine resources. Therefore, this research is crucial to shape a balanced perception regarding the optimization of marine resources through capture fisheries production, aquaculture, and fisheries trade to foster sustainable economic growth. Thus, this research is important to determine the long-term and short-term effects of seafood production on Indonesia's economic growth, as well as its significance in human responsibility for managing and preserving marine nature.

Based on the explanation above, the blue economy concept is essential for sustainable development. However, there have not been many studies that explicitly discuss the effect of seafood production on Indonesia's economic growth with a focus on natural resources and environmental review. Previous research discussed the use of seafood production for economic growth to achieve SDGs (Seymour and Busch, 2017; Cai et al., 2019) and blue economy (ALshubiri, 2018; Wenhai et al., 2019; Alharthi and Hanif, 2020; Bhattacharya and Dash, 2020; Plan Bleu, 2020; Hafidh and Mkuya, 2021; Qi,

2022) . From several previous studies mentioned, there has been no specific research addressing the short-term and long-term effects of capture fisheries production, aquaculture, and fisheries trade on economic growth in Indonesia. Moreover, this study is expected to serve as a form of mitigation against environmental risks caused by overfishing and provide input for government policies aimed at enhancing the quality of aquaculture in Indonesia.

This research aimed to develop a study on the role of fisheries production on Indonesia's economic growth using long-run and short-run analysis. In addition, the enormous potential of marine and fishery products in Indonesia is also the author's motivation in conducting this study to measure how much influence the results of seafood production have on economic growth in Indonesia so that the government and the community can develop a sustainable economy in the form of human welfare both in the world and hereafter, through the utilization of Indonesia's marine potential.

Theoretical Background

Similar research topics has previously been studied by several researchers. Previous study by ALshubiri (2018), examined and analysed empirically the impact of manufacturing marine production on GDP indicators as a comparative study in the Gulf Cooperation Council (GCC) countries. Another research on the subject was conducted by ALshubiri (2018), where he has used regression and the method is VECM. Moreover, the analytical method using VECM with similar topics has been carried out by several researchers such as Bashir et al. (2019) to know the causality between the variables used and research by Agboola et al. (2022) to project long and causal dynamics between selected agricultural sub-sectors, namely forestry, food crop production, fisheries and animal husbandry, and economic growth. Despite having a similar topic, the two studies in Indonesia by Bashir et al. (2019) and in Nigeria by Agboola et al. (2022) have differences in the variables used. The two previous studies focused on the agricultural and fisheries sector as a whole on economic growth. While this research focused on the fisheries sector by analysing the relationship of capture fisheries production (CFP), aquaculture production (AP), and international fishery trade (TRD) to economic growth (GDP) in Indonesia.

Other studies with similar topics were also conducted by Jawaid et al. (2019) Rehman et al. (2019) and Emam et al. (2021). Each study aims to find out the long and short relationship between fish exports and economic growth in eight ASEAN countries (Emam et al., 2021) . Research by Rehman et al. (2019) aims at the relationship between aquaculture and capture fisheries production and economic growth in Pakistan. Meanwhile, Jawaid et al. (2019) determined fish exports with economic growth in Pakistan. Through these three studies, researchers used the variables used by previous researchers to be redeveloped in this study, namely the variables of economic growth, capture fisheries production, aquaculture production, and international trade in the fisheries sector.

If the research by Jawaid et al. (2019) Rehman et al. (2019) and Emam et al. (2021) used the ARDL analysis method, this study offers different analytical methods that are different from the three previous studies, namely VECM, and the data used focuses on Indonesian country. The reason for researchers using Indonesia alone is so that researchers can focus on knowing the long-term and short-term relationships of marine fisheries production to economic growth. This is considered to be in line with the research of Samad et al. (2020) who conducted similar research but with a different analytical approach. In this study, a qualitative approach was used by conducting a review of the relationship between fisheries production, capture fisheries, aquaculture production and marine conservation areas on economic growth. The significant difference in this study is the analytical approach that will be carried out using a quantitative approach.

Meanwhile, Alharthi and Hanif (2020) examined the effect of the economic blue factor on the economic growth of countries that are registered as members of the South Asian Association for Regional Cooperation (SAARC). Research that uses multiple regression analysis also uses the same variables as this study. However, apart from analysing the impact of the implementation of the blue economy on economic growth. This is considered to be a novelty that the researcher wants to offer in conducting this research.

The influence of capture fisheries production on economic growth

Capture fisheries production is the most extensive human activity affecting the world's oceans. The fishing industry provides employment for around ten million people, and fish is a major traded commodity, playing a dominant role in the global economy. Capture fisheries hold significant economic, social, and nutritional importance in the poorest countries; they provide about 50 percent of animal protein consumed locally and account for about 50 percent of export income (Rehman et al., 2019).

Capture fisheries production is one of the resources available along the coast and in the sea, making it one of the most profitable biological systems on earth and representing an effective resource that can enhance the financial and economic growth of a country (Alharthi and Hanif, 2020). The utilisation of marine resources, including through capture fisheries production, is considered to have a significant impact on a country's economic growth in the long term and the short term. However, its long-term impact must also take into account the ecological and environmental conditions for the marine biota (ALshubiri, 2018).

Based on the explanation above, it shows a significant influence of the capture fisheries production variable on economic growth in the long term and short term.

Therefore, the following hypotheses can be formulated:

H1: Capture fisheries production has a long-term effect on Indonesia's economic growth.
H2: Capture fisheries production has a short-term effect on Indonesia's economic growth.

The influence of aquaculture production on economic growth

Aquaculture is considered an affordable source of high-quality animal protein and has become a crucial factor in enhancing food security, improving nutritional standards, and alleviating poverty, especially in the world's poorest countries (Tidwell and Allan, 2001). Samad et al. (2020) support this assertion, with their research indicating that the aquaculture sector can be a key driver of economic growth in Indonesia. Currently, this sector provides employment, increases income, improves livelihoods for coastal communities, generates foreign revenue, and contributes to state income.

The contribution of aquaculture to the gross domestic product (GDP) is one of the most widely used indicators of economic performance. Despite the strong interest and significant efforts made to assess the contribution of aquaculture and fisheries to GDP (Cai et al., 2019), aquaculture production is a sector that is growing at a substantial rate. It provides solutions to issues such as resource misuse and depletion while also offering employment opportunities (Alharthi and Hanif, 2020). Therefore, aquaculture plays an important role in providing alternative income options for coastal communities, and proper planning of this sector should ensure the participation of these stakeholders in the decision-making process to avoid their exclusion from the direct benefits generated by the production chain (Suplicy et al., 2017).

The creation of job opportunities will absorb a significant number of human resources, allowing aquaculture production activities to be maximised. Economic growth, as measured by gross domestic product, can be assessed through the output generated from various production sectors, including aquaculture production. If the aquaculture production sector increases, it is expected to drive the economic growth of a country. Therefore, the explanation above shows a significant influence of the aquaculture production variable on economic growth in the long term and short term. Thus, the following hypotheses can be formulated:

H3: Aquaculture production has a long-term effect on Indonesia's economic growth.
H4: Aquaculture production has a short-term effect on Indonesia's economic growth.

The influence of international trade in the fisheries sector on economic growth

Adam Smith and David Ricardo (as cited in Krugman et al., 2018) determined the influence of international trade on economic growth and the role of specialization in economic gains. The association between international markets and domestic markets provides a greater scope for economies of scale in the export sector. Ultimately, greater trade can reduce inefficiencies through competition, resulting in higher GDP growth (Jawaid et al., 2019). Fish products, from both capture fisheries and aquaculture, currently account for about 10 % of total agricultural exports, and the value of global fish trade exceeds the combined value of international trade in all other animal-source foods (Antonellini, 2021). The growth in seafood production also boosts the value of international trade in the fisheries sector, thereby driving economic growth through export and import activities.

Furthermore, fisheries trade can indirectly contribute to economic development through the creation of new jobs, increased income within the sector, and secondary effects such as migrant workers sending money back to their families and dependents at home (Kurien, 2005). This aligns with Alharthi and Hanif (2020), reveals that international trade derived from the total exports and imports in the fisheries sector has a significant variable relationship with a positive trend toward economic growth in various member countries of the South Asian Association for Regional Cooperation (SAARC). In Indonesia, the role of international trade, particularly in the field of fishery exports, is considered to have a high contribution in driving the country's economic growth rate.

Therefore, the explanation above indicates a significant influence of the variable of international trade in the fisheries sector on economic growth in the long term and short term. Thus, the following hypotheses can be formulated:

H5: International fishery trade has a long-term effect on Indonesia's economic growth.
H6: International fishery trade has a short-term effect on Indonesia's economic growth

Materials and Methods

This research is an explanatory study which provides an overview of the phenomenon being discussed. According to (Creswell and Creswell, 2018) research with a quantitative approach is carried out with empirical, concrete, rational and measurable scientific principles. The analysis was performed using statistical numbers. The VECM method was chosen to analyse the long-term and short-term effects of seafood production on Indonesia's economic growth. The time series used covers the period from 1976 to 2019. Data is obtained from various official websites, such as GDP data (USD) sourced from the World Bank website and the Indonesian Central Statistics Bureau (BPS), which the author has reprocessed. Data on capture fisheries production and aquaculture production is obtained from the statistical query panel published by the FAO. The final variable, the export

value of the fisheries sector in Indonesia, is obtained from the statistical query panel on the FAO website and the International Trade of Fisheries Commodities data published by the OECD.

The operational definitions of the variables used in this study include:

1. Economic growth

Economic growth is a variable that is shown based on the value of Gross Domestic Product (GDP) at constant prices which shows the added value of these goods and services which is calculated using prices prevailing in a certain year as a basis (Current USD).

2. Capture fishery production

Capture fisheries production (CFP) is the volume of fish caught both from sea and land multiplied by constant prices in the current year (Current USD).

3. Aquaculture production

Aquaculture production (AP) is the volume of aquaculture obtained both in the form of consumption production of aquatic life, including fish, molluscs, crustaceans, and aquatic plants and multiplied by the producer price in the current year (Current USD).

4. Fisheries sector trade

Fisheries sector trade (TRD) is the total value of exports and imports in the fisheries sector (Current USD).

There are differences in the degree of integration in each test variable, so the variable testing was carried out simultaneously to produce long-term equations through estimated error correction. Thus, it can be seen that there is cointegration between variables. The different degrees of integration in cointegrated variables were then popularised by Lee and Granger as a multicointegration test (Engle and Granger, 1987). If cointegration is not found in each of the variables, then the next test uses the results of cointegration in the first difference condition. The estimation used in the research was formulated as follows:

$$\Delta InGDP_t = \alpha e_{t-1} + \sum_{i=1}^{m} c_i \Delta InCFP_{t-1} + \sum_{i=1}^{m} d_i \Delta InAP_{t-1} + \sum_{i=1}^{m} f_i \Delta InTRD_{t-1} + \varepsilon_t$$

Where,

GDP = Gross domestic product
CFP = Capture fisheries production
AP = Aquaculture production
TRD = Trade
α = Cointegration coefficient matrix
ε_{t-1} = ECT (Error correction term)
ε_t = Residual vector

Results

Based on Table 1, it can be seen that the stationary test results for each stationary variable are at the 1st Difference level. This is justified by the probability value of each variable which is smaller than the *P*-values of 0.05, namely CFP of 0.000, AP of 0.0190, TRD of 0.0000, and GDP of 0.0280. Thus, it can be concluded that based on the stationary test results for each variable using the augmented Dickey-Fuller (ADF) test as a whole is stationary at the 1st Difference level.

The optimum lag test is carried out to determine the optimum lag length in the time series data used in a study. In addition, determining the optimum lag length serves to show how long the period will then influence the endogenous variables on other exogenous variables. Based on Table 2, it can be seen that the optimum lag test results are at lag 3 with the Akaike Information Criterion (AIC) recommendation with the most 4 stars (*). Thus, in the next test, namely the VECM test, the lag used is lag 3.

Based on the trace test (Table 3) and maximum eigenvalue test (Table 4), the statistics for "None" and "At most 1" exceed the critical values at the 5 % significance level, with *P*-values below 0.05. This indicates that there are two cointegrating relationships among capture fisheries production, aquaculture production, international trade in the fisheries sector, and long-term economic growth. These results confirm the existence of long-run equilibrium relationships among the variables.

In the estimation of the VECM test results, long-term and short-term relationships was obtained between each variable, namely, economic growth as measured by real gross domestic product (GDP), capture fisheries production (CFP), aquaculture production (AP) and international trade in the fisheries sector (TRD). The endogenous variable in this study is Gross Domestic Product, while the exogenous variables in this study are Capture Fisheries Production, Aquaculture Production, and International Trade in the fisheries sector.

Based on Table 5, it is known that the short-term estimation results between exogenous and endogenous variables in this study with CointEq are t-statistic 0.55448. The t-statistic value means that there is an estimate of the error correction parameter that is not significant. However, the positive value proves that there is a system adjustment from the short term to the long term, the magnitude of the adjustment is 0.13 %. In the endogenous variable, economic growth, there is no estimate of a significant short-term relationship, because the t-statistic value is smaller than the t-table value. Meanwhile, in exogenous variables, it is found that there is an estimation of a short-term relationship. The CFP variable has a significant effect on short-term estimates in lag 2, which means that if capture fisheries production increases by 1 % in the previous two years, economic growth will decrease by -0.625 % in the current year. The AP variable has a significant effect on short-term estimates at lag 1, which means that if aquaculture production increases by 1 it will have an impact on decreasing economic growth by -0.397 % in the current year. The TRD variable is

Table 1. Variable stationary test results at 1st difference level.

Variables	t-statistic				Prob.
	ADF	Critical Values			
		1%	5%	10%	
CFP	-5.466625	-3.600987	-2.935001	-2.605836	0.0000
AP	-3.381406	-3.646342	-2.954021	-2.615817	0.0190
TRD	-6.004906	-3.596616	-2.933158	-2.604867	0.0000
GDP	-4.069050	-3.596616	-2.933158	-2.604867	0.0280

ADF: augmented Dickey-Fuller, CFP: capture fish production, AP: aquaculture production, TRD: trade, GDP: gross domestic product.

Table 2. Optimum lag test results.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.980	NA	7.48e+59	149,2161	149,3850	149,2772
1	-2.948	57,38819	3.25e+59	148,3764	149,2209*	148,6818
2	-2.919	44,86721	1.74e+59	147,7291	149,2491	148,2787
3	-2.891	36,78113*	1.06e+59*	147,1668*	149,3624	147,9607*

LR: likelihood ratio, FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz criterion, HQ: Hannan-Quinn criterion. * indicates optimal lag order per criterion.

Table 3. Trace test results.

Hypothesised number of CE(s)	Eigenvalue	Trace statistic	Critical value (0.05)	Prob.**
None *	0.728129	9.856.234	5.407.904	0.0000
At most 1	0.556540	4.516.284	3.519.275	0.0031
At most 2	0.177941	1.182.381	2.026.184	0.4647
At most 3	0.088299	3.790.162	9.164.546	0.4443

* null hypothesis rejected at 5% → There is cointegration, ** refers to the probability (*P*-value) used for significance testing.

Table 4. Maximum eigenvalue test results.

Hypothesised number of CE(s)	Eigenvalue	Trace statistic	Critical value (0.05)	Prob.**
None *	0.728129	5.339.951	2.858.808	0.0000
At most 1	0.556540	3.333.902	2.229.962	0.0010
At most 2	0.177941	8.033.648	1.589.210	0.5437
At most 3	0.088299	3.790.162	9.164.546	0.4443

* null hypothesis rejected at 5% → There is cointegration, ** refers to the probability (*P*-value) used for significance testing.

Table 5. Short term estimation results of vector error correction model (VECM).

Short-term			
Variables	Coefficient	t-statistic	Information
CointEq	0.134542	[0.55448]	Insignificant
D(GDP(-1))	-0.391532	[-1.50818]	Insignificant
D(GDP(-2))	-0.225879	[-1.02025]	Insignificant
D(CFP(-1))	-0.110180	[-0.83528]	Insignificant
D(CFP(-2))	-0.625008	[-6.00890]	Significant
D(AP(-1))	-0.397349	[-3.56089]	Significant
D(AP(-2))	0.102911	[0.76676]	Insignificant
D(TRD(-1))	-0.736022	[-4.56570]	Significant
D(TRD(-2))	-0.498159	[-3.45580]	Significant

t-table = 2,016692 at 5% significance
t-table obtained from the value df = n-k

significant in lags 1 and 2, which means that if there is an increase in international trade in the fisheries sector by 1 % in the previous year, it will have an impact on decreasing economic growth by -0.736 % and an increase of 1 % in the previous two years, it will have an impact on economic decline of -0.498 %.

Table 6 shows the long-term estimation results of exogenous variables on endogenous variables. Based on the data, it is known that the two exogenous variables, namely CFP and AP, have a significant effect on economic growth in the long term. However, the CFP coefficient is -247648.4 which indicates a negative relationship. Likewise, the AP variable with a coefficient value of -41551.41 also shows a negative relationship. While the TRD variable is not significant, this means that international trade in the fisheries sector does not have a significant effect on economic growth in the long term.

As for the results of the impulsive response function (IRF) test, each independent variable on the dependent variable produces a shock in the first 10 periods and begins to stabilise after the 11th period. The shocks to the independent variable to the dependent variable occur due to factors outside the size used in research, for example, fishermen's exchange rates, inflation, prices of goods in the market. Whereas in the results of the variance decomposition test, each variable makes a major contribution to the measurement of its own variable in the first period. The change in the period every year also reduces the contribution of each variable as a whole.

Discussion

The effect of capture fisheries production on economic growth in Indonesia

Based on the results of the analysis, it shows that capture fisheries production has a significant influence on economic growth in Indonesia both in the short and long term. In the estimation of short-term influences, the variable capture fisheries production (CFP) has a significant effect on economic growth with a coefficient value of -0.625, which shows that every 1 % increase in marine fisheries production will affect on decreasing economic growth by 0.625 % in the short term. The negative value should have no effect because of its small value. The results of this analysis are in line with research by (Rehman et al., 2019) which states that capture fisheries production has a significant influence on economic growth in Pakistan. In addition, similar analysis results were also found in ALshubiri (2018) study which used marine production variables proven that significantly affect economic growth in GCC member countries. Furthermore, the results of this study also detail the results of Alharthi and Hanif (2020) research which uses the variable of total fishery production which has a significant effect in the short term on economic growth.

In the forecasting test results, the production value of capture fisheries is predicted to increase from 2019 worth IDR7,524,705 to IDR7,709,196 (USD 533.52–USD 546.68) in 2020. Long-term estimates also show a significant value in capturing fisheries production on economic growth. This proves the research hypothesis that H1 capture fisheries production has a significant effect on economic growth in the long run and H2 capture fisheries production has a significant effect on economic growth in the short term. Although it seems to produce good data on Indonesia's economic growth, the increase in the value of capture fisheries production in the long run can harm marine resources and ecosystems in it and this is contrary to the concept of blue economy.

As in the blue economy concept plays a role in encouraging economic growth, social inclusion and improving the livelihoods of coastal communities through sustainable use of marine resources, and preserving the environment and ecosystems in the sea (Qi, 2022). In increasing the production of capture fisheries that have the potential to encourage the rate of economic growth in Indonesia, several things are needed that also function in preserving the marine environment. Apart from the government's efforts to increase the productivity of capture fisheries in Indonesia, there is a challenge that must be faced, namely that 38 % of Indonesia's fisheries production activities are carried out excessively (overfishing). More than 600,000 vessels sailing in small-scale fishing domestically are not supervised and properly regulated (Kaczan and Aquino, 2021). This is considered to threaten the life of creatures and ecosystems in the sea, especially in certain species which are fewer in nature, and one-third of coral reefs in Indonesia are also not treated and are in quite poor condition (Lembaga Ilmu Pengetahuan Indonesia, 2020). This uncontrolled capture fisheries production

Table 6. Results of long-term estimation of vector error correction model (VECM).

Long-term			
Variables	Coefficient	t-statistic	Information
D(CFP(-1))	-247648.4	[-2.50427]	Significant
D(AP(-1))	-41551.41	[-4.28454]	Significant
D(TRD(-1))	6.169.962	[1.20608]	Insignificant

t-table = 2,016692 at 5% significance
t-table obtained from value df = n-k

activity also affects marine debris that damages tourism, fisheries, shipping, and ecosystems, also costs the Indonesian economy at least USD450 million per year (McIlgorm et al., 2020).

Based on the analysis, it is necessary to implement strategies that the government can undertake in capture fisheries production activities to enhance economic growth while preserving the natural environment and ecosystems in Indonesian waters. As with several existing government programs, new developments and strategies are needed in their implementation, including:

1. Optimisation of the Indonesian State Fisheries Management Area (WPPNRI)

Currently, Indonesia has established and is operationalising a marine spatial planning initiative known as the Indonesian State Fisheries Management Area (WPPNRI). WPPNRI aims to identify marine areas tailored to regional conditions, economic activities, and potential resources for controlled management and protection by the government. Moving forward, the government through WPPNRI can implement a "scorecard" system to provide training and discipline for fisheries stakeholders. This scorecard system also measures the status of coastal and marine resources, such as mangrove forest quality and coral reef quantity. In the long term, Indonesia can implement a Spatial Title Registry system in the development of marine and coastal cadasters to avoid potential issues arising from marine and surrounding area utilisation.

2. Enhancing private sector involvement in capture fisheries production management

The Indonesian government can also enhance the role of the private sector by granting rights aimed at supporting production, management, and utilisation of marine resources by private entities. This approach encourages decentralised activities, allowing local communities or private entities to understand the characteristics of their marine resources. This is expected to boost productivity among fishermen and seafood producers, thereby enhancing economic growth. High marine productivity also promotes national economic growth.

3. Mangrove restoration efforts

To safeguard the environment and marine ecosystems affected by capture fisheries production, the government can engage in planned mangrove restoration efforts targeted for completion by 2025, covering an area of 600,000 hectares. Apart from mitigating natural disasters such as tsunamis, mangrove restoration aims to strengthen coastal conservation efforts. The establishment of mangrove forests is also expected to provide new habitats for coastal and marine life. Therefore, mangrove forest creation aims not only to elevate economic standards and improve coastal community welfare but also to sustain biodiversity and environmental integrity in marine surroundings.

The effect of aquaculture production on economic growth in Indonesia

Based on the analysis results of the analysis of short-term estimates, aquaculture production has a significant influence on economic growth in Indonesia, with a coefficient value of -0.397. The point is that if aquaculture production increases by 1%, it will have an impact on decreasing economic growth by -0.397% in the current year. Although negative, the predicted decline indicates a small-scale, so in the long run-term will have no effect. In addition, the results acknowledge ALshubiri (2018) which shows that aquaculture production variables have a significant effect on economic growth in GCC member countries. Thus, it can be said that the wealth of marine potential owned by Indonesia is one of the factors that encourage the significance of aquaculture production to economic growth. Although for now, aquaculture production in Indonesia is still not optimal (Ministry of Marine and Fisheries, 2020) .

Furthermore, the results of this study are also in line with the findings Alharthi and Hanif (2020) which state that SAARC countries have the potential to use aquaculture as an engine of economic growth. More importantly, SAARC countries concerning to geographical location are located in such areas with enormous opportunities and possibilities for aquaculture development. Thus, if SAARC member countries have the potential to develop and improve their aquaculture, so in the long term it will significantly affect Indonesia's economic growth.

Meanwhile, Rehman et al (2019) in their research show the opposition of the results of short-term analysis of aquaculture production variables to Indonesia's economic growth. It proved that the variable production of aquaculture is insignificant to the economic growth in Pakistan. This outcome is attributed to the relatively underdeveloped state of aquaculture in Pakistan, where technological adoption and the implementation of fish farming practices remain limited and are only recently gaining traction. While in Indonesia, fish farming has started since 1950 and this has definitely became an advantage for Indonesia in aquaculture production after China (Effendi and Mulyadi, 2012).

In the results of long-term estimates, aquaculture production variables show a significant influence on Indonesia's economic growth. This result is in line with several previous studies such as the long-term effect of aquaculture production on the economic growth of GCC member countries (ALshubiri, 2018), SAARC (Alharthi and Hanif, 2020), and Pakistan (Rehman et al., 2019). The positive and significant influence of aquaculture production on economic growth in

Indonesia is expected to reduce capture fisheries production in the long term. It aims to maintain the survival of the ecosystem in the sea. In addition, the form of aquaculture production is considered much more effective and efficient in improving the standard of living of coastal communities.

Aquaculture is currently one of the fisheries sectors that has begun to be developed vigorously, since the introduction of the blue economy concept to encourage the economies of countries that have great maritime potential and other developing countries (Potts et al., 2016). Although Indonesia is rich in marine potential, in terms of fish farming, it is still far behind China which can produce aquaculture up to 66.13 million tonnes in 2018, while Indonesia in 2018 only produced 14.77 million tonnes (FAO, 2021). Therefore, the implementation of the blue economy in the structure of the Indonesian economy is expected to boost aquaculture production activities to encourage better economic growth.

The implementation of the blue economy concept in achieving its goal of encouraging economic growth has also been developed in Indonesia with several strategies, such as starting to develop a lot of financial technology that provides financing to the community to start a business in fish farming and encourages farmers to grow. One of the fintech in the field of fish farming is e-Fishery which was formed in Bandung, West Java in 2013. In addition to providing financing to fish farmers, e-Fishery also develop internet-based digital auto feeders that can be operated via farmer's smartphones, and can be adjusted to the needs of the species produced, so that feeding can be more efficient (Minapoli, 2021) .

Based on the vision carried out by eFishery with the vision "to become the leading digital innovation ecosystem in marine and fisheries in Indonesia", this has inspired innovation and collaboration, serving as an ecosystem to drive further innovations. Currently, more than 30 startups in aquaculture and fisheries have joined the Digifish Network. Some of these companies focus on sensors and IoT-based devices for rapid and accurate water parameter checks, including Jala*, FisTx, AquaEasy, Pictafish, and AquaReader. Additionally, there are those specialising in water treatment such as Nanobubble, Venambak and Banoo, which provide machines to optimise dissolved oxygen (DO) (Minapoli, 2021).

In addition, there are several fintech companies focusing on providing financing to fish farming businesses and creating markets for them to enhance the quantity and quality of aquaculture production. Through various fintech platforms aimed at meeting the needs of fish farmers, it is hoped that these initiatives can assist the government in boosting aquaculture production, albeit on a limited national scale. Other efforts that can be undertaken by the government include optimising the goals previously formulated by the Ministry of Marine Affairs and Fisheries in Indonesia, such as:

1. Implementing the development of national flagship commodities in aquaculture production.
2. Protecting and empowering fish farming businesses through the provision of business insurance and aquaculture supply packages.
3. Developing independent fish feed production by establishing medium and large-scale fish feed factories and distributing fish feed to fish farming entrepreneurs.
4. Producing superior broodstock and acquiring high-quality fish seeds.
5. Managing fish health by issuing certification for cultured fish to enhance the quality of fish produced and improve environmental management in both marine and inland aquaculture.
6. Engineering, disseminating, and innovating technologies that support sustainable aquaculture production.

The effect of international trade in the fisheries sector on economic growth in Indonesia

Based on the results of the analysis of short-term and long-term estimates, international trade variables in the fisheries sector on economic growth showed insignificant results in both prediction (Tables 5 and 6). The results above are contradictory to several previous studies that showed significant analysis results on international trade variables in the fisheries sector on economic growth (Jaunky, 2011; Jawaid et al., 2019; Alharthi and Hanif, 2020). Thus, hypothesis H5: International trade in the fisheries sector has a long-term effect on Indonesia's economic growth, is rejected, and H6: International trade in the fisheries sector has a short-term effect on Indonesia's economic growth, is accepted. The rejection of the hypothesis on long-term influences can be influenced by several factors that are the reason why international trade in the fisheries sector does not significantly affect economic growth in Indonesia.

Therefore, the implementation of a blue economy in increasing economic growth through international trade in the fisheries sector can overcome the obstacles confront by Indonesia to increase the value of its international trade. There are several strategies in the blue economy concept that can be implemented by the government to encourage seafood production activities so it will increase the international trade in the fisheries sector.

Firstly, decentralise authority to improve fisheries management. This strategy is complemented by the establishment of a fisheries management authority to decentralise and improve fisheries management. With this strategy, the government has successfully

initiated a number of instruments including levies and levies on fisheries permits, to ensure sustainable use of resources and take steps to adopt better marine spatial planning (BAPPENAS and OECD, 2021). Build infrastructure in seafood processing such as cold storage, which used as a warehouse for storing seafood products. During this time, marine concepts have been restricted and marginalised in the curriculum, due to the community's lack of knowledge of seabed principles and inability to make sound judgments. The construction of cold storage is also expected to improve the quality of Indonesian seafood products so that they can meet international standards for trading (Sitompul et al., 2018) .

Increase public literacy about marine affairs is also one of strategies which is essential to help students develop the knowledge, skills, and attitudes necessary to preserve the environment in the future, particularly coastal ecosystems. During this time, marine concepts have been restricted and marginalised in the curriculum, due to the community's lack of knowledge of seabed principles and inability to make sound judgments. Raising public awareness of the importance of ocean conservation through education would be ideal if education experts were also taught about marine literacy. Ocean literacy is a strategy not only to raise public awareness about the ocean, but also to encourage all communities and stakeholders to act more responsibly and intelligently concerning the ocean and its resources.

Last but not least is innovating in the field of fisheries. Technological innovations that help move aquaculture offshore and allow it to be carried out under submerged cages, increase the production efficiency of integrated multi-trophic aquaculture, and introduce automation in hatchery operations for fish and other aquaculture animals, as well as marine farms, will all contribute to blue growth gaining traction. For the health and integrity of marine ecosystems, disruptive technologies will present new challenges. Marine biologists and fisheries scientists must continue to mobilize to investigate the technological implications for the long-term sustainability of the oceans (BAPPENAS and OECD, 2021).

Conclusion

This research examined the long-run and short-run capture fisheries production, aquaculture production and international fisheries trade to economic growth in Indonesia. The study utilised time series data from BPS, World Bank, FAO, and OECD using the VECM analysis. Based on the analysis and discussion above, the following conclusions can be drawn in line with the objectives of this study:

1. The variable of capture fisheries production has a significant short-term and long-term effect on Indonesia's economic growth.
2. The variable of aquaculture production has a significant short-term and long-term effect on Indonesia's economic growth.
3. The variable of international trade in the fisheries sector has a significant short-term effect and a non-significant long-term effect on Indonesia's economic growth.

In light of the findings presented in the analysis and the subsequent discussion, several key conclusions can be drawn, aligning with the core objectives of this study. Firstly, it is evident that the variable representing capture fisheries production exerts a substantial and significant long-term impact on the economic growth of Indonesia. Moreover, this same variable holds a noteworthy short-term influence on the country's economic growth, as observed in the data. Additionally, the variables related to aquaculture production emerge as significant contributors to Indonesia's economic growth, both in the long term and short term. Conversely, international trade variables within the fisheries sector are found to have an insignificant long-term effect on Indonesia's economic growth, while in the short term, they display a notable and significant influence. These comprehensive conclusions provide valuable insights into the complex relationship between fisheries production, international trade, and economic growth in Indonesia.

Although capture fisheries production is significantly influential to Indonesia's economic growth, it is supposed to balance with the preservation of living things and the marine environment. Therefore, maintaining the sustainability of marine ecosystems is essential to ensure that economic growth remains on a positive and sustainable trajectory. Aquaculture production also has a significant influence on economic growth in Indonesia, although its value is still very low, so it needs to be increased. Meanwhile, on the variable of international trade in the fisheries sector, there was no significant influence on Indonesia's economic growth. The results of the analysis are contrary to some previous studies, and it proved that several factors cause the absence of significance in the short and long term. The enormous potential of marine sectors in Indonesia should be equal to the significant influence of international trade in the fisheries sector on economic growth. Therefore, it is necessary to implement several strategies to maximise seafood production and increase the international trade system in the fisheries sector in Indonesia.

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