Journal of Global Economy, Business and Finance (JGEBF) ISSN: 2141-5595
DOI: 10.53469/jgebf.2024.06(07).08

The Correlation between Marine Fishery Economy, Fishermen's Fishery Investment and Fishery Science and Technology Progress based on VAR Model: A Case Study of Zhoushan Fishery

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Abstract: ***The economic growth of marine fisheries is an important driving force for the high-quality development of the marine economy. Technological innovation in marine fisheries and investment in fishermen's fisheries are two basic elements that promote the economic growth of marine fisheries. However, there is little literature that delves into the internal relationship between the three. This article first constructs a model for the internal relationship between fishermen's fishery investment, fishery technology innovation, and marine fishery economic growth, and captures relevant data on marine fisheries in Zhoushan City from 2000 to 2021. Based on this, a VAR model is used for empirical research. The research results indicate that: (1) there is a significant positive mutual promotion effect between fishermen's fishery investment and marine fishery economic growth; (2) The progress of marine fishery technology and the growth of marine fishery economy also have a significant positive mutually promoting effect; (3) The investment expenditure of marine fishermen on fisheries has a certain positive effect on the progress of marine fishery technology, but the progress of marine fishery technology has no impact on the investment expenditure of fishermen on fisheries. Therefore, in order to achieve high-quality development of the marine economy, attention should be paid to the guidance of fishermen's fishery investment, further improve the market protection mechanism of fishermen's investment expenditure, and strengthen technological innovation in marine fisheries to promote high-speed growth of the marine fishery economy.***

Keywords: Marine fishery economy, Fishermen's fishery investment expenditure, Progress in fishery science and technology, VAR, Zhoushan fishing ground**.**

1. Introduction

The development of the marine economy plays a pivotal role in China's comprehensive promotion of the construction of a strong maritime nation (Li et al., 2023). In the marine economic system, marine fishery is an irreplaceable and important part of it. According to data from authoritative departments, in 2023, the marine fishing and aquaculture industry created an output value of 712.775 billion yuan. Therefore, China should make every effort to tap the strong integration capacity of marine resources, and step up the construction of an all-round marine science and technology innovation network, which will promote China's marine economy to realize smooth and efficient rapid growth (Sun et al., 2023). At the same time, in the application of marine fishery economy and science and technology, the majority of fishermen play an indispensable role in driving the fishery industry chain and its related economic activities forward (Khan et al., 2023). The prosperous development of marine fisheries undoubtedly highlights the significance of building a blue "granary", reconciling the relationship between fishermen and scientific and technological progress, and thus promoting the steady progress of China's marine economy. Unfortunately, however, the current theoretical research has not paid sufficient attention to the key role played by fishermen in marine fisheries investment. As the most typical Zhoushan fishery in China, the development of marine fishery science and technology interacts with the investment in all aspects of the fishery industry, and the further enhancement of fishery science and technology promotes the vigorous development of the marine fishery economy. Therefore, this thesis hopes to build a linkage model among fishery, fishermen and science and technology by using vector autoregression, aiming to deeply analyze the high-quality development strategy of marine fishery in Zhoushan fishery and provide theoretical references for the development planning of other coastal fisheries and even the national marine economy.

2. Literature Review

The party in the twentieth report put forward to strengthen agricultural science and technology and equipment support, and in the 2023 Central Document No. 1 similarly put forward to strengthen agricultural science and technology innovation (Padilla-Pérez and Gaudin, 2014), clear fishery science and technology progress as an important part of the high-quality development of the marine fisheries economy (Chen et al., 2024). As one of the traditional pillar industries of marine industry, marine fishery plays an important role in the development of marine economy (Kauer et al., 2024). Zhoushan fishery, as the fifth largest fishery in the world, has unique location advantages and is also the most typical fishery in China. Therefore, exploring the factors of marine fishery economic growth in Zhoushan fishery is of exemplary significance for promoting the high-quality development of China's overall marine fishery economy (Fu et al., 2022a). On the one hand, marine fishery scientific and technological progress not only makes marine fishery scale farming (Fu et al., 2022b), but also improves fishery increment , as well as through the use of C-D production function and Solow residual value method, it is calculated that the contribution rate of marine fishery scientific and technological progress in the coastal area is higher than 55% , and marine fishery science and technology has become the main driving force for the growth of marine fishery (Ma et al., 2024). Fisheries science and technology progress can promote the high quality development of the marine economy by promoting the upgrading of marine industrial structure and enhancing the conduction path of marine labor productivity (Lin et al., 2019). At the same time, the rapid growth of the total output value of marine fisheries will also promote the progress of fishery science and technology, and promote the investment of social capital. More scholars have studied the growth factors of marine fishery economy from the aspects of marine industry structure (N'Souvi et al., 2023), building a cooperation platform for marine science and technology high-end academics and industry development , etc. as well as applying vector autoregressive model (PVAR) to analyze the dynamic relationship between scientific and technological innovations, total factor productivity, and economic development of the oceans and seas (Liang, 2023), but most of them select provincial level data as the object of the study . The following is a summary of the data.

On the other hand, Robert Merton Solow, a western economist, believes that the mechanism of economic growth is based on three major elements, which are manpower, investment and technology (Yao et al., 2023). Through the analogy method, whether in industry, agriculture is equally applicable, so in analyzing the economic growth of marine fisheries should consider the relationship between the three, scientific and technological progress will improve the efficiency of fishery production also means to increase the income of fishermen (Morzaria-Luna et al., 2020). In the process of fishermen's income growth, it promotes fishermen's capital investment in fishery aquaculture and fishing, but along with the progress of fishery mechanization will bring the high cost of fishermen's production (Sovacool et al., 2024). Through the FGLS test provincial panel data, it is concluded that when the mechanization reaches a certain level will reduce the living standard of fishermen, and then the progress of fishery science and technology will affect the fishermen's production expenditures, and to a certain extent will slow down the growth rate of the marine fishery economy (Jiang and Li, 2021).

In summary, quantitative and qualitative analysis of fishery science and technology progress and marine fisheries economy and fishermen to increase income and other aspects of the study more, but few scholars will be the most important main body of fishermen in the marine fisheries self-investment in the role of the combination of the study, but the use of economics Cobb Douglas C-D production function of the fisheries analysis of the fisheries of Fujian Province and Shandong Province, resulting in the contribution of the growth of the marine fisheries economy, the capital input is greater than the labor input . In order to better understand the mechanism of influence between the three, based on the development trend of marine fisheries and carrier magnitude, this paper selects the data related to marine fisheries in Zhoushan City from 2000 to 2021, and constructs the VAR model to explore the correlation between the marine fisheries economy, fishermen's fishery investment and fishery scientific and technological progress, as well as the influence effect between the variables. It is hoped that it will enrich the research content of marine fishery economic development and provide policy insights for promoting the high-quality development of China's marine fishery.

3. Research Design

3.1 VAR Model Construction

Traditional economic theory is difficult to accurately explain the dynamic links between variables. 1980 Christopher Sims proposed the VAR model (Vector Autoregressive Model), which is not based on economic theory, and adopts the form of multi-equation linkage, in which the endogenous variables are regressed on the lagged values of all the endogenous variables of the model in each equation of the model(Clements and Mizon, 1991), to estimate the dynamic relationship of each variable, which is then used to predict the interconnected time series system and analyze the dynamic shocks of random disturbances to the system of variables, so as to explain the impact of various economic shocks on the formation of economic variables (Keating, 1990). The VAR model is one of the classic models for studying such dynamic changes.

In any system (or model), there are a number of variables, of which the dependent and independent variables are called endogenous variables (Aydin and Cavdar, 2015). Endogenous variables usually refer to variables, defined by economic factors "theoretically necessary to explain the variables" are variables that are determined by economic factors within the economic mechanism, independent variables that are not affected, but are controlled by external conditions that may also affect the modeled system. It is often difficult to distinguish between endogenous and exogenous variables. To avoid this error, the VAR model considers each variable as an endogenous variable. After determining the optimal lag order the lagged endogenous variables are brought into the model and become explanatory variables, and then the dynamic relationship between each variable is investigated.

The VAR model is constructed in the form:

$$Y_t = \alpha + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_\rho Y_{t-\rho} + \varepsilon_t \quad (1)$$

Eq. (1) where: is the m-dimensional endogenous variable in period t,; is the corresponding parameter to be estimated; p is the lag of the m-dimensional endogenous variable and the model is not contemporaneously correlated; and is the disturbance term.

3.2 Data Sources and Selection of Indicators

The article selects the time series data from 2000-2021, which comes from Zhoushan City Statistical Yearbook. Considering the limitation of sample capacity and the availability of data, the indicators are selected as follows:

(1) Marine fishery economy (gdp): this paper uses Zhoushan City's marine fishery gross domestic product GDP as a measure of the economic growth of marine fisheries (Meng et al., 2024);

(2) Fishermen's investment in fisheries (IN): fishermen's expenditures on fishing and aquaculture as the sum of fishermen's expenditures on fisheries as a measure of fishermen's investment in marine fisheries production (García-de-la-Fuente et al., 2020);

(3) marine fisheries science and technology progress (th):

according to the fishery science and technology development plan to achieve fishery equipment science and technology significantly improve the degree of mechanization of fishing vessels to measure the level of scientific and technological progress in the means of production, and marine fisheries operations are dependent on the vessel, so the degree of vessel mechanization will determine the degree of productivity as well as improve the efficiency of production (Koričan et al., 2023), so take the end of the year fishery production vessel mechanical total power (unit / kW) Therefore, the total mechanical power of fishery production vessels at the end of the year (unit/kW) is taken, including production vessels and auxiliary vessels, etc., as the scientific and technological progress of fishery.

In order to eliminate the effect of heteroskedasticity in the time series, it is necessary to process the data of Zhoushan City's gross marine fishery product, fishermen's marine fishery investment, and the power of the fishery production vessels at the end of the year i.e. to take the logarithm of the data, which are recorded as: lngdp, lnin, lnth, respectively. The measurement software used in this study is stata16.0.

4. Empirical Results and Analysis

4.1 Data Unit Test

VAR theory requires that each time series variable entering the model is a smooth sequence, and if the time series variables are not flat, the time series variables need to be differenced, and a VAR model is established for the series that are smooth after differencing, and then the differenced variables are further analyzed. When analyzing time series data, regression between multiple trending time series often results in an otherwise non-existent regression relationship due to indirect and temporal correlation, and pseudo-regression occurs to bias the estimated and tested statistics (Zeeshan et al., 2024). In order to rule out this possibility, the ADF test was performed on the logarithmized time series as shown in Table 1. The results show that the ADF test for all the series cannot reject the original hypothesis at 1% significance level, which indicates that all the sample variables in this study are non-stationary, but their first-order differences are all stationary series at the same confidence level, so all the variables are first-order single-integrated series, and they are in the same-order single-integrated relationship with each other.

Table 1: ADF test results

Variable	Z(t)	1% threshold	reach a verdict
lnin	-0.711	-3.750	non-stationary
dlnin	-4.303	-3.750	smoothly
lngdp	-0.023	-3.750	non-stationary
dlngdp	-3.042	-3.750	smoothly
lnth	-0.155	-3.750	non-stationary
dlnth	-3.163	-3.750	smoothly

4.2 Final Variable Descriptive Statistics

After all three variables are smooth series by first-order differencing at the same confidence intervals, the descriptive statistics of the data for the final choice of variables are analyzed as shown in Table 2.

Table 2: Statistical description of the data for the final selection variables

Variable	Obs	Mean	Std. Dev.	Min	Max
dlngdp	21	0.067329	0.0741013	-0.0651894	0.2267256
dlnth	21	0.0099739	0.0342553	-0.0735474	0.0720167
dlnin	21	0.0373413	0.0694776	-0.1027155	0.2043924

4.3 Determination of Lag Order

The estimation of the VAR model requires the selection of the optimal lag of the model, which the article determines by minimizing the information criterion. The value of each information criterion of the VAR model set by the article is shown in Table 3.From the table, it can be seen that the value of each information criterion of the VAR model constructed by the article FPR, the article uses Akaikei Information Criterion (AIC), Schwarz Criterion (HQIC) and Hannankei (BIC) to select the optimal lag order respectively(Ma et al., 2022), and the result shows that the article should select the optimal lag of 4 periods, so the article sets the VAR The lag selected by the model is 4 periods.

Table 3: Information criterion value and optimal lag of VAR model set in the article

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	80.7128				2.1e-08*	-9.14806	-9.12806	-8.99564*
1	87.0132	12.601	9	0.182	3.0e-08	-8.82508	-8.76662	-8.23693
2	93.6559	13.286	9	0.150	4.5e-08	-8.54545	-8.44554	-7.51849
3	111.097	34.882	9	0.000	2.4e-08	-9.59467	-9.39465	-8.07045
4	122.5023	22.81*	9	0.007	4.7e-08	-9.82377*	-9.63376*	-7.791228

4.4 Vector Autoregressive Estimation, Wald Test

According to the optimal lag order derived from Table 3, the VAR model regression estimation of each variable is shown in Table 4. (1) Fishermen's fishery investment expenditures and fishery science and technology progress for the development of marine fishery economy have a promotional effect, in the lag of 4 periods after the development of marine fishery economy have a positive promotional effect at a significant level of 5%, 1%, respectively. (2) Marine fishery economy for fishery science and technology progress there is a significant role in promoting, and at a significant level of 1% there is a positive role in promoting; fishermen fishery investment in marine science and technology progress there is a smaller effect of promotion. (3) The marine fishery economy has a promotion effect on fishermen's investment expenditure and has a positive promotion effect at a significant level of 1%, but fishery science and technology progress has no effect on fishermen's investment expenditure, which indicates that fishery science and technology progress will increase the production cost of fishermen, but fishermen play an inhibitory role in fishery investment expenditure.

In order to determine the joint significance of the equations and the coefficients of each order of the equations, this paper performed the Wald test, and the results were all significant see Table 5, which allows for subsequent testing.

Table 4: Estimation results of VAR model set up in the article

explanatory variable	Variable	Coef.	Std. Err.	z	P	[95% Conf. Interval]	
dlngdp	dlngdp						
	L1	1.0894	0.3325	3.28	0.001	0.4376	1.7412
	L2	0.4337	0.3647	1.19	0.234	-0.2811	1.1487
	L3	-0.3946	0.3431	-1.15	0.2501	-1.067	0.2778
	L4	-1.2249	0.5494	-2.23	0.0261	-2.3017	-0.1480
	dlnth						
	L1	-0.6322	0.6712	-0.94	0.346	-1.9470	0.6834
	L2	-0.1879	0.7325	-0.26	0.798	-1.6236	1.2477
	L3	2.4414	0.7644	3.19	0.001	0.9431	3.9397
	L4	-0.9223	0.8675	-1.06	0.288	-2.6226	0.7779
	dlnin						
	L1	-1.3083	0.5042	-2.59	0.009	-2.2967	-0.3199
	L2	-0.3515	0.3639	-0.96	0.335	-1.0667	0.3637
	L3	0.7299	0.3365	2.17	0.030	0.7087	1.3895
	L4	0.2762	0.3310	0.83	0.404	-0.3726	0.9251
	cons	0.1074	0.3992	2.69	0.007	0.2918	1.8570
dlnth	dlngdp						
	L1	0.3850	0.1204	3.20	0.001	0.1489	0.6211
	L2	0.2978	0.1321	2.25	0.024	0.3887	0.5568
	L3	0.4637	0.1242	3.73	0.000	0.2201	0.7073
	L4	-0.1268	0.1990	-0.64	0.524	-0.5168	0.2632
	dlnth						
	L1	-0.8757	0.24314	-3.60	0.000	-1.3522	-0.3991
	L2	0.4700	0.2653	1.77	0.076	-0.0499	0.9901
	L3	0.2092	0.2768	0.76	0.450	-0.3339	0.7519
	L4	-1.1049	0.3142	-3.52	0.000	-1.7208	-0.4891
	dlnin						
	L1	-0.4102	0.1826	-2.25	0.025	-0.7682	-0.0522
	L2	-0.4203	0.1321	-3.18	0.001	-0.6794	-0.1612
	L3	-0.4126	0.1218	-3.39	0.061	-0.6514	-0.1737
	L4	-0.2178	0.1199	-1.82	0.001	-0.4528	0.1722
	cons	0.1600	0.1446	1.11	0.268	-0.0123	0.4434
dlnin	dlngdp						
	L1	0.9501	0.2257	4.21	0.000	0.5077	1.3925
	L2	-0.1776	0.2475	-0.72	0.473	-0.6628	0.3076
	L3	-0.6290	0.2328	-0.27	0.007	-1.0855	-0.1726
	L4	-0.0617	0.3728	-0.17	0.868	-0.7926	0.6690
	dlnth						
	L1	0.20495	0.4559	0.45	0.653	-0.6879	1.0978
	L2	-0.2182	0.4971	-0.44	0.661	-1.1926	0.7561
	L3	1.4550	0.5188	0.28	0.779	-0.8713	1.1623
	L4	-0.6151	0.5887	-1.04	0.296	-1.7691	0.5387
	dlnin						
	L1	-0.6978	0.3422	-2.04	0.041	-1.3686	-0.0270
	L2	-0.0492	0.2476	-0.20	0.842	-0.5347	0.4361
	L3	0.4536	0.2283	1.99	0.047	0.0599	0.9012
	L4	-0.1821	0.2246	-0.81	0.417	-0.6225	0.2582
	cons	0.5810	0.2709	2.14	0.032	0.0439	0.1112

Table 5: Ward's test

lag	Chi2	df	P
1	50.8188	9	0.000
2	32.1916	9	0.000
3	67.3131	9	0.000
4	34.0324	9	0.000

4.5 Stability Test and Residual Autocorrelation Test

To determine whether the estimation results of the VAR model are correct, it is necessary to perform the autocorrelation test of the residuals and further verify whether this VAR system is stable. In this paper, the autocorrelation test of the residuals of the estimated results of the VAR model is carried out firstly by performing the LM test, and the results are shown in Table 6. The results show that the original hypothesis "no autocorrelation of residuals" can be confirmed, indicating that there is no autocorrelation of residuals. The results of the further serial correlation test are shown in Table 7, which shows that the original hypothesis of "no autocorrelation" can be accepted, and there is no autocorrelation in the series. Finally, the article through the VAR system stability of the discriminant diagram to test the article set the stability of the VAR system, the discriminant diagram is shown in Figure 1. The discriminant diagram is shown in Figure 1. From the diagram, it can be seen that all the eigenvalues are within the unit circle, and it can be determined that the VAR system set in the article is stable.

Table 6: Results of residual autocorrelation test

lag	chi2	df	P
1	13.5557	9	0.13903
2	13.7611	9	0.13108
3	9.8146	9	0.36570
4	9.1661	9	0.42208

Table 7: Sequential autocorrelation test

lag	chi2	df	P
1	16.3600	9	0.05973
2	12.2040	9	0.20205
3	11.1197	9	0.26759
4	4.9038	9	0.84261

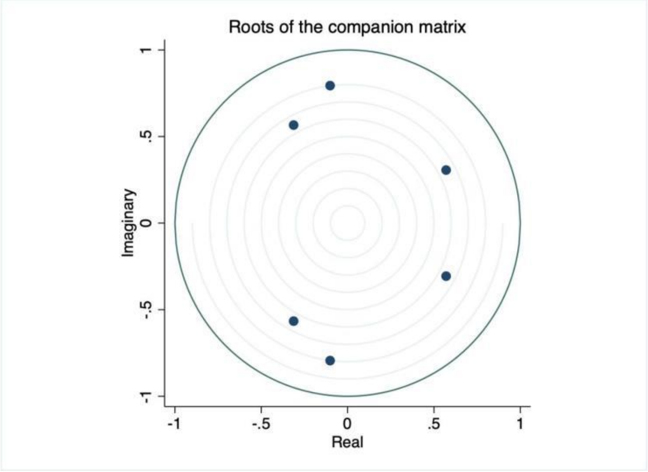

Figure 1: Stability discriminant diagram of VAR system

4.6 Granger Causality Test

The article further conducted Granger causality test on the three variables of the VAR model, only through the Granger causality test, the next impulse response is more effective, and the test results are shown in Table 8. It can be seen from the table that the total output value of marine fisheries and fishermen's investment in fishery expenditures are Granger causality, the progress of fishery science and technology and the total output value of marine fisheries are Granger causality, and the fishermen's investment in fishery science and technology is a unidirectional Granger cause for the economic growth of marine fisheries. The investment in fisheries is a unidirectional Granger causality for the scientific and technological progress of marine fisheries, which further proves that the existing studies have neglected that the investment in fishermen's fisheries expenditures will have an impact on the economic growth of marine fisheries and the scientific and technological progress of fisheries.

Table 8: Results of Granger causality test

Equation	Excluded	chi2	df	P	reach a verdict
Marine fisheries economy	dlnth	11.456	4	0.022	rejection
	dlnin	12.167	4	0.016	rejection
	ALL	23.651	8	0.003	rejection
Scientific and technological progress in marine fisheries	dlngdp	36.171	4	0.001	rejection
	dlnin	23.37	4	0.000	rejection
	ALL	3.1709	8	0.000	rejection
Fishermen's investment in fisheries	dingdp	30.027	4	0.000	rejection
	dlnth	3.215	4	0.523	acceptance
	ALL	8.5847	8	0.000	rejection

4.7 Impulse Response Function (ERF)

Since there is no need to make any a priori constraints on the variables in the VAR model, it is often not necessary to focus on the role of one variable for another when analyzing the vector autoregressive model, and the impulse response function can comprehensively reflect the dynamic relationship among the variables. The impulse response function operates on the principle of applying a shock of one standard deviation to an endogenous variable in the model and then calculating the current and future values of each variable. In this paper, the examination period is set as 8 periods with 95% confidence interval, and the impulse response results are shown in Figure 2.

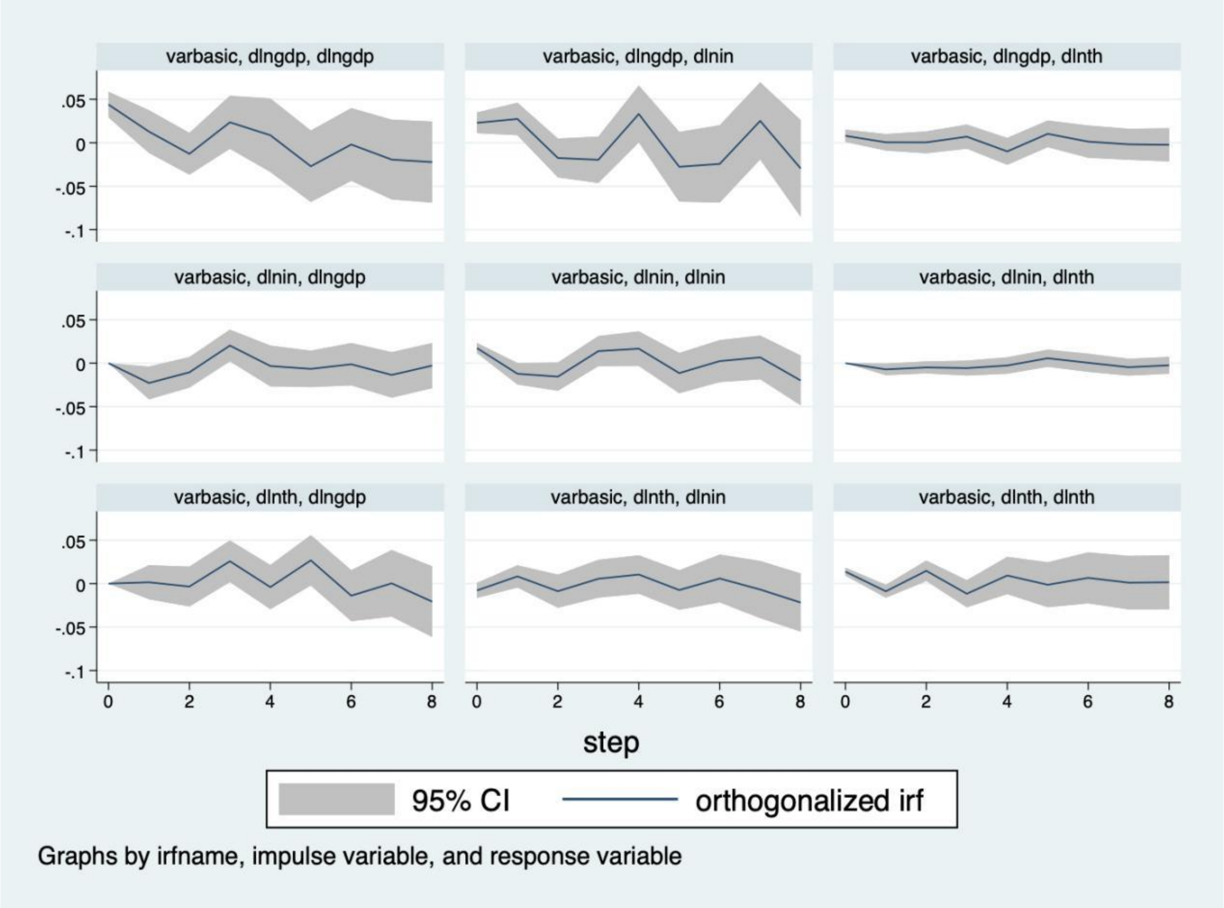

Figure 2: Impulse response function of the relationship between gross value of marine fishery output, fishermen's investment in fishery, and scientific and technological progress in fishery in the sample area

When the overall impact response effect of the marine fishery economy on the investment from fishermen is first positive and then negative and then positive, the positive response reached the maximum value in the 4th period, and it is a positive impact in the short term; the overall impact effect of the marine fishery economy on the scientific and technological progress from the fishery industry is flat, and it reached the maximum value of the positive response in the 3rd and 5th period, and it tends to flatten out gradually.

When the effect of fishery investment on the overall shock from the marine fishery economy is first negative and then positive, in the long run is leveling off; fishery investment on the shock from the fishery scientific and technological progress in the long run results are in a smooth, just to verify the results in the Granger test.

When the fishery science and technology progress on the overall shock response effect from the marine fishery economy shows a sawtooth shape, with obvious pulling effect, and in the 3rd and 6th period to reach the maximum value; fishery science and technology progress on the shock from the fishermen's investment there is a certain fluctuation, short-term is a positive pull, and in the 4th period to reach the maximum value, in the late stage of the weakening or even appear a certain inhibition effect.

In summary, the results above fully illustrate the difference between short-term and long-term effects of fishermen's fishery investment expenditures and fishery science and technology progress on the economic development of marine fisheries.

4.8 ANOVA (Analysis of Variance)

Through ANOVA, the contribution of each shock to the endogenous variables can be derived as a measure of the importance in different shocks. This article analyzes the relationship between the marine fisheries economy, fishermen's investment in fisheries and fisheries scientific and technological progress, and describes the results of the ANOVA of the three.

Since the variance decomposition tends to stabilize after the 8th period, the results of the variance decomposition of marine fishery economy, fishermen's fishery investment expenditures and fishery science and technology progress in Zhoushan fishery from the 1st prediction period to the 8th period are revealed here. As can be seen from Figure 3, the marine fishery economy is mainly affected by fishermen's investment expenditure and fishery science and technology progress, in which fishermen's investment expenditure contributes more than 50%, realizing a large degree of growth; fishermen's fishery investment expenditure in the 2nd period of the marine fishery economy on the impact of the increase from 0% to 25%; fishery science and technology progress in the 3rd period of the contribution of the marine fishery economy from 0% to start growing, and fishermen's investment expenditure for fishery technology progress almost no. investment expenditures have almost no effect on fishery science and technology progress, indicating that fishermen's investment expenditures cannot significantly contribute to the rise of fishery science and technology progress.

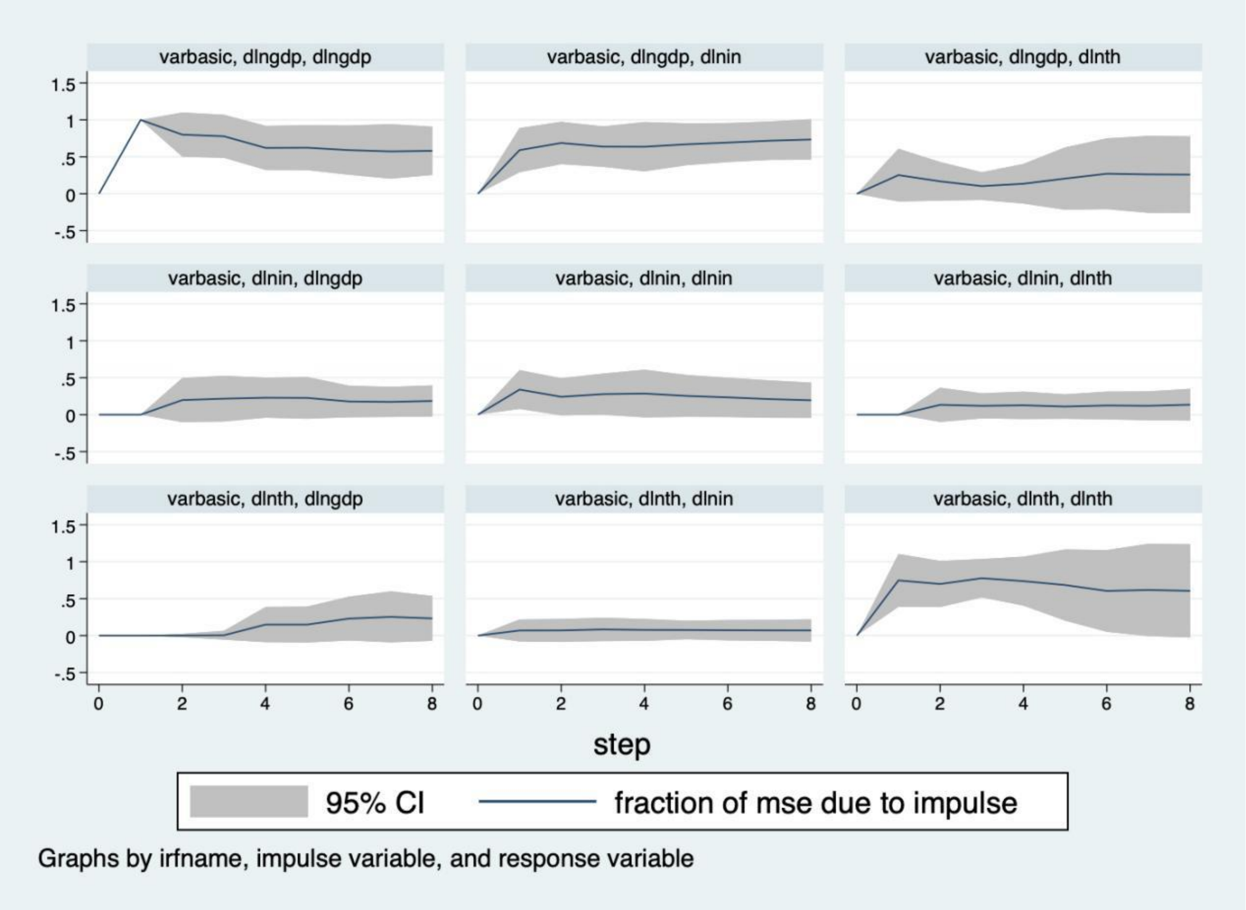

Figure 3: Results of variance decomposition

5. Conclusions and Recommendations for Response

5.1 Conclusions

This paper chooses Zhoushan City, a prefecture-level city and the location of China's largest fishing ground, as the research object, combines the local statistical yearbook, constructs a VAR model, carries out Granger causality test, impulse response function and ANOVA, and draws the following conclusions:

(1) From the VAR model, there is a long-term equilibrium relationship between fishery S&T progress and marine economic growth. The impact of fishery science and technology on marine economic growth is a positive effect.

(2) From the perspective of Granger causality, as a whole, fishery science and technology progress and marine fishery economy are Granger causes of each other, and fishermen's fishery investment and marine fishery economy are also Granger causes; among them, fishery science and technology progress is the Granger cause of fishery science and technology progress, but fishermen's fishery investment is not the Granger cause of fishery science and technology progress; in particular, the popularization and universality of fishery science and technology progress is slower than that of fishermen's investment, which indirectly increases the cost of fishermen's production and inhibits their investment. The slow progress in fishery science and technology indirectly raises the cost of fishermen's production and inhibits fishermen's investment. The development of fishery science and technology progress can promote the growth of marine fishery economy.

(3) From the impulse response function, the progress of fishery science and technology can promote the growth of marine fishery economy. In part, it has a positive response to the growth of the marine economy; in whole, it promotes the growth of the marine economy; in the short term, the growth of the marine economy alternates between positive and negative impacts on marine science and technology innovation, and in the long term, the growth of the marine fishery economy has a positive trend on the impacts of the fishery science and technology creation and progress and fishermen's investment in fishery.

(4) From the viewpoint of variance decomposition, the average variance contribution rate of fishermen's fishery investment to marine economic growth is very high, and the whole is in a steady upward trend, while the average variance contribution rate of marine fishery economic growth to fishery scientific and technological progress and fishermen's fishery investment is relatively low, and there is also a slight upward trend in recent years.

5.2 Recommendations for Countermeasures

First, the quality training of fishermen should be strengthened and inefficient investment expenditures should be eliminated. The Government should give full play to its functions and adopt locally adapted methods in different regions to maximize the quality of fishermen's training and minimize the proportion of inefficient investment expenditures by fishermen, while at the same time giving full play to the scale effect of human capital. Individual and social capital investment should be improved, and the flow of factors of production in fishery should be rationally allocated, guided by the market mechanism and relevant policies. Improve the construction of the fishery market and enhance the confidence of individuals and society in the investment value and investment environment of the marine fishery.

Secondly, we should promote scientific and technological progress in the fisheries industry and guide the sharing and distribution of scientific and technological progress. First, the efficiency of local fishery science and technology promotion should be strengthened and the cost of fishery production use should be reduced. At the same time, it is necessary to strengthen the scale advantages of marine fishery farming supported by science and technology, promote the cross-fertilization of marine ranching and fishery scientific and technological progress, guide the free flow of fishery production factors between industries, and effectively incentivize the ability of fishery scientific and technological independent innovation. In addition, research institutions and local universities should be encouraged to develop joint innovations, promote the coupled and coordinated development of marine economy and science and technology among regions, and give full play to the spillover effect brought about by fishery science and technology progress within a reasonable interval.

Thirdly, we should lead the development of convergence between fishery science and technology advancement and fishermen's investment expenditures, and fully utilize the interactive mechanism between fishery science and technology development and the marine fishery economy. Policies should guide fishermen's fisheries investment expenditures in cutting-edge mariculture technology or in upgrading offshore fishing technology, so as to improve financial inclusion. Encourage fishermen to reasonably invest in the use of sustainable fishery-related technologies, not only to improve fishermen's production methods and efficiency, but also to avoid the inefficient redundancy of production factors and vicious circle caused by fishermen's blind investment, so as to improve fishermen's incomes and the economy of marine fisheries, and to build sustainable "blue grain silos" under the "Big Food Concept". The "blue granary" under the "big food concept".

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