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Research on the Development of Mariculture Industry in Guangdong Based on Multiple Linear Regression Model

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Abstract: *In order to quantitatively analyse the influencing factors of mariculture production in Guangdong Province, a multiple linear regression model was used to analyse the influence of mariculture area, export value of aquatic products, number of mariculture professionals, number of mobile phone users coverage and R&D expenditure costs on mariculture production by using Guangdong's marine economic data from 2008 to 2020. The results show that mariculture production in Guangdong Province is highly correlated with five influencing factors, with the degree of influence being R&D expenditure > export value of aquatic products > mobile phone subscriber coverage > mariculture area > number of mariculture professionals, in that order. Finally, recommendations are made based on the findings of the study.*

Keywords: *Multiple Linear Regression; Farm Production; Guangdong Province; Influencing Factors*

1. Introduction

Guangdong Province, with its vast sea area, is rich in islands, mudflats and marine biological resources. There are about 1,500 species of fish and 250 species of shellfish in the South China Sea area, which are suitable for artificial aquaculture, which promotes the development of fisheries in Guangdong Province. The mariculture industry is crucial to the income of fishermen and the development of fishing villages, and has also led to the development of upstream and downstream industrial chains, such as seedling, feed, drugs, equipment manufacturing, cold chain logistics, aquatic product processing and import and export trade. Guangdong Province attaches great importance to research and investment in marine science and technology. in 2018, Guangdong Province ranked first in terms of R&D investment in the coastal region, exceeding the national average, and demonstrated an obvious clustering effect. In addition, Guangdong Province has many scientific research units and focuses on cultivating professional marine science and technology talents, who provide important support and technical guarantee for the construction of Guangdong's strong marine province.

Therefore, studying the influencing factors of mariculture production in Guangdong Province is of great significance in ensuring national food security, promoting regional economic and social development, and improving fishermen's income. Based on the statistical data of mariculture production in Guangdong Province from 2008 to 2020, this study analyses its impact on mariculture production using multiple linear regression models and proposes policy recommendations for the development of the mariculture industry based on the results of the analysis..

2. Materials and methods

2.1 Model construction

The multiple linear regression analysis method was used to analyse the factors influencing the mariculture industry in Guangdong Province, and five aspects of mariculture area, export value of aquatic products, number of professional mariculture employees, fishermen's public information services and R&D expenditure were selected for the empirical analysis of mariculture production growth factors. Assuming that the dependent and independent variables meet the conditions of the

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classical multiple linear regression model, the classical multiple linear regression equation[1] was established using the least squares method as follows:

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \cdots + \alpha_n x_n + \varepsilon \tag{1}$$

Considering the excessive differences in values between the variables due to different units, in order to reduce the volatility of the variables and alleviate the subsequent heteroskedasticity problem, logarithms were taken for the independent and dependent variables and the logarithmic multiple linear regression equation was established as follows:

$$\ln y = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \ldots \beta_n \ln x_n + \varepsilon \tag{2}$$

Where y denotes the dependent variable, αi and βi denote the coefficients, xi denotes the independent variable and ε denotes the error term.

2.2 Variable selection

In this study, based on existing studies and taking into account the geographical conditions and human activities in Guangdong Province, the influencing factors that are most closely related to mariculture production are selected so that they cover as many input factors as possible that are closely related to mariculture production, such as var1 mariculture area[2] and var3 number of mariculture professionals[3]. Fishermen's income and increased domestic and foreign demand are likely to stimulate growth in mariculture production, var2 fish export value was selected[4]. The level of fisheries public information services represents the level of information technology services that can improve the development of local fisheries and thus influence the increase in mariculture production, selected var4 number of households covered by mobile phone users[5]. Technological progress plays an important role in the development of the mariculture industry, var5 research and development expenditure cost was selected[6].

2.3 Data sources

The data used were mainly obtained from the China Fisheries Statistical Yearbook, the China Marine Statistical Yearbook, the Guangdong Provincial Statistical Yearbook and the Ministry of Finance from 2009 to 2021, and a multiple regression model was constructed using Stata software to conduct an empirical study.

2.4 Analysis process

The variables were first subjected to descriptive statistics to briefly compare the differences in the indicators across years, followed by correlation analysis, multiple cointegration tests, smoothness tests, EG cointegration tests and autocorrelation tests, further correction for cointegration by ridge regression, and finally significance analysis to rank the dependent variables according to their degree of influence.

3. Results and analysis

3.1 Descriptive statistics

The results in Table 1 show that the data for mariculture production, mariculture area, aquatic product exports, number of mariculture professionals, mobile phone subscriber coverage and R&D expenditure costs vary considerably from year to year, with a high degree of dispersion, indicating that there are more significant differences in the indicators from year to year.

Table 1 Descriptive statistics

Var Name	Obs	Mean	SD	Min	Median	Max
ln_y	13	14.861	0.127	14.617	14.895	15.013
ln_var1	13	12.134	0.089	11.993	12.180	12.223
ln_var2	13	12.528	0.262	11.997	12.644	12.789
ln_var3	13	11.696	0.048	11.569	11.703	11.770
ln_var4	13	10.987	0.647	9.685	11.113	11.684
ln_var5	13	7.315	0.602	6.220	7.381	8.155

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3.2 Correlation coefficient matrix

The results in Table 2 show that each explanatory variable has a significant relationship with mariculture production, but individual explanatory variables are also significantly related at the same time, indicating that the model may have a multicollinearity relationship.

Table 2 Correlation coefficient matrix

	ln y	ln var1	ln var2	ln var3	ln var4	ln var5
ln y	1.000					
ln var1	-0.581**	1.000				
ln var2	0.907***	-0.400	1.000			
ln var3	0.330	0.336	0.455	1.000		
ln var4	0.706***	-0.193	0.766***	0.516*	1.000	
ln var5	0.987***	-0.696***	0.870***	0.251	0.682**	1.000

In order to avoid co-linearity in the data, a multicollinearity test is required, which is generally used to detect the presence of multicollinearity through the Variance Inflation Factor, (VIF):It is the ratio of the variance in the presence of multicollinearity between the explanatory variables to the variance in the absence of multicollinearity. The larger the VIF, the more severe the covariance. The details are shown in Table 3.

Table 3 Multicollinearity test

Variance inflation factor	VIF	1/VIF
ln var5	12.122	.082
ln var2	6.623	.151
ln var1	5.12	.195
ln var4	2.844	.352
ln var3	2.409	.415
Mean VIF	5.824	.

3.3 Stability test

If the original series is not smooth and the regression analysis is carried out directly, it may lead to a "pseudo-regression". The ADF unit root test was used to determine this. From the test results, it can be seen that the original series of the ln_var1 variable accepts the original hypothesis, so all variables were tested again after first-order differencing, and the original hypothesis was rejected, i.e. there is no unit root. The details are shown in Table 4.

Table 4 Stability test

Variable	Level	ADF statistics	Level	ADF statistics	conclusion
ln_y	origin	-2.722**	Diff(1)	-2.696**	stationary
ln_var1	origin	-0.676	Diff(1)	-3.636***	stationary
ln_var2	origin	-2.729**	Diff(1)	-1.808*	stationary
ln_var3	origin	-4.706***	Diff(1)	-4.795***	stationary
ln_var4	origin	-2.225**	Diff(1)	-2.678**	stationary
ln_var5	origin	-4.792***	Diff(1)	-2.001**	stationary

3.4 EG co-integration test

Considering that not all of the original series were smooth, it was necessary to conduct a cointegration test to demonstrate the existence of a long-run cointegration relationship between the variables. The EG two-step method was used to perform a unit root test on the residuals, and the results in Table 5 indicate that the original series of residuals is smooth, so there is a cointegration relationship.

Table 5 Co-integration test

variable	Level	ADF statistics	conclusion
e	origin	-4.657***	stationary

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3.5 Autocorrelation test

The time series needs to be tested for autocorrelation and after using the LM test, the result from Table 6 shows that the statistic is 1.840, p=0.175>0.05 and the acceptance of the original hypothesis indicates that there is no autocorrelation.

Table 6 Autocorrelation test

Breusch-Godfrey LM test for autocorrelation chi2	df	Prob>Chi2
1.840	1	0.175

3.6 Ridge Regression

In order to solve the problem of multicollinearity in the regression equation (2), this study used ridge regression to correct for the covariance, and the regression model (3) was calculated using Stata software. The results are shown in Table 7.

$$\ln y = 0.548\ln x_1 - 0.12\ln x_2 - 0.178\ln x_3 + 0.296\ln x_4 + 0.997\ln x_5 + \varepsilon \quad (3)$$

Table 7 Ridge Regression

ln_y	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
ln_var1	0.548***	0.006	85.230	0.000	0.533	0.563
ln_var2	-0.120***	0.009	-13.090	0.000	-0.142	-0.099
ln_var3	0.178***	0.020	-8.780	0.000	-0.225	-0.130
ln_var4	0.296***	0.026	11.230	0.000	0.234	0.358
ln_var5	0.997***	0.049	20.420	0.000	0.881	1.112

The explanatory variable, ln_var1, is positively correlated with the dependent variable, ln_y, at the 1 per cent level of significance, with a coefficient magnitude of 0.548 meaning that for every 1 per cent increase in the independent variable, all else being equal, ln_y increases by an average of 54.8 per cent.

3.7 Dominance Analysis

Table 8 Dominance Analysis

	Dominance	Standardized	Ranking
ln_var1	0.130	0.131	4
ln_var2	0.277	0.277	2
ln_var3	0.041	0.041	5
ln_var4	0.142	0.142	3
ln_var5	0.408	0.408	1

The results in Table 8 show that in this linear regression, the relative importance of each variable is ranked as follows: ln_var5 > ln_var2 > ln_var4 > ln_var1 > ln_var3. That is to say, among the factors influencing mariculture production in Guangdong Province, R&D expenditure is the most important influence, followed by the export value of aquatic products, followed by the number of mobile phone subscribers coverage, mariculture area and finally number of mariculture professionals.

4. Conclusions and recommendation

4.1 Conclusions

This study established a multiple linear regression model based on mariculture production in Guangdong Province from 2008 to 2020 and related data, and selected the most significant variables for linear regression analysis. Overall, mariculture production in Guangdong Province was highly correlated with mariculture area, export value of aquatic products, number of mariculture professionals, number of mobile phone users coverage and R&D expenditure costs, with the degree of influence in descending order of R&D expenditure, export value of aquatic products, number of mobile phone users coverage, mariculture area and number of mariculture professionals.

4.2 Recommendation

(1) The mariculture industry has great potential for expanding foreign trade. Guangdong Province should focus on exploring overseas markets, strengthening marketing and branding, and improving product quality and value-added in order to increase the export value of aquatic products.

(2) Guangdong Province should explore and rationalise the planning of marine resources and appropriately expand the area for aquaculture to meet market demand and increase production.

(3) Aquatic technology extension agencies at all levels should be responsible for increasing the integration of information technology service platforms, establishing a variety of information communication channels for fishermen, and solving their problems in the aquaculture process.[7].

(4) Government departments should develop policies on subsidies for the promotion of aquatic science and technology, increase the scope and standard of subsidies, and strengthen direct financial subsidies for grassroots extension workers, efficient technologies, course training and demonstration base construction[8].

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