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Research on Dialectic Relation between Marine Industrial Structure and Macro Economic Growth

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Abstract

With Fujian Province as object of study, panel data from 1981 to 2013 is selected in this paper. Besides, VAR model is established. Co-integration test, Granger causality and impulse response function are used for quantitative analysis on correlation between the three main marine industries and economic growth in Fujian Province. In the paper, the long-term stable relation between the three main marine industries and economic growth is revealed, and the causal relations between the primary marine industry and economic growth, between the secondary marine industry and economic growth and between tertiary marine industry and economic growth are verified. The government should give priority to the secondary marine industry and effective support to the tertiary marine industry when adjusting the industrial structure and optimizing policies.

Keywords: *Marine Industry, Economic Growth, VAR*

1. Introduction

In recent decades, the economy of Fujian province has been taking on a speedy increase trend, and tremendous achievements have been made. According to *2015 Fujian Statistical Yearbook*, as of 2014, the GDP of Fujian province reached RMB240.576 billion, representing an increase of 10% over the previous year, as shown in the Figure 1.

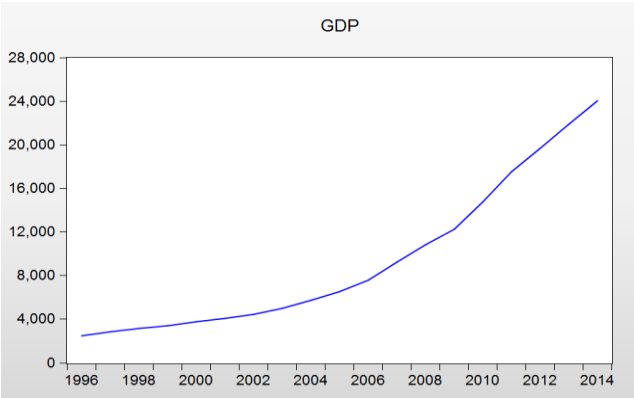

Figure 1. GDP of Fujian Province(Unit: Million Yuan)

It can be seen from the Figure 1, that since 1996, the economy of Fujian province has been taking on an speedy increase trend, which should be owed to the economic policies of the state. Since 1953 on, the state has made a "five-year plan" for every five years. Echoing the state's policy, the Fujian provincial government unswervingly adhered and implemented the policy, which promoted the economy of Fujian province take on an speedy increase trend. As a coastal province of China, Fujian is rich in marine resources,

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and it has an advantageous geographical location. Will the development of the three main marine industries affect the GDP growth of Fujian province?.

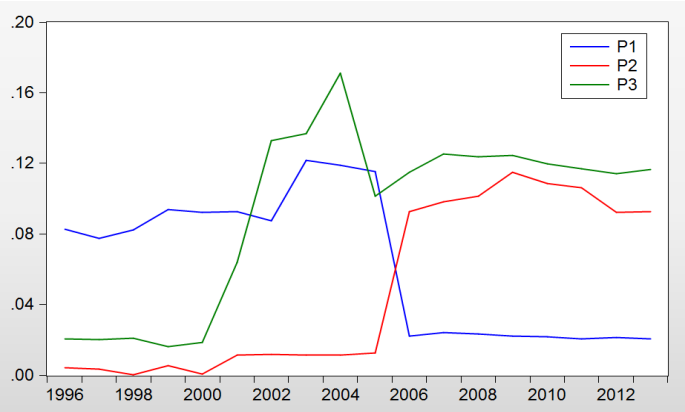

Figure 2. The Proportion of the Output Value of the Three Main Marine Industries to GDP in Fujian Province

It can be seen from the Figure 2, that between 1996 and 2013 the proportion of the output value of the first marine industry to GD P(namely P1) reached peak of 12.2%in 2003, had been continuously decreasing since 2005, and became stable in 2006 remaining about 2.2%; the proportion of the output value of the secondary marine industry to GDP(namely P2) had been always fluctuating around 4% until 2005, rose fast thereafter, and reached peak of 11.5% in 2009; the proportion of the output value of the tertiary marine industry to GDP(namely P3) had been always remaining around 2% until 2000, rose fast thereafter, and reached peak of 17.1% in 2004. Thus, the influence of the three main marine industries on economic growth varies in different periods.

As a large coastal province of China, Fujian is both the "core area of the Maritime Silk Road in the 21st century" and a pilot area of free trade, which shows the importance paid by the state to the development of marine economy, and the important position of Fujian. In future development, the free trade area and the "One Belt and One Road Initiative" inevitably will interact with and make their respective advantages complementary to each other, to raise the external cooperation and communication level of Fujian in marine economy. It is of great significance to Fujian in interacting with Taiwan and the entire globe. Meanwhile, according to the new policy, the marine economy of Fujian should advance with the times by continuously optimizing its industrial structure. In this paper, an attempt to figure out what influence the three main marine industries exerts on macro economic growth, how the influence of the three main marine industries on economic growth is and the internal relation there between will be made. The solutions to these problems contribute to providing theoretical basis for government sector of Fujian Province to formulate effective policies and have realistic significance for rapid development of marine economy in Fujian Province.

2. Literature Review

Other countries got involved in marine research any years before China did. The earliest marine research was carried out by British, a four-year ocean exploration via the "Challenger" in 1872, which marked the starting of an age of scientific marine survey and marine research. In the late 1960s, countries represented by America, Canada, Korea, Australia *etc.*, started research on ocean economic theories and methods in succession. The World Ocean Economy, the Ocean Research and Exploitation and the Economic Issues in Ocean Exploitation compiled by scholars of the former Soviet Union made in-depth exploration and research on ocean development and marine economy. Colgan and

Plunstead (1993) made in-depth research on the contribution and effect of some specific ocean industries to and on regional economy in a few of states or districts thereunder with an employment or regional economic output evaluation model [1]. Di Jin P.Hoagland(2003) made conjoint analysis and research of marine economy and ecological system with an input-output model based on the analysis of data on marine food chain [2]. Kwaka(2005) analyzed the effect of ocean industries of South Korea on its national economy between 1975 and 1998 with an input-output method, based on which it is found that the ocean industrial distribution of South Korea has a remarkable boosting effect and industry leading effect on marine economy, but the ocean industrial structure of South Korea is relatively slow in reacting to supply shortage and domestic market price changes [3]. Henriela and Hoagland(2006) discussed the correlations between commercial whaling and ecological oceanic tourism, international trade and commercial fishing through analysis of conflict and contradiction coordination among correlative industries, and puts forward suggestions on coordinating contradictions among correlative industries [4].

Since the 1980s, China has continuously intensifying marine resource exploitation, and marine economy developed rapidly as a result. Not only the output value of the main ocean industries increased rapidly, but also the situation where traditional ocean industries dominated has been changed, and a new situation of diversified development of ocean industries emerged. Domestic scholars started to research marine economy intensively from multiple perspectives and aspects. Zhang Yan(2009) made in-depth research on the harmonious development relation between marine industrial structure transformation and regional economies in his master's thesis, *etc.*, [5]. Zhao Xin(2010) made modeling analysis and research on the correlative mechanism of China marine industries and macro economic growth with VAR models [6]. Wang Changjiang and Liu Jie(2010) pointed out in his paper "Analysis and Reflections on the development of marine economy in China" that further development of marine economy required further enrichment and perfection of the concept of marine economy in accordance with the scientific outlook on development, and rising the attention to marine exploitation from an "industry concept" to an "economic concept" [7]. Fang Chunhong, Liang Xiangbo and Qi Lianming(2011) analyzed the mechanism of Chinese marine economy influencing national economy by means of VAR data analysis [8]. As marine economy grows rapidly, people become more and more concerned about the development of regional marine economy. Gai Mei and Chen Qian(2010) made research on the contributions of Change of marine industrial structure to marine economic growth in LiaoNing province [9]. Wang Duanlan(2013) made research on the correlation between Change of marine industrial structure to marine economic growth in Fujian province [10].

In respect of research trend, although the abovementioned documents cover analysis and research on the correlation between marine economy and marine industrial structure from different aspects and perspectives, domestic scholars mainly focused on some area, specifically Liaoning, Guangdong, Zhejiang and Shandong province, due to its solid marine economic foundation and strong scientific research ability. This provides a solid theoretical foundation for the research. On the other hand, the existing researches are limited. Especially, the empirical research on the adjustment of industrial structure and marine economic growth in Fujian province is relatively scarce. First, there is a little research on the correlation analysis of the three main marine industries and economic growth let alone such research on Fujian data; second, the traditional linear regression method is insufficient and unreliable for making good dynamic analysis on variables, for the sequence of variables is not stable in normal conditions. In view of this, this paper analyzes the cause-and-effect relation between the three main marine industries and

economic growth with cause-and-effect relation analysis method, researches the dynamic adjustment mechanism between the marine industry and the three main marine industries and economic growth with VAR models and impulse response function, and checks the foregoing and establishes Co-integration equations for in-depth research of the correlative mechanism of them influencing each other in a long run.

3. Vector Auto Regression Model

In traditional econometrics, simple linear regression equation cannot well analyze dynamic relations among variables. In normal conditions, time series of variables is non-stationary. Vector auto-regression model proposed by Sims can better and more objectively analyze and reveal dynamic relations among variables than traditional econometrics method. Meanwhile, it can reveal variables in economics are usually non-stationary time series problem. Vector auto-regression model is adopted to analyze variables. The models are established as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + B_0 X_t + \cdots + B_r X_{t-r} + \varepsilon_t \quad (1)$$

In Formula (1), Y_t is k-dimensional endogenous variable; Y_{t-i} (i=1,2,•••, p) is lagged endogenous variable; X_{t-i} (i=0,1,…,r) is exogenous variable or lagged exogenous variable; p and r are lagged orders of endogenous variable and exogenous variable, respectively; A_i and B_r represent corresponding coefficient matrix; ε_t represents residual error term of the model.

Two aspects should be noticed during establishing VAR model: (1) variable selection. If variables are excessive, model effectiveness of the model will be influenced. If variables are too fewer, the relevance among variables cannot be reflected. (2) Lagged order selection. If lagged order is too large, degree of freedom is insufficient. If lagged order is too small, dynamic features of the model cannot be fully reflected [11].

4. Empirical Analysis

4.1. Data Processing

This study selects panel data from Fujian Statistical Yearbook over years and China MARINE Statistical Yearbook between 1997 and 2014, and carries out data preprocessing. Variables of empirical research are GDP, GDP of the first marine industry, GDP of the secondary marine industry, GDP of the tertiary marine industry of Fujian Province denoted by GDP, A1, A2, A2 respectively. To get a stationary series more easily, take natural logarithm of each variable, which will not change co-integration relationship and short-term adjustment mode among variables, but eliminates possible heteroscedasticity among variables to a certain degree. The processed data series are named LNGDP, LA1, LA2, LA3 respectively. Data series after first-order difference are named DLNGDP, DLNA1, DLNA2, DLNA3 respectively.

Table 1. The Original Variable Time Sequence Table (Unit: Million Yuan)

YEAR	A1	A2	A3	GDP
1996	205.35	10.86	50.66	2484.25
1997	222.56	9.48	57.36	2870.90
1998	259.88	0.65	65.86	3159.91
1999	319.83	18.17	55.15	3414.19
2000	347.76	2.01	69.38	3764.54
...	...	...	...	...
2010	317.70	1602.50	1762.70	14737.12

2011	361.40	1866.00	2056.60	17560.18
2012	416.30	1815.90	2250.70	19701.78
2013	452.52	2026.28	2549.20	21868.49
2010	317.70	1602.50	1762.70	14737.12

4.2. Unit Root Test

Unit root test aims to test stationarity of time series. Quantitative analysis can be conducted for only stationary time series, or else quasi-regression may be easily caused. This paper adopts ADF method to test variable stationarity. The optimal lag phase is confirmed by AIC minimum rule to make sure residual error is non-autocorrelated. Through root test of each index variable after the logarithm and first-order difference are taken, we can gain each economic index variable of first-order difference is stationary, as shown in Table 2.

Table 2. Unit Root Test

Variable	(C, T, K)	DW	ADF	5% Critical Value	Result
LNA1	(0,0,2)	0.261	-1.97	(0,0,2)	Unstable
LNA2	(H,I,0)	-4.43	-3.71	(H,I,0)	Stable
LNA3	(H,0,2)	-2.51	-3.10	(H,0,2)	Unstable
LNGDP	(H,0,2)	0.97	-3.08	(H,0,2)	Unstable
DLNA1	(H,0,0)	-4.23	-3.07	(H,0,0)	Stable
DLNA2	(H,I,0)	-7.62	-3.73	(H,I,0)	Stable
DLNA3	(0,0,0)	-2.32	-1.96	(0,0,0)	Stable
DLNGDP	(H,0,4)	-3.35	-3.15	(H,0,4)	Stable

In the Table 2, C is constant term, T is time trend term, K is the number of lag phase. It can be seen from Table2 that, original series of each variable has unit root at 5% significance level, so original series of each variable is non-stationary. But, after first-order difference is conducted for each variable, ADF value of DLNGDP, DLNA1, DLNA2, DLNA3 series is less than the critical value at 5% significance level. Thus, we can prove that the series of each variable is stationary after first-order difference.

4.3. The Optimum Lag Order

The selection of lag phase number is very important for estimation in VAR model, because different lag phases will result in significant differences of mode estimation results. This paper determines the optimum lag order in combination with SC information criterion, AIC information criterion, likelihood ratio test statistics, HQ information criterion and final prediction error method. SC information criterion and AIC information are to determine lag order according to the optimum degree of fitting of model; LR criterion uses the ratio of maximum values of likelihood function with and without constraints; HQ criterion, AIC and SIC have similar principles only with different degrees of punishment for damage of prediction precision by new parameters; FPE criterion is put forward in consideration of a series of changes brought by the decline of residual variance and the rise of model order, and thus further determines the optimum lag order. The results are shown as shown as follows.

Table 3. The Optimum Lag Order of LR, FPE, AIC, SC and HQ

Lag	LR	FPE	AIC	SC	HQ
0	NA	7.76E-05	1.88705	2.075863	1.885039
1	38.91792*	1.49E-05	0.128591	1.072658	0.118535
2	18.01642	1.18e-05*	-0.740811*	0.958509*	-0.758913*

It is known from test results that when the number of lag order is 2, the optimal lag order recommended by FPE, AIC, SC and HQ is 2 except that the results of LR information norms are not optimal. Thus, we choose 2 as the best lag order.

4.4. Johansen Co-integration Test

Because VAR is an unconfined model, and co-integration test is constrained. Since the best lag order of VAR model is 2, the optimal lag phase of co-integration test is 1, after natural logarithm is taken for original variable, trace statistics and maximum eigenvalue are used for co-integration test. The Eviews test results are shown as follows.

Table 4. Unrestricted Co-Integration Rank Test(Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.940722	76.97846	54.07904	0.0001
At most 1	0.660635	31.77022	35.19275	0.1118
At most 2	0.394431	14.47937	20.26184	0.2577
At most 3	0.331938	6.453981	9.164546	0.1585

Table 5. Test Result of Maximum Eigenvalue

Hypothesized No. of CE(s)	Eigenvalue	Maximum Eigenvalue	0.05 Critical Value	Prob.**
None *	0.940722	45.20824	28.58808	0.0002
At most 1	0.660635	17.29085	22.29962	0.2162
At most 2	0.394431	8.025385	15.8921	0.5447
At most 3	0.331938	6.453981	9.164546	0.1585

It can be seen from the Table 4, and Table 5 that, the results of Johansen's trace statistic value and maximum likelihood value indicate original test without co-integration relationship is rejected at 5% significance level. Thus, we can judge the four index variables have co-integration relationship at 5% significance level.

Normalized cointegrating coefficients (standard error in parentheses)

LNGDP	LNA3	LNA2	LNA1	C
1.000000	1.304980	-0.965432	-1.330787	-4.681941
	(0.10550)	(0.05967)	(0.13309)	(0.51975)

Figure 3. Parameters of Co-integration Regression Model Equation

Through co-integration test results, specific parameters of co-integration regression model equation can be determined and thus establish this equation. The formula is shown as follows.

$$LNGDP = -1.304980\ LNA3 + 0.965432\ LNA2 + 0.1330787\ LNA1 + 4.681941 \qquad (2)$$

It is found from the equation that LNGDP, LNA1, LNA2 and LNA3 have long-term stable equilibrium relationship. In other words, the three main marine industries can facilitate national economy growth, where the first marine industry can best promote economy growth. According to formula, if the logarithm of household consumption increases by 1%, the logarithm of GDP will increase by about 1.13% accordingly. If the logarithm of investment increases by 1%, the logarithm of GDP will increase by about 0.97% accordingly. The standard error of the first marine industry is 0.13309. The standard error of the secondary marine industry is 0.05967. The tertiary marine industry has a negative influence on economic growth, however. As the logarithm of the tertiary marine industry increases by 1%, that of economic growth decreases by about 1.30%, with a standard error of 0.10550. This equation only analyzes the influence of change of a variable on economic growth while other variables remain unchanged, but in fact there is mutual influence among variables. Thus, Granger Causality Test shall be further applied.

4.5. Granger Causality Test

For stationary data after difference, Granger causality test is adopted to analyze mutual relations of each index variable, establish variable model about GDP, A1, A2, A3 and test null hypothesis. The test results are shown in Table 6.

Table 6. Granger Cause and Effect Test Results of Variables

Cause and effect relation assumption	LP	F	P	Decision	Conclusion
GDP of secondary marine industry is not the cause of change of economic growth.	1	8.8746	0.0100	reject	GDP of secondary marine industry is the cause of change of economic growth.
Economic growth is not the cause of change of GDP of secondary marine industry.	1	9.6268	0.0078	reject	Economic growth is the cause of change of GDP of secondary marine industry.
GDP of secondary marine industry is not the cause of change of GDP of tertiary marine industry.	1	0.0243	0.8781	accept	GDP of secondary marine industry is not the cause of change of GDP of tertiary marine industry.
GDP of tertiary marine industry is not the cause of change of GDP of secondary marine industry.	1	9.4737	0.0082	reject	GDP of tertiary marine industry is the cause of change of GDP of secondary marine industry.

P is the concomitant probability of F statistic, meaning the probability of rejecting the first column of null hypothesis. When the probability is lower than 5%, the null hypothesis is rejected. It can be seen from conclusion that:

(1) The secondary marine industry and economy growth have bi-directional causal relationship. In other words, the secondary marine industry is the cause for growth of economy growth. After Phase I, the secondary marine industry will effectively spur economy growth, and economy growth also will stimulate the development of the secondary marine industry in return.

(2) The secondary marine industry and the tertiary marine industry have a one-way cause-and-effect relation. Specifically, the tertiary marine industry is the cause of the secondary marine industry, and can significantly affect the secondary marine industry in a short time, but the secondary marine industry is not the cause of the tertiary marine industry.

(3) The tertiary marine industry and economic growth has no cause-and-effect relation in the short run.

4.6. Vector Auto Regression

In this paper, the best lag order is 2 to set up VAR model about LNGDP, LNA1, LNA2, LNA3 whether VAR model is stationary needs to be judged according to system stationarity, *i.e.*, calculation the value of characteristic polynomial. Since lag length of the model is 2, and there are 4 endogenous variables, there are 2×4 unit roots of the model, as shown in Figure 3. It can be seen from the figure that the module of 8 unit roots is less than 1, *i.e.*, all roots are within the unit circle. This proves estimated VAR model is stationary.

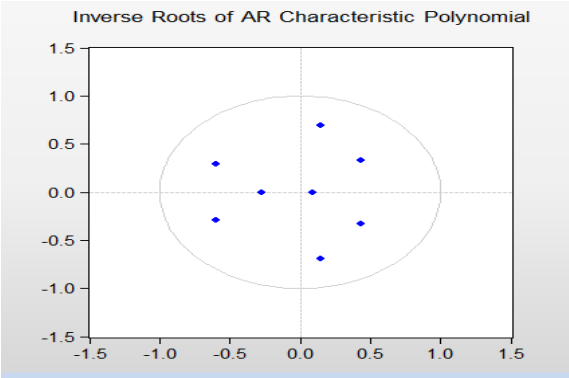

Figure 4. AR Test Result

4.7. Impulse-Response Analysis

In order to further analyze the short-term dynamic relation among variables in future, the influence of the tertiary marine industry on the change of economic growth is generated. The function among GDP, household consumption, domestic investment and government consumption based on VAR model is set up.

The results of impulse response functions are as follows:

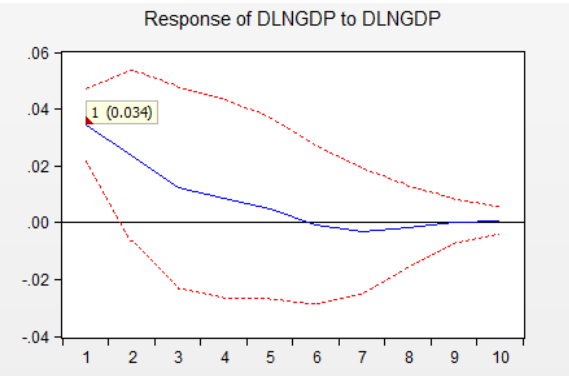

Figure 5. Economic Growth's Response to Economic Growth's Disturbance

In the Figure 5, horizontal coordinate represents the number of phases; the vertical coordinate represents the magnitude of impulse-response function; the solid line represents the trend of economic growth after the impact; the imaginary lines at both sides represent twofold standard errors of the trend. It can be seen from impulse response value that economic growth in Fujian Province makes an immediate response to standard deviation information (*i.e.*, random disturbance term in VAR model). In the first phase, such response is maximal (about 0. 034). Later, the impact of economic growth on itself

gradually decreases. From the first phase to the fifth phase, positive impact effect is shown. After the fifth phase, the impact effect is basically 0. This indicates economic growth has obvious positive influence in a short term.

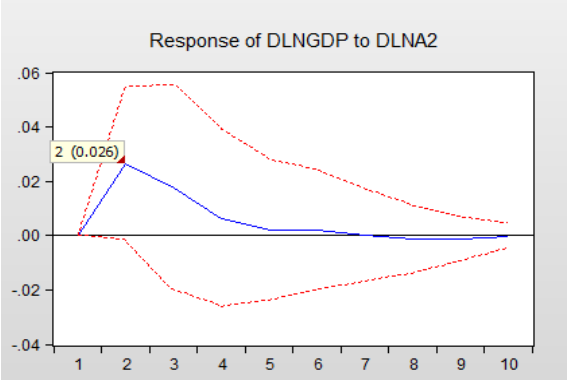

Figure 6. Secondary Marine Industry's Response to Economic Growth's Disturbance

It can be seen from Figure 6, that economic growth fails to make an immediate response to government consumption changes. Positive impact effect is shown from the first phase to the second phase. Impact peak is reached in the second phase (0.026). After the second phase, slow decline is shown. Until the sixth phase, it tends to be stable (near 0). It can be seen from the track that the impact of the secondary marine industry on economic growth is big relative to other factors. This result is consistent with the results of co-integration regression test result and correlation coefficient matrix of residual error, but the influence duration of such impact on economic growth is long.

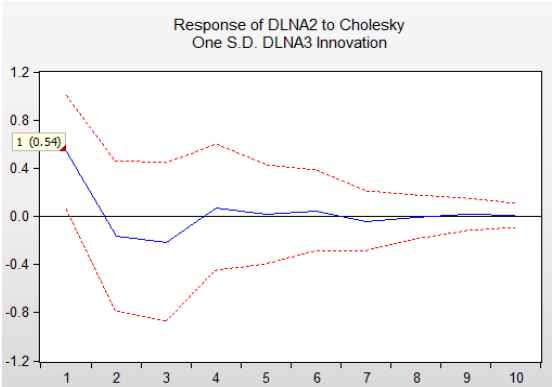

Figure 7. Tertiary Marine Industry's Response to Secondary Marine Industry's Disturbance

The response of the tertiary marine industry to the secondary marine industry is big in the first phase and the second phase. The impact from the first phase to the second phase is positive. From the second phase to the fourth phase, there is negative impact effect on economic growth. Later, the impact turns to positive and then keeps stable near zero. On the whole, the impacts of the secondary marine industry in Fujian Province and domestic investment impose the largest effects on economic growth and they become main driving force of promoting China's economic growth.

5. Conclusions

Based on empirical analyses, the following conclusion can be reached:

(1) The long-term stable relation between the three main marine industries and economic growth is revealed.

(2) The long-term stable relation between the three main marine industries and economic growth is revealed.

(3) The long-term stable relation between the three main marine industries and economic growth is revealed.

On this basis, the following suggestions are put forward to relevant departments of government for reference:

(1) Priority should be given to the secondary ocean industry, and it should be encouraged to make scientific and technical innovation, revitalize the country through marine economy development, strictly control quality, and actively echo the development strategy of "supply side" reform of the state.

(2) Although the boosting effect of the tertiary ocean industry on economic growth in a short time is not significant, the tertiary ocean industry (especially oceanic tourism and marine culture) will certainly become the consumption hotpots in the future as the economic reform is comprehensively deepened, residents' income and living standard constantly rise. Therefore, the tertiary ocean industry should be cultivated and supported proactively and greatly.

Acknowledgments

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