Research on the marine human resource development based on VAR model

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Abstract. This paper selects the data of China's marine human resources data from 1996 to 2016, and uses the VAR model to conduct an empirical analysis. Research shows that marine human resource development can promote the development of marine system, but mainly contributing to the marine scientific research investment, while the contribution of marine education investment is relatively small, resulting in insufficient supply of marine talents and affecting the positive development. Therefore, in order to promote the construction of a maritime power, corresponding suggestions are put forward.

1. Introduction

As early as 2013, Comrade Xi Jinping stated that the maritime industry is related to the survival and development of the nation and the country's prosperity and decline [1]. Human resources, as the key to the development of marine undertakings, determine the success or failure of the development of marine undertakings. The key to developing the marine economy and building a maritime power lies in the cultivation of talents. Only by rationally and scientifically managing and using talents can we realize the lasting, efficient and sustainable development of the marine industry. A world power must be a maritime power. Since the reform and opening up, our country's marine industry has developed rapidly. The party and the country have also strengthened the construction of marine talents and achieved certain achievements. However, the current situation of our country's marine human resources is not optimistic due to various reasons. Therefore, studying the relationship between marine human resource development and economic development in this context is of great significance for promoting the high-quality development of marine undertakings and jointly building a maritime power.

The marine economy at home and abroad is developing rapidly, and the relatively rich research results are obtained. However, the research on the relationship between the development of marine human resources and the development of the marine economy is relatively limited. Zhao Xin and Li Dan [3] pointed out that in order to meet the rising demand for marine talents in the future, it is imperative to strengthen the talent training of marine colleges and universities and consolidate the quality of talents. Deng Shasha [2] believes that as economic development enters a new normal, my country's coastal marine industry is gradually transforming and upgrading, and a large number of marine professional human resources are needed. Zhao Shuangshuang [3] believes that the most important issue facing marine work is how to effectively develop marine human resources. Through the development of marine human resources, high-quality talents suitable for the development needs of the times are cultivate to promote the steady development of marine human resources. Zhiqian Li [4]
indicated that continuous investment in education is an important foundation and link to promote the
economic development of coastal provinces, and vigorous investment in marine education is
conducive to the sustainable development of the marine economy and industrial upgrading. Li Bo [5]
believes that as an important part of the education system, cultivating high-skilled talents to better serve the development of the local marine economy is the fundamental task of higher vocational education. Du Jun and Kou Jiali [6] used the VAR model to conduct an empirical analysis on the relationship between marine education, the application of scientific and technological marine achievements, and marine economic growth, concluding that marine economy has become a new growth point for the national economy.

2. Research methods and data sources

2.1. Research method
This article chooses to measure the relationship between my country's marine human resource
development and marine economic development based on the VAR model. The model expression is as follows:

\[ y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \mu_t \]  \hspace{1cm} (1)

Among them, \( y_t \) is the \( m \)-dimensional endogenous variable, and \( x_t \) is the \( d \)-dimensional exogenous variable; \( A_1, \ldots, A_p \) are the parameter matrices to be estimated; there are \( p \) and \( r \) order lag periods respectively; \( \mu_t \) is the random disturbance term. The VAR model is transformed into a matrix as:

\[
\begin{bmatrix}
Y_{1t} \\
Y_{2t} \\
\vdots \\
Y_{kt}
\end{bmatrix}
= A_1 \begin{bmatrix}
Y_{1t-1} \\
Y_{2t-1} \\
\vdots \\
Y_{kt-1}
\end{bmatrix}
+ A_2 \begin{bmatrix}
Y_{1t-2} \\
Y_{2t-2} \\
\vdots \\
Y_{kt-2}
\end{bmatrix}
+ \cdots
+ \begin{bmatrix}
\mu_{1t} \\
\mu_{2t} \\
\vdots \\
\mu_{kt}
\end{bmatrix}
\]  \hspace{1cm} (2)

2.2. Data Sources
This paper selects time series data from 1996 to 2016, which comes from the “China Marine Statistics Yearbook”, and uses the estimated number of graduates of marine majors in the country to measure the investment in marine education in my country, which is recorded as DG (Dr. Prospective graduates). Employees of marine scientific research institutions across the country measure the investment in marine scientific research in my country and record it as SRI (scientific research institution), and the marine economic development of the country (excluding Hong Kong, Macao and Taiwan) is used to measure marine economic development and recorded as GDP.

3. Empirical analysis

3.1. Unit root test
In order to eliminate the possible heteroscedasticity influence and obtain a stationary time series, all data are taken as natural logarithms and recorded as lnDG, lnSRI and lnGDP. Because time series data may have a “pseudo-regression” phenomenon. Therefore, this paper uses the ADF test method to perform unit root test on the data. The unit root results are shown in Table 1. lnGDP is a stationary series, and the lnDG and lnSRI variables cannot pass the 5% significance level and are non-stationary series. After the first-order difference, ΔlnDG, ΔlnSRI and ΔlnGDP pass the 5% significance level, which is a stationary series. Therefore, the three variables all satisfy the first-order single integration, and the co-integration test can be performed.
Table 1. Unit root test results.

| variable name | inspection type(C,T,K) | ADF value | 1% Critical Value | 5% Critical Value | 10% Critical Value | conclusion |
|---------------|------------------------|-----------|-------------------|-------------------|-------------------|------------|
| lnDG          | (C,T,0)                | -1.992258 | -4.498307         | -3.658446         | -3.268973         | unstable   |
| ΔlnDG         | (C,0,0)                | -4.634421 | -3.831511         | -3.029970         | -2.655194         | stable     |
| lnSRI         | (0,0,0)                | 0.581870  | -2.685718         | -1.959071         | -1.607456         | unstable   |
| ΔlnSRI        | (0,0,0)                | -3.472185 | -2.692358         | -1.960171         | -1.607051         | stable     |
| lnGDP         | (C,0,4)                | -4.372218 | -3.920350         | -3.065585         | -2.673459         | stable     |
| ΔlnGDP        | (C,T,3)                | -6.082085 | -4.667883         | -3.733200         | -3.310349         | stable     |

Note: (1) C in the test form means constant term, T means time trend term, K means lag order; (2) Δ means first-order difference

3.2. Determine the best lag order
The choice of the variable lag order is closely related to the pros and cons of the VAR model construction results. Using the information criterion of the smallest AIC and SC indicators and the largest loglike indicator, the best lag order can be determined as 1. The test results are shown in Table 2.

Table 2. Lag order test result.

| Lag | LogL     | LR   | FPE     | AIC     | SC      | HQ      |
|-----|----------|------|---------|---------|---------|---------|
| 0   | -20.35336| NA   | 0.002346| 2.458248| 2.607370| 2.483485|
| 1   | 46.75731 | 105.9642* | 5.27e-06* | -3.658664* | -3.062176* | -3.557715* |
| 2   | 51.37258 | 5.829814 | 9.15e-06 | -3.197113 | -2.153260 | -3.020452 |

Note: The superscript * represents the best lag order determined according to the inspection criteria.

3.3. Test of the stability of VAR model
In this paper, the VAR model has 3 variables, and the lag period is 1, so the VAR model needs 3 points to fall within the unit circle to be stable. It can be seen from the results that all the eigenvalues fall within the unit circle, indicating that the established VAR model with a lag period of 1 is stable.
3.4. Cointegration test

It can be seen from Table 3 that Johansen's maximum eigenvalue and trace statistic value two cointegration test methods both show that under the significance of 5%, there are at least two cointegration relations between the variables lnDG, lnSRI and lnGDP, namely the three There is a long-term correlation between them.

Table 3. Johansen Cointegration Relation Test Results.

| Null hypothesis          | Eigenvalue | Trace Statistic | 5% Critical Value | P value |
|--------------------------|------------|-----------------|-------------------|--------|
| None*                    | 0.693232   | 32.50603        | 29.79707          | 0.0238 |
| At most 1                | 0.219865   | 8.872786        | 15.49471          | 0.3773 |
| At most 2*               | 0.177454   | 3.907024        | 3.841466          | 0.0481 |

| Null hypothesis          | Eigenvalue | Max − Eigen Statistic | Critical Value | P value |
|--------------------------|------------|-----------------------|----------------|--------|
| None*                    | 0.693232   | 23.63324              | 21.13162       | 0.0218 |
| At most 1                | 0.219865   | 4.965763              | 14.26460       | 0.7462 |
| At most 2*               | 0.177454   | 3.907024              | 3.841466       | 0.0481 |

Note:* indicates that the null hypothesis is rejected under the significant condition of 5%

3.5. Granger causality test

The above-mentioned cointegration test can only show that there is a long-term stable equilibrium relationship between lnDG, lnSRI and lnGDP, and whether there is a statistically causal relationship requires further testing. This paper conducts Granger causality test based on the VAR model.
established above to analyze the relationship between the three variables. The test results are shown in Table 4.

| Dependent variable: lnSRI | Excluded | Chi-sq | df  | Prob. | result                        |
|---------------------------|----------|--------|-----|-------|-------------------------------|
| lnGDP                     | 0.027465 | 1      | 0.8684 | accept the null hypothesis    |
| lnDG                      | 0.650896 | 1      | 0.4198 | accept the null hypothesis    |
| All                       | 3.550047 | 2      | 0.1695 | accept the null hypothesis    |

| Dependent variable: lnGDP | Excluded | Chi-sq | df  | Prob. | result                        |
|---------------------------|----------|--------|-----|-------|-------------------------------|
| LnSRI                     | 0.139127 | 1      | 0.7092 | accept the null hypothesis    |
| lnDG                      | 0.099395 | 1      | 0.7526 | accept the null hypothesis    |
| All                       | 0.163439 | 2      | 0.9215 | accept the null hypothesis    |

| Dependent variable: lnDG  | Excluded | Chi-sq | df  | Prob. | result                        |
|---------------------------|----------|--------|-----|-------|-------------------------------|
| lnSRI                     | 0.002725 | 1      | 0.9584 | accept the null hypothesis    |
| lnGDP                     | 11.40480 | 1      | 0.0007 | reject the null hypothesis    |
| All                       | 12.08470 | 2      | 0.0024 | reject the null hypothesis    |

It can be seen from Table 4 that there is a causal relationship between marine human resource development and marine economic development. The specific conclusions are as follows: (1) When marine scientific research input lnSRI is used as the dependent variable, neither marine economic lnGDP nor marine education input lnDG is the Granger cause of lnSRI; (2) When marine economic lnGDP is the dependent variable, marine scientific research input lnSRI and marine Education investment lnDG is not the Granger cause of lnGDP; (3) When marine education lnDG is used as the dependent variable, at a significant level of 5%, marine scientific research investment lnSRI is not the Granger cause of lnDG, but marine economic development lnGDP and the joint two variables are Granger reason of lnDG.

3.6. Impulse response function analysis

In the VAR model, the impulse response function describes the impact of an endogenous variable on itself and all other endogenous variables [7]. The horizontal axis represents the lag order in years, and the vertical axis represents the degree of reflection.
It can be seen from Figure 2 that when marine scientific research investment is disturbed or impacted by the marine economy and fails to respond in the first period, it then begins to decline, and then rises to above zero after a brief decline, which tends to be a positive effect; when marine scientific research investment was disturbed or impacted by marine education investment, it did not respond in the first period, and then began to rise, reaching a peak of 0.0193 in the third period, indicating that for every 1% increase in marine education investment, marine scientific research investment will increase. An increase of 0.0193%, and a gradual decline thereafter, but the overall response is still positive.

It can be seen from Figure 3 that when the marine economy is disturbed or impacted by marine scientific research input, it responds negatively in the first phase, and then slowly rises after the decline, but the overall response is still negative, indicating that the quality of marine scientific research personnel is not high and seriously affected The development of the marine economy; when the marine economy is disturbed or impacted by marine education investment, it did not respond in the first period, and then began to rise, reaching a peak of 0.0048 in the third period, and then showing a downward trend, but the overall response was positive. The continuous positive response has shown
that the marine education investment has been increasing year by year, which has brought a stable and continuous effect on the increase of the marine economy.

![Graph showing impulse response function](image)

**Figure 4.** The impulse response function graph of lnDG to lnSRI, lnGDP and lnDG.

It can be seen from Figure 4 that when marine education investment is disturbed or impacted by marine scientific research investment, it responds positively in the first period, and reaches the maximum value of 0.0697. In the third period, it drops below 0, resulting in a continuous negative response until only in the tenth period has the upward trend gradually; when the marine education investment is disturbed or impacted by the marine economy, it responds negatively in the first period, and then rises sharply, reaching a peak of 0.0671 in the fifth period, and then slowly declines. Shanghai has a positive response to investment in marine education.

3.7. *Analysis of variance*

Variance decomposition is to further analyze the contribution of each endogenous variable to the predicted variance. By calculating the mutual contribution of lnDG, lnSRI and lnGDP variables, the relationship between marine human resource development and marine economic development can be analyzed.

**Table 5.** Variance decomposition results of lnGDP.

| Period | S.E.  | LNSRI  | LNGDP  | LNDG  |
|--------|-------|--------|--------|-------|
| 1      | 0.172609 | 1.878939 | 98.12106 | 0.000000 |
| 2      | 0.218948 | 2.406848 | 97.50700 | 0.086155 |
| 3      | 0.240294 | 3.016962 | 96.83406 | 0.148975 |
| 4      | 0.250231 | 3.631723 | 96.18812 | 0.180158 |
| 5      | 0.254904 | 4.205654 | 95.60194 | 0.192405 |
| 6      | 0.257284 | 4.718900 | 95.08595 | 0.195152 |
| 7      | 0.258769 | 5.166932 | 94.63952 | 0.193544 |
| 8      | 0.259971 | 5.552911 | 94.25694 | 0.190148 |
| 9      | 0.261127 | 5.883209 | 93.93059 | 0.186196 |
| 10     | 0.262305 | 6.165073 | 93.65267 | 0.182259 |
It can be seen from Table 5 that excluding the impact of lnGDP on itself is the most significant, the average variance contribution rate of marine scientific research investment lnSRI to marine economic development lnGDP is greater than the average variance contribution rate of marine education investment lnDG to marine economic development lnGDP, and is rising steadily. In other words, the impact of marine scientific research investment lnSRI on marine economic development lnGDP remains lasting and stable. The impact of marine economic development lnGDP on itself was 98.12% in the first year, and then slowly declined, and basically stabilized at 93.65% after the tenth year; the impact of marine economic development lnGDP on lnSRI from marine scientific research input was 1.879% in the first year. Since then, there has been a growth trend; the impact of ocean economic development lnGDP on lnDG from marine education investment was 0% in the first year, and then increased year by year, and basically stabilized at 0.18% in the tenth year, indicating that the impact of marine education investment lnDG on marine economic development lnGDP is weak and lasts for a long time on the lag. Marine scientific research investment is the main driving force to promote the development of marine economy, that is, marine scientific research investment can stimulate the positive development of marine economy. However, the contribution rate of marine education investment to marine economic development is very low, and has shown a downward trend in recent years. Insufficient investment in marine education has seriously affected the quality of marine scientific research personnel and led to the undesirable development of the marine economy.

4. Conclusion and suggestion

This paper conducts an empirical analysis on the relationship between marine human resource development and marine economic development, and finally draws the following conclusions:

(1) From the perspective of the VAR model, there is a long-term equilibrium relationship between marine human resource development, namely scientific research investment and education investment of marine is consistent with the economic development. The development of marine human resources has a positive impact on the development of marine economy.

(2) From the perspective of Granger causality, on the whole, marine human resource development is not the Granger reason for marine economic development, and marine economic development is not the Granger reason for marine human resource development; specifically speaking, marine economic development is the Granger reason for marine education investment, and the combination of marine economic development and marine scientific research investment is also the Granger reason for marine education investment, but marine scientific research investment is not the Granger reason for marine education investment.

(3) From the perspective of impulse response function, marine scientific research investment and marine education investment have a positive response to the impact of marine economic development, and the impact of marine economic development on the development of marine human resources is a positive trend.

(4) From the perspective of variance decomposition, the average variance contribution rate of marine scientific research investment to marine economic development is higher than that of marine education investment to marine economic development, and the overall variance is at a steady rising level. The contribution rate of marine education investment to marine economic development is relatively low, and has shown a downward trend in recent years, and the supply of marine talents is insufficient.

From the above conclusions, it can be seen that the development of marine human resources can promote the development of the marine economy, but it is mainly because the contribution of marine scientific research investment is relatively large, while the contribution of marine education
investment is relatively small, resulting in insufficient supply of marine talents and affecting the
development of marine economy. Therefore, in order to promote the construction of a maritime power,
the following suggestions are made: (1) Increase investment in marine education. Appropriately
increase the number of high-quality talents such as marine masters and doctors, strictly control and
strengthen training, enhance the development of marine human resources, and promote the steady
development of marine economy. (2) Build a stable marine talent team structure, strengthen the
introduction of marine talents, and provide marine talents with better benefits, salary standards, higher
social recognition, and better career development space. Only by creating such a superior talent
environment can it form a lasting attraction to talents. At the same time, a variety of channels are used
to recruit talents, especially to attract top-notch talents from overseas and studying abroad to serve my
country's marine industry. (3) Increase government investment in marine scientific and technological
innovation. Innovation is the first driving force for development. Marine technological innovation is
the core driving force for the development of the marine economy. The development of the marine
economy needs to rely on marine human resources. The effective development of marine human
resources can lay a foundation for building a marine power with advanced marine technology and
developing marine economy Talent base.

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