Research on Shanghai Port Logistics Based on VAR Model

Weiwei Ji1

1 College of Transport & Communications, Shanghai Maritime University, Shanghai, 201306, China

*Corresponding author’s e-mail: 202030610137@stu.shmtu.edu.cn

Abstract. This article mainly analyzes how to use the vector autoregressive VAR model to study the development of Shanghai port logistics. First, the use of co-integration test to analyze the long-term co-integration relationship between Shanghai port logistics and the regional economy; Then, by constructing a vector autoregressive model of port cargo throughput and Shanghai's GDP, construct an impulse response function to analyze the dynamic mechanism between the two; Then analyze the contribution rate between the two through variance decomposition.

1. Introduction

In recent years, with the rapid development of the global economy, ports have increasingly become an important link for trade links between countries. It is under this background that port logistics has flourished. The development of port logistics has not only continuously optimized and upgraded the functions of the port itself, it has also promoted the economic development of the city where the port is located. At the same time, the development of urban economy has provided support and guarantee for the development of port logistics.

Foreign research on the relationship between logistics and economy is relatively extensive, and has not started the rating research of port logistics capabilities. It mainly uses qualitative research methods to discuss the importance of port development to urban economic development. Through reading the literature, in 1953, the Delaware Port Authority of the United States published "The Value of Each Ton of Cargo to the Regional Economy" [1], which can be said to be the first article in the world to study the relationship between ports and regional economies. Jane Bryan, Max Munday, Davidpickernell and Annette Roberts (2006) [2] pointed out that industries that rely on port development are the main support of the regional economy, and the port industry is also a fast-growing industry that contributes more to the economy. Bottasso et al.[3]analyzed the spillover effect of port logistics on the relationship of regional economic development by using the GMM estimation method and establishing a spatial panel data econometric model. In China, port logistics is a new research field that has only been put forward in recent years. The research on port logistics has gone through a research phase from basic construction to management. At the beginning, qualitative research was transitioned to quantitative research of selecting indicators. Hu Yuying et al. established a VAR model to analyze the relationship between the cargo throughput of Tianjin port and the GDP of Tianjin area [4]. Chen Na uses the entropy weight method to calculate the weights of the two subsystems of Shanghai Port Logistics and Shanghai Economy, thereby calculating the order parameters of the two subsystems, and constructs the coordination degree model through the order parameters of these two subsystems Perform analysis [5]. Qiu Chunlong (2014) [6] studied the relationship between urban economy and port logistics. Taking Xiamen Port as an example, the research results show that there is a mutual influence between cargo
throughput and GDP for a certain length of time, as well as other short-term effects, such as regional GDP and total net exports and GDP only have a short-term impact.

2. Empirical analysis of Shanghai port logistics and regional economy

Based on the analysis of the relationship between port logistics and regional economy at home and abroad, this article uses the VAR model to analyze the interactive relationship between Shanghai port logistics and Shanghai’s economic development from a quantitative perspective, which is for the sustainable development of Shanghai’s port logistics industry and economy. Provide the necessary basis for decision-making.

2.1. Model selection and index selection

In order to reasonably and objectively evaluate the development status of Shanghai port logistics and regional economy, as well as comprehensive previous studies, this paper selects port cargo throughput as an indicator of Shanghai port logistics development. This paper selects the port cargo throughput and GDP output value of Shanghai from 1990 to 2019. The sample size is 30. The data are from the "Shanghai Statistical Yearbook" from 1990 to 2019. The following table shows the main representative variables of port logistics and regional economy in Shanghai Port City

| variable                      | Original sequence | Logarithm | First-order difference sequence |
|-------------------------------|-------------------|-----------|---------------------------------|
| Cargo Throughput of Shanghai Port | GIP               | LNGIP     | DLNGIP                          |
| Shanghai GDP                  | GDP               | LNGDP     | DLNGDP                          |

2.2. Stationarity test

Because the time series selected in this article are mostly non-stationary, in order to avoid the pseudo-regression phenomenon in the regression equation, the unit root test is performed before the analysis to select stable variables for regression. Choose ADF test here to judge whether each series is stable. During the operation of Eviews8.0, according to the minimum criterion of AIC value, SC value and HQ value, it is judged whether the intercept term and the trend term are not the most appropriate in the test equation. The ADF inspection results are as follows.

| variable | ADF value | ADF threshold | P value | Stationarity    |
|----------|-----------|---------------|---------|----------------|
| LNGIP    | -1.152233 | -3.689194     | -2.971853 | 0.6803         | Nonstationary |
| LNGDP    | -3.296031 | -3.737853     | -2.991878 | 0.0265         | Smooth **     |
| DLNGIP   | -1.974081 | -2.650145     | -1.953381 | 0.0478         | Smooth **     |
| DLNGDP   | -5.172511 | -4.467895     | -3.644963 | 0.0024         | Smooth *      |

(Note: **Indicates that the null hypothesis is rejected at the 5% level, *Indicates that the null hypothesis is rejected at the 1% level)

From the test results, the original sequence LNGIP rejects the null hypothesis, but LNGIP accepts the null hypothesis, so the original sequence is not stationary. The corresponding ADF values of the first-order difference series of LNGIP and LNGDP are both smaller than the critical value, which reject the null hypothesis at the 5% and 1% level, respectively, so the first-order difference series are all stationary series. The initial conditions for establishing VAR are met. In order to analyze the co-
integration relationship of the same-order difference sequence, the co-integration test is performed below.

2.3. Cointegration test

The co-integration relationship can be explained as a long-term stable equilibrium relationship between variables. First, determine the maximum lag order of the model. According to the AIC and SC information criteria, the maximum order is when the two values are the smallest at the same time. The table of the optimal lag order determined by the operation of Eviews8.0 is as follows.

| Lag | LogL  | LR   | FPE  | AIC   | SC    | HQ   |
|-----|-------|------|------|-------|-------|------|
| 0   | -22.80293 | NA   | 0.023104 | 1.907918 | 2.004694 | 1.935786 |
| 1   | 87.49562   | 195.1436 | 0.00000651 | -6.268894 | -5.978564 | -6.185289 |
| 2   | 98.61624   | 17.96408* | 3.79e-06* | -6.816634* | -6.332750* | -6.677293* |
| 3   | 101.8178   | 4.679267 | 4.10e-06 | -6.755218 | -6.077782 | -6.560141 |
| 4   | 103.5273   | 2.235422 | 5.06e-06 | -6.579022 | -5.708032 | -6.328208 |

According to the five kinds of lag order provided by Eviews8.0, it can be seen from the above table that when the lag order is 2, AIC and SC reach the minimum at the same time. Therefore, this article should select the second order as the maximum lag order to establish the VAR (2) model.

Since the two time series data are both first-order identical, a co-integration test can be performed on LNGIP and LNGDP to see whether there is a long-term equilibrium relationship between the two. In this paper, the residual-based EG method is used for co-integration test. First, the co-integration regression is performed on LNGIP and LNGDP. The results are as follows (t-value and p-value in parentheses):

\[
\text{LNGIP} = 0.541407 \times \text{LNGDP} + 5.638363 \\
(16.11519) \quad (18.61201) \\
(0.0000) \quad (0.0000) \\
R^2 = 0.902676, F=259.6993, n=30
\]

It can be seen that the equation has a good fit, and the residual sequence is error for unit root test. In this article, we choose not to contain trend items and constant items, and the test results are shown in the table below.

| ADF value | 0.01  | 0.05  | 0.1   | P value |
|-----------|-------|-------|-------|--------|
| -2.465761 | -2.650145 | -1.953381 | -1.609798 | 0.0157 |

The test result shows: due to t=-2.465761<-1.953381. It shows that the residual sequence rejects the null hypothesis at the 5% level and accepts the conclusion that there is no unit root, indicating that LNGIP and LNGDP have a long-term stable co-integration relationship.

It can be seen from the above formula that in the long term, for every 1% change in LNGDP, LNGIP will change in the same direction by 0.541407%. From a long-term perspective, the elasticity coefficient of Shanghai port logistics to Shanghai’s GDP is 0.541407, between the two There is a significant positive relationship.

2.4. Establishment of VAR model

In this paper, a VAR model is established by a system consisting of two variables consisting of port cargo throughput as a logistics index and Shanghai's GDP as an economic index. From the above analysis, the optimal lag order p of the model is 2. Next, the stability of the VAR model is tested. After
testing, the VAR model with a lag period of 2 and 2 endogenous variables, The characteristic root polynomial has $2 \times 2 = 4$ characteristic roots. The modulus of the reciprocal of each characteristic root is inside the unit circle, and there is no root outside the unit circle. Therefore, the VAR model passes the stability test and is considered stable. The test results are shown in the figure below.

![Inverse Roots of AR Characteristic Polynomial](image)

Figure 1 AR root test result graph

The result of the VAR model estimation is:

$$
\text{LNGIP} = 1.571552 \times \text{LNGIP}(-1) - 0.613506 \times \text{LNGIP}(-2) - 0.636673 \times \text{LNGDP}(-1) + 0.627969 \times \text{LNGDP}(-2) + 0.625305
$$

$$
\text{LNGDP} = 0.178030 \times \text{LNGIP}(-1) - 0.077049 \times \text{LNGIP}(-2) + 1.194620 \times \text{LNGDP}(-1) - 0.285414 \times \text{LNGDP}(-2) - 0.154691
$$

2.5. Granger causality test

The aforementioned co-integration test can only show that there is a long-term stable equilibrium relationship between LNGIP 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 causal relationship between two variables. The test results are shown in the table below.

| Null Hypothesis                        | Obs | F-Statistic | Prob. | conclusion |
|----------------------------------------|-----|-------------|-------|------------|
| LNGDP does not Granger Cause LNGIP     | 28  | 3.81205     | 0.0372| Refuse     |
| LNGIP does not Granger Cause LNGDP     |     | 6.67051     | 0.0052| Refuse     |

It can be seen from the above table that at the 5% confidence level, rejecting LNGDP is not the original hypothesis of Granger reason for LNGIP, that is, the change in LNGDP is the Granger reason for the change in LNGIP, indicating that the change in Shanghai’s GDP is Under a certain level, it will promote the development of Shanghai port logistics; At the same time, with a confidence level of 1%, the original hypothesis that rejecting LNGIP is not the Granger reason for LNGDP, that is, the change in LNGIP is the Granger reason for the change in LNGDP, indicating that the development of Shanghai’s port logistics will promote Shanghai’s economy. Development has a certain contribution to the economy of Shanghai.

2.6. Impulse response

On the basis of the VAR model, we can use the impulse response function to further analyze the dynamic relationship between the two. The results of impulse response to LNGIP and LNGDP are shown in Figure 2 and Figure 3. The solid lines represent the trends of LNGIP and LNGDP respectively, and the dotted lines represent the plus or minus two standard errors of the trends.
Figure 2 shows the impulse response of Shanghai’s GDP to Shanghai’s ports. The horizontal axis represents the number of lag periods, and the vertical axis represents the fluctuation of port logistics caused by the impact of Shanghai’s GDP. From Figure 2, we can see that LNGIP did not immediately respond to the disturbance from LNGDP. The response value of LNGIP in the first phase was 0, and then dropped rapidly, and reached the lowest point of the impact in the fourth phase, with a response value of -0.038144%. After the fourth period, it bottomed out and the negative response gradually decreased. In the ninth period, the impact turned positive, and then stabilized at about 0.009826%.

The impact of Shanghai's GDP on port cargo throughput GIP was negative in the first nine periods. This finding is unprecedented in many documents. There may be two reasons for this incident. First, the decline in Shanghai’s dependence on foreign trade has made the GDP growth of the economy’s GDP have not brought about a proportional increase in the volume of imports and exports of goods. With the growth of Shanghai’s economy, Shanghai has increased its investment in intermediate products to localize and increase its value. Focus on the localized market. Second, competition from major ports and competition between waterway transportation and public, rail, and air transportation have shifted the throughput demand of Shanghai’s ports. Therefore, in the context of the decline in economic outward orientation and the decline in the growth rate of Shanghai’s total import and export trade, Shanghai’s ports are still facing competition from land transportation and other ports. With the growth of the economy, Shanghai has gradually turned to road, rail transportation and other ports, Therefore, the existence of the above factors has caused the economic growth of Shanghai to not promote the rapid development of Shanghai port logistics in the early stage. Of course, with the passage of time, from a general point of view, Shanghai’s economic development still drives the development of Shanghai’s port logistics to a certain extent, although this pulling effect is very weak.

Figure 3 shows the impact of Shanghai port cargo throughput on Shanghai’s GDP (LNGDP impulse response function to LNGIP). It can be found that after a positive shock response to Shanghai port cargo throughput in the current period, the current response value is 0.003221%, peaked in the seventh period, with a response value of 0.050059%. After that, the impact of LNGIP on LNGDP declined, and then about 0.031166% stabilized. Through the impulse response function graph, it can be judged that the development of Shanghai port logistics has a continuous positive impact on the regional economic development of Shanghai. This discovery coincides with the positive role of port logistics in promoting regional economic development.

2.7. Analysis of variance decomposition

The variance decomposition can be used to see the contribution of each variable's change to the VAR system variable. This article is based on the VAR model for variance decomposition, and the specific variance decomposition results are as follows.
It can be seen from the figure that the contribution of LNGDP to LNGIP gradually increases, reaching about 12% in the seventh phase, and then reaching 10% in the twelfth phase and maintaining a long-term stability, while the contribution of LNGIP to itself is gradually decreasing. And stabilized at around 90% by the twelfth period. This shows that Shanghai's regional economic development has only a weak leading role in Shanghai's port logistics. At the same time, LNGIP's contribution to LNGDP gradually increased. By the eleventh period, the contribution rate reached 84% and remained stable for a long time, while the LNGDP's contribution to itself gradually decreased until the eleventh period reached 16% and remained stable for a long time. This shows that the development of Shanghai port logistics has significantly promoted the development of Shanghai's regional economy.

3. Conclusions and recommendations

3.1. Main conclusions

This paper selects the data of Shanghai port cargo throughput and Shanghai’s GDP from 1990 to 2019 as samples to construct evaluation indicators for port logistics and regional economy. In terms of empirical research, this paper adopts a vector autoregressive model to systematically analyze the interactive relationship between Shanghai’s port logistics and regional economic development. Based on this article, the following conclusions are obtained:

(1) Through empirical analysis, the logarithmic value of Shanghai port cargo throughput and Shanghai’s GDP is a first-order single integer, and there is a long-term stable dynamic relationship between the two; in the post-second-order VAR model, there is a Granger causality between port cargo throughput and Shanghai’s GDP. This reflects from the side that the development of Shanghai’s port logistics will promote the development of Shanghai’s economy. Similarly, The economic development of Shanghai will also stimulate the development of Shanghai port logistics to a certain level.

(2) In the early stage, Shanghai’s economic growth did not have a positive impact on Shanghai’s port cargo throughput. This may be due to the slowdown in foreign trade growth caused by the decline in Shanghai’s economic outward orientation, as well as waterways. The competition of transportation methods and the competition among neighboring ports have adversely affected Shanghai's port logistics. But in the long run, Shanghai's economic growth will still promote Shanghai's port logistics.

(3) The increase in cargo throughput of Shanghai ports can promote the growth of Shanghai's GDP, which is consistent with traditional positive promotion theories such as agglomeration economies, economies of scale, and industry linkage effects. Finally, the variance decomposition shows that the changes in Shanghai’s regional economic GDP can explain 16% of the fluctuations in Shanghai’s port cargo throughput, while the Shanghai port’s cargo throughput can explain 84% of the fluctuations in Shanghai’s regional economic GDP. There is a dynamic relationship between them.
3.2. Suggestions for Shanghai Port Development

(1) Expand the functional construction of Shanghai port and enhance the core competitiveness of the port. Development competition of modern ports is no longer a competition between traditional hardware, but a competition between software such as modern management models and functional policies. In the future, the construction of Shanghai port logistics must rely on the platform of the Shanghai International Shipping Center and the establishment of the Shanghai Free Trade Zone, closely focus on the basic connotation of software construction, and combine the characteristics of port logistics to conduct a more systematic research on the construction of Shanghai port logistics software. In this way, the two-wheel drive of hardware and software can be realized and the core competitiveness of Shanghai Port can be improved.

(2) Accelerate the integration of transportation resources in the port and city

First, we must increase the integration of resources for various transportation entities, focus on sea-rail combined transportation, and form a sea-rail strategic alliance. Facing the competition of railway transportation represented by China-Europe Railway Express and the competition of Ningbo-Zhoushan Port port logistics, Shanghai Port should strive to open up more ocean trunk lines, build fast passages for gathering and dispersing ports, and form a sea port as a port. The center’s highly integrated and closely coordinated port collection and distribution system can expand the channel and deepen the port depth to increase the capacity to accommodate large ships, improve the transport network connection between the Shanghai port and the economic hinterland, enhance multimodal transport, and improve the collection. Evacuation system to save switching costs.

(3) Improve the construction of port logistics information

Information networking is an inevitable requirement for the construction of high-quality ports, and it is also the fundamental technical guarantee for the development of modern logistics in ports. With the continuous breakthrough of blockchain technology and 5G technology, it also brings new development opportunities to port development. The development of Shanghai port and shipping enterprises should strengthen the in-depth integration with the Internet, big data, and artificial intelligence technology in order to promote The efficiency of Shanghai port logistics has been improved.

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