EMPIRICAL ANALYSIS ON THE IMPACT OF ECONOMIC DEVELOPMENT IN NORTHEAST CHINA ON THROUGHPUT OF DCT

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Abstract: This paper tries to study the dynamic relationship between throughput of DCT and economic development of Northeast China with time-varying parameter state space model. The following three indicators are selected to be the explanatory variables: 1) actual GDP; 2) total value of export & import; 3) proportion of second industry output value to GDP, which represent the overall economic level, degree of economic opening and industry structure respectively. The conclusions are that the first and second indicators always have positive impact on the throughput of DCT, and the second indicator’s influence has become more obvious than the first one since 2002. But the third indicator has a negative impact on it, and furthermore this influence has become stronger since 2000. Government should fully consider the impact of industry structure on the long-term development of DCT in order to avoid waste of resources.

Key word: DCT, Hinterland, Time-varying parameter state space model

1. INTRODUCTION

Boasted of its advantageous natural conditions, the container throughput of Dalian Port (DCT) has always been lagging behind other major seaports in China, which is illustrated in Table 1. Some scholars, such as Mr. Sun Guangqi (2004), think the backward economic development and majority of heavy industry in Northeast China are the major reasons for the situation, but the analysis was mostly conducted in qualitative perspective. Other scholars, such as Mr. Lu Jing (2005), have analyzed the relationship between container throughput of DCT and GDP of its hinterland by linear analysis approach, but the analysis didn’t consider other important economic indicators, and in general regression model $y_t = x_t \beta + u$, the parameter $\beta$ is fixed during samples. But the economic structure has gradually changed in recently years due to various outside impact and policy alteration, so the general fixed parameter model is not suitable for the research.

Table 1 Throughput of Major Container Terminals of China in 2005

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name of Terminal</th>
<th>Throughput (One Thousand TEU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shanghai</td>
<td>18,080</td>
</tr>
<tr>
<td>2</td>
<td>Shenzhen</td>
<td>16,200</td>
</tr>
<tr>
<td>3</td>
<td>Qingdao</td>
<td>6,310</td>
</tr>
<tr>
<td>4</td>
<td>Ningbo</td>
<td>5,210</td>
</tr>
<tr>
<td>5</td>
<td>Tianjin</td>
<td>4,800</td>
</tr>
<tr>
<td>6</td>
<td>Dalian</td>
<td>2,690</td>
</tr>
</tbody>
</table>

Data Source: Communication Statistics Communique in 2005

Some other researches on throughput of container terminal mainly focus on the forecast of the
container throughput, whereas the quantitative study on the correlation between local economic development and throughput of container terminal is rare.

This paper will focus on the dynamic correlation between throughput of DCT and economic development of its hinterland with time-varying parameter state space model. The plan of the paper is as follows: section 2 is the methodology of this paper. In this section we describe the time-varying parameter state space model and select the explanatory variables which represent the economic growth of hinterland. In section 3 we do the data analysis, firstly we analysis the changes of the DCT, actual GDP of northeast China, total value of export & import of northeast China, and proportion of second industry output to GDP in northeast China. Then, we make the Co-integration Examination. Finally, we estimate the parameters of the model. Section 4 is the conclusion of the paper. In section 5, we discuss possible future research directions.

2. Methodology

2.1 Model

In order to represent the dynamic relationship between throughput of DCT and economic development of its hinterland, in this paper, we select the time-varying parameter state space model. The equation of time-varying parameter state space model is as follows:

\[ y_t = x_t \beta_t + z_t \bar{\xi} + u_t \quad t = 1, 2, ..., T \]  

(1)

In above equation, \( z_t \) is the explanatory variable matrix with fixed parameter \( \bar{\xi} \), and \( x_t \) is the explanatory variable matrix with variable parameter \( \beta_t \), while the parameter \( \beta_t \) is the unobserved variable, and must be estimated by the observed variable, \( x_t \) and \( y_t \). In this paper \( \beta_t \) is assumed to estimate with \( AR(1) \), so \( \beta_t \) can be described as follow:

\[ \beta_t = \varphi \beta_{t-1} + \varepsilon_t \]  

(2)

\( \beta_t \) also can be expanded to \( AR(p) \), and assumed that:

\[ (u_t, \varepsilon_t) \sim N \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2 & 0 \\ 0 & 0 \end{pmatrix} \right) , \quad t = 1, 2, ..., T \]  

(3)

Actually time-varying parameter model is part of state space model. Equation (1) equals to the signal equation in the state space model, and Equation (2) equals to the state equation in the state space model. Estimated with the method of Kalman filter, the time-varying parameter model fully displays the change of explanatory variables’ impact on dependent variable during the samples. So this model could overcome the disadvantage of fixed parameter.

2.2 Selection of the explanatory variables

In this paper, we talk about how the hinterland’s economic growth affects the port throughput, so firstly we must talk about which factor affect the throughput of port. We consider that the overall economic level, industry structure, and extroversion of a region have great influence on the container throughput of its port.

So in this paper the following three indicators are selected to explain the throughput changes of DCT: 1) actual GDP of northeast China; 2) total value of export & import of northeast China; 3) proportion of second industry output value to GDP in northeast China, which represent the overall economic level, degree of economic opening and industry structure respectively. In order to avoid
the high multicollinearity, the logarithm of GDP and total value of export & import are used.

The equation of time-varying parameter model on throughput of DCT is as follows:

Signal equation:
\[ \ln(y) = sv1 \times \ln(x_1) + sv2 \times \ln(x_2) + sv3 \times (x_3) \]

State equation:
\[ sv1 = sv1(-1) \]
\[ sv2 = sv2(-1) \]
\[ sv3 = sv3(-1) \]

\( y \): Throughput of DCT
\( x_1 \): Actual GDP
\( x_2 \): Total value of export & import of northeast China
\( x_3 \): Proportion of industrial output value to GDP of northeast China

The coefficients \( sv1, sv2 \) and \( sv3 \) in the model include the impact of three independent variables on the container throughput of DCT in the past 15 years, among which GDP and total value of export & import have adopted logarithmic form, so \( sv1 \) and \( sv2 \) explained the respective influence of one percentage growth of GDP and total value of export & import on throughput of the DCT. From the above trend we could analyze the influence of these explanatory variables on the throughput of DCT.

3. DATA ANALYSIS

3.1 Data Source
“Northeast China” in this paper refers to the following three provinces: Heilongjiang, Jilin, and Liaoning. The annual data of throughput of DCT came from the almanac of Dalian City and Port Dalian. The data of GDP of northeast China, total value of export & import and second industry output value all came from the summary of almanac of the above three provinces.

3.2 Throughput of DCT and GDP of Northeast China

![Fig. 1 Throughput of DCT and actual GDP of Northeast China](image)

In this paper GDP is the actual GDP, which has been adjusted by the price factors. The trend of GDP in Northeast China and throughput of DCT between 1990 and 2005 is illustrated in Fig. 1, from which we could find the two indicators have been increasing steadily, and there has been a rapid increase since 1999.
3.3 Export & import of Northeast China
The Export & Import Volume has been increasing in the past 15 years, which is illustrated in Fig. 2, except a valley during 1998-1999 due the influence of financial crisis in ASEAN countries.

![Fig. 2 Total value of export & import of northeast China](image)

3.4 Proportion of Second Industry Output to GDP in Northeast China
Northeast China is one of the most import industrial bases in China. As illustrated in fig. 3, the proportion of Second Industry Output to GDP fluctuated a little, but maintained average level at 50%.

![Fig. 3 Proportion of second industry output value to the GDP of northeast China](image)

3.5 Co-integration Examination
According to the Co-integration theory, if there is Co-integration relationship between the independent and dependent variables, that is to say the dependent variables can be explained by the linear combination of independent variables. The purpose of Co-integration examination is to eliminate pseudo regression. Engel-Granger Co-integration examination is used in this paper. According to the procedure of E-G examination, the unit root examination of variables should be conducted firstly. With the method of ADF the result of examination is illustrated in Table 2.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>T Value</th>
<th>1% Critical Value</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>-0.6438</td>
<td>-4.9923</td>
<td>Unstable</td>
</tr>
<tr>
<td>$\ln(x_1)$</td>
<td>-1.4834</td>
<td>-4.0044</td>
<td>Unstable</td>
</tr>
<tr>
<td>$\ln(x_2)$</td>
<td>-0.4572</td>
<td>-4.7284</td>
<td>Unstable</td>
</tr>
</tbody>
</table>
According to the unit root examination result, all samples’ level value are unstable series, whereas their single order difference are stable series, so the selected variables are single order integration, that is $y, x_{1,2,3} \sim I(1)$.

Then, unit root examination on residual should be conducted, the residual (e) comes from the equation: $e = y_t - \alpha_1 x_{1t} - \alpha_2 x_{2t} - \alpha_3 x_{3t}$, the result of which is illustrated in Table 3:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>T Value</th>
<th>5% Critical Value</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>-3.4343</td>
<td>-3.0989</td>
<td>Stable</td>
</tr>
</tbody>
</table>

Table 3 Unit examination result of residual

So, it is co-integration between throughput of DCT and the three independent variables, and there is long-term stable relationship between them.

3.6 Discussion of Results

We can estimate the value of time-varying parameter, and the following equation is the parameter value of the last year (2005):

$$y = 7.19 + 74.55 \ln(x_1) + 148.19 \times \ln(x_2) - 21.10 \times (x_3)$$

Z value: 6.25 2.76 -5.63

The trend of time-varying parameters: sv1, sv2 and sv3, which represent the impact of actual GDP, total value of export & import and the proportion of second industry output value on the throughput of DCT, is illustrated in Fig. 4. From the figure we could discover the following result:

(1) In most years actual GDP and total value of export & import have positive correlation with throughput of DCT, and the latter’s influence has become more obvious than the first one since 2002. But the proportion of second industry output value has negative correlation with throughput of DCT.

(2) The impact of actual GDP on throughput of DCT has been growing smoothly since 2000. In 2000, one percentage increase in actual GDP could only bring out throughput growth by 3,178TEU. In 2002, one percentage increase in actual GDP could produce throughput growth by 5,020TEU, and the same figure became 7,456TEU in 2005.
(3) Total value of export & import has become more influential on the container throughput of DCT since 2002. In 2001 one percentage increase in the total value of export & import could bring out increase of container throughput by 1,088TEU, while this value became 3,336TEU in 2002, and the same figure jumped to 14,800TEU in 2005. The trend explained the fact that the change in export & import commodity composition has significant impact on the container throughput of DCT.

(4) The proportion of second industry output value to GDP kept negative correlation with container throughput in many years. The coefficient value has been around 3 between 1990 and 2000, which means one percentage increase of the proportion would bring out decrease of throughput by 30,000TEU. The absolute value of the influential parameter has expanded since 2001. Up to 2005, one percentage increase in the proportion of second industry output value would cause decrease of container throughput by 210,000TEU.

4. Conclusions
This paper have analyzed the impact of actual GDP, total value of export & import and proportion of second industry output value to GDP in northeast China on the throughput of DCT between 1990 and 2005. Firstly, Engel—Granger co-integration is used to testify the long-term equilibrium relationship between the above-mentioned three indicators and throughput of DCT. Secondly, time-varying parameter model is used to estimate the dynamic influence of the three indicators on throughput of DCT between 1990 and 2005.

With the analysis on the modeling result, the opinions of some scholars like Mr. Sun Guangqi, are further testified that it is development of heavy industry in northeast China that has strong negative impact on the container throughput of DCT, moreover the new conclusion is found that the impact has become stronger since 2000.

The fact also been discovered that actual GDP and total value of export & import has ever-increasing impact on the growth of container throughput of DCT. Such trend indicates the overall rapid economic growth in northeast China in recent years and adjustment to composition of export & import commodity is important factor to support the increase of container throughput of DCT.

Heavy industry in Northeast China possesses comparative advantage in domestic economy, and future development of northeast China will also focus on machinery, resource exploitation, and fundamental raw materials industries. So the planning of DCT need also take the above trend into consideration in order to avoid waste of resources.

5. Recommendations for Future Research

This paper has only made simple analysis of the influential factors on the throughput of DCT with time-varying parameter state space model. If the data of second industry output value can be disassembled, further analysis on the influence of each part of it on the throughput of DCT can be conducted, and more detailed proposals could be made. It will be the direction of further study.

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