Grey Analysis on Logistics and Textile Industry in Hebei Province

Hui Hongqi¹, Zu Yidan²
¹ College of Economics and Management, Hebei University of Science and Technology, Shijiazhuang, P.R. China, 050018
² College of Textile and Garment, Hebei University of Science and Technology, Shijiazhuang, P.R. China, 050031

Abstract Analyze the relationship of major indexes between logistics industry and textile industry in Hebei province by the method of degree of grey incidence. The output value of logistics industry has high incidence degree with textile profit, value-added of textile; export value, chemical fiber output, cotton yarn output and cotton cloth output, whose synthetic degree of grey incidence exceed 0.6 wholly. The indexes of high incidence degree are chosen to set up MGM(1,n) grey forecast model, which has better precision.

Key words Logistics industry, Textile industry, Degree of grey incidence, Grey forecast

1 Introduction
Belonging to backbone industry of Hebei province, logistics and textile have great function in economic development. They contribute nearly 20% GDP to Hebei province. At the same time, textile industry has great relationship with logistics. As we know, during the process of textile production and sale, average of 5% time is used to machine and manufacture, while the other 95% is used to store, handle, wait for machining and transport. The development of logistics will reduce the cost of textile manufacture and management, and the development of textile will promote the growth of logistics. Therefore, it is worth studying the relationship of major indexes of them.

The studies of logistics have become variable at present, involving key link of logistics. Generally speaking, the researches have emphasized all kinds of functions of logistics, tending to supply chain management, less combining with concrete industry. Only integrating logistics with the concrete industry, especially emphasizing the industry characteristics, to study on storing, transportation and distribution of concrete industry, can profits increase and cost decrease. Studies on logistics and textile industry have mainly aimed at qualitative research, while quantitative studies, especially grey analysis, have not been familiar.

Grey method has been widely used in economic field with its gradually developing and perfecting. For the sake of speciality of economic data, grey forecast can be used to forecast even if the data are few. It may result in good effect in the study of logistics and textile industry if combining the degree of grey incidence with grey forecast

2 the Principle of Degree of Grey Incidence
The grey incidence method is an objective analysis method, applying to such sample as the sample number is large or small, and to the one which has regular pattern or not. The calculation work is not much, and calculation is convenient. The basic thought is to judge whether the incidence degree is close according to the similar degree of geometrical shape of sequence curve. The more similar the sequence curve has, the more degree of grey incidence the data sequence has. Otherwise, the less. The steps of grey incidence analysis are as follows:

2.1 The Behavior Sequence of Factor
Given that $X_i$ is system factor, its sequent observation data are $X_i(k) (k = 1, 2, \cdots, n)$, and $X_i = [X_i(1), X_i(2), \cdots, X_i(n)]$ is called behavior sequence of factor.

2.2 The Absolute Degree of Grey Incidence
Given the behavior sequence $X_i = [X_i(1), X_i(2), \cdots, X_i(n)]$, its initial zero image is
\[ X_i^0 = [X_i(1) - X_i(1), X_i(2) - X_i(1), \ldots, X_i(n) - X_i(1)] \]; then \[ \varepsilon_{ui} = \frac{1 + |S_i| + |S_i|}{1 + |S_i| + |S_i| - S_i} \] is the absolute degree of grey incidence between \( X_0 \) and \( X_i \).

Wherein

\[ |S_i| = \sum_{k=1}^{n-i} X_i^0(k) + \frac{1}{2} X_i^0(n), \quad |S_i - S_0| = \sum_{k=1}^{n-i} [X_i^0(k) - X_i^0(k)] + \frac{1}{2} [X_i^0(n) - X_i^0(n)] \].

### 2.3 The Relative Degree of Grey Incidence

Given system factor \( X_i \), its initial image is \[ X_i' = \begin{bmatrix} X_i(1) & X_i(2) & \cdots & X_i(n) \end{bmatrix} \]; then

\[ r_{ui} = \frac{1 + |S_i'| + |S_i'|}{1 + |S_i'| + |S_i'| - S_i'} \] is the relative degree of grey incidence between \( X_0 \) and \( X_i \).

### 2.4 The Synthetic Degree of Grey Incidence

Given \( \theta \in [0, 1] \), then \( \rho_{ui} = \theta \varepsilon_{ui} + (1 - \theta) r_{ui} \) is the synthetic degree of grey incident. The value of \( \theta \) is between 0 and 1, commonly assumed \( \theta = 0.5 \). If the absolute degree of grey incidence is more concerned, the value of \( \theta \) can be bigger; otherwise, if the relative one is more concerned, smaller.

### 3 The Calculation of Degree of Grey Incidence Between Logistics Industry and Textile Industry

#### 3.1 Influence Factors and Data

According to the analysis of the main factors of affecting textile logistics, the influence factors are textile profit, value-added of textile; export value, chemical fiber output, cotton yarn output and cotton cloth output and so on. The corresponding data are shown in Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Logistics output value (100 million yuan) ( X_0 )</th>
<th>Textile profit (100 million yuan) ( X_1 )</th>
<th>Cotten yarn output (10 000 tons) ( X_2 )</th>
<th>Cotten cloth output (100 million metre) ( X_3 )</th>
<th>Chemical fiber output (10 000 tons) ( X_4 )</th>
<th>Value-added of textile (100 million yuan) ( X_5 )</th>
<th>Export value (100 million dollar) ( X_6 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>498.81</td>
<td>8.5</td>
<td>46.0</td>
<td>16.7</td>
<td>9.2</td>
<td>94.5</td>
<td>10.1</td>
</tr>
<tr>
<td>2002</td>
<td>554.91</td>
<td>13.4</td>
<td>48.3</td>
<td>16.0</td>
<td>10.2</td>
<td>101.5</td>
<td>12.1</td>
</tr>
<tr>
<td>2003</td>
<td>611.96</td>
<td>16.7</td>
<td>49.2</td>
<td>16.3</td>
<td>13.7</td>
<td>108.5</td>
<td>19.1</td>
</tr>
<tr>
<td>2004</td>
<td>724.34</td>
<td>21.1</td>
<td>49.9</td>
<td>18.2</td>
<td>19.8</td>
<td>115.3</td>
<td>32.3</td>
</tr>
<tr>
<td>2005</td>
<td>925.23</td>
<td>25.1</td>
<td>53.6</td>
<td>23.4</td>
<td>28.4</td>
<td>122.2</td>
<td>54.2</td>
</tr>
</tbody>
</table>

Source: Hebei Stat. 2001-2005

#### 3.2 The Calculation of Absolute Degree of Grey Incidence

According to the formula mentioned above (2.2), calculate the initial zero images first, and then calculate the absolute degree of grey incidence, shown in Table 2.

<table>
<thead>
<tr>
<th>( \varepsilon_{01} )</th>
<th>( \varepsilon_{02} )</th>
<th>( \varepsilon_{03} )</th>
<th>( \varepsilon_{04} )</th>
<th>( \varepsilon_{05} )</th>
<th>( \varepsilon_{06} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.528</td>
<td>0.517</td>
<td>0.503</td>
<td>0.522</td>
<td>0.546</td>
<td>0.546</td>
</tr>
</tbody>
</table>

#### 3.3 The Calculation of Relative Degree of Grey Incidence

According to the formula mentioned above (2.3), calculate the initial images and the initial zero images, and then obtain the relative degree of grey incidence, shown in Table 3.

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### Table 3 The Relative Degree of Grey Incidence

<table>
<thead>
<tr>
<th>( r_{01} )</th>
<th>( r_{02} )</th>
<th>( r_{03} )</th>
<th>( r_{04} )</th>
<th>( r_{05} )</th>
<th>( r_{06} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.691</td>
<td>0.776</td>
<td>0.711</td>
<td>0.761</td>
<td>0.817</td>
<td>0.644</td>
</tr>
</tbody>
</table>

#### 3.4 The Calculation of Synthetic Degree of Grey Incidence

In consideration of the rapid economy development trend, the relative incidence degree is more important than the absolute one, therefore, assume \( \theta = 0.4 \). According to the formula mentioned above (2.4), the synthetic degree of grey incidence is shown in Table 4.

### Table 4 The Synthetic Degree of Grey Incidence

<table>
<thead>
<tr>
<th>( \rho_{01} )</th>
<th>( \rho_{02} )</th>
<th>( \rho_{03} )</th>
<th>( \rho_{04} )</th>
<th>( \rho_{05} )</th>
<th>( \rho_{06} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.626</td>
<td>0.673</td>
<td>0.628</td>
<td>0.665</td>
<td>0.709</td>
<td>0.605</td>
</tr>
</tbody>
</table>

#### 3.5 Result Analysis

From Table 4, we know that the synthetic degree of grey incidence is \( \rho_{05} > \rho_{02} > \rho_{04} > \rho_{03} > \rho_{06} \), that is, the importance of affecting factors of textile industry to logistics industry in Heibei province from the top to the bottom is: value-added of textile, cotton yarn output, chemical fiber output, cotton cloth output, textile profit and export value, which matches the fact.

### 4 Grey Forecast of Logistics and Textile Index in Heibei Province

The MGM(1,\( n \)) grey forecast model is chosen, for the model takes several related variables interacted into consideration. Set up differential equation whose variable number is \( n \), and whose equation number is \( n \) too.

According to the calculation of degree of grey incidence, logistics output value has close relations with value-added of textile and cotton yarn output, whose coefficient are 0.709 and 0.673 respectively. Cotton yarn, cotton cloth and chemical fiber all belong to the index of production ability, while value-added, textile profit and export value belong to the index of output value. So logistics output value, value-added of textile and cotton yarn output are chosen to set up MGM(1,3) model.

#### 4.1 Setup and Solution of Model MGM(1,3)

The differential equation is as follows:

\[
\begin{align*}
\frac{dx_1^{(i)}}{dt} &= a_{11}x_1^{(i)} + a_{12}x_2^{(i)} + a_{13}x_3^{(i)} + b_1 \\
\frac{dx_2^{(i)}}{dt} &= a_{21}x_1^{(i)} + a_{22}x_2^{(i)} + a_{23}x_3^{(i)} + b_2 \\
\frac{dx_3^{(i)}}{dt} &= a_{31}x_1^{(i)} + a_{32}x_2^{(i)} + a_{33}x_3^{(i)} + b_3
\end{align*}
\]

Wherein, \( x_1^{(i)} \) is the first accumulation sequence of original sequence \( x_1^{(0)} \). Accumulate from Table 1, thus

\[
Y = \begin{bmatrix} Y_1 & Y_2 & Y_3 \end{bmatrix} = \begin{bmatrix} x_1^{(0)}(2) & x_2^{(0)}(2) & x_3^{(0)}(2) \\ x_1^{(0)}(3) & x_2^{(0)}(3) & x_3^{(0)}(3) \\ x_1^{(0)}(4) & x_2^{(0)}(4) & x_3^{(0)}(4) \\ x_1^{(0)}(5) & x_2^{(0)}(5) & x_3^{(0)}(5) \end{bmatrix} = \begin{bmatrix} 554.91 & 101.5 & 48.3 \\ 611.96 & 108.5 & 49.2 \\ 724.34 & 115.3 & 49.9 \\ 925.23 & 122.2 & 53.6 \end{bmatrix}
\]

Wherein, \( Y_1, Y_2, Y_3 \) represent logistics output value, value-added of textile and cotton yarn output respectively.
Parameter \( a \) and \( b \) can be estimated according to the least square method; and the formula is as follows:

\[
\hat{a}_i = \left[ \hat{a}_{i1}, \hat{a}_{i2}, \ldots, \hat{a}_{in}, \hat{b}_i \right]^T = \left( L^T L \right)^{-1} L^T Y_i \quad (i = 1, 2, \cdots, n)
\]

The sequence forecast accumulation formula is:

\[
\hat{X}^{(1)}(k) = e^{\hat{d}(k-1)} X^{(0)}(1) + \hat{A}^{-1} \left( e^{\hat{d}(k-1)} - I \right) \hat{B}
\]

Wherein \( k = 1, 2, \cdots, n; \) and \( I \) is unit matrix.

Using software Matlab6.5 to calculate, the solution is:

\[
\hat{A} = \begin{bmatrix}
\hat{a}_{i1} \\
\hat{a}_{i2} \\
\vdots \\
\hat{a}_{in}
\end{bmatrix} = \begin{bmatrix}
0.91953 & -2.8396 & -3.7185 \\
-0.0087857 & 0.066698 & 0.10508 \\
0.070554 & -1.0654 & 1.4689
\end{bmatrix} \quad \hat{B} = \begin{bmatrix}
514.42 \\
91.261 \\
45.245
\end{bmatrix} \quad \hat{X}^{(1)}(1) = \begin{bmatrix}
498.81 \\
94.5 \\
46
\end{bmatrix}
\]

After getting the solutions of \( \hat{X}_1^{(1)}(k), \hat{X}_2^{(1)}(k), \hat{X}_3^{(1)}(k) \), calculate the forecast value according to the formula as follows; and the sequence forecast values are shown in Table 5.

\[
\begin{align*}
\hat{X}^{(n)}(k) &= \hat{X}^{(1)}(k) - \hat{X}^{(1)}(k - 1) \quad k = 2, 3, \ldots, n \\
\hat{X}^{(n)}(1) &= \hat{X}^{(0)}(1)
\end{align*}
\]

### 4.2 Model MGM(1,3) Precision Test

Owing to the limit of paper length, only the remainder error is conducted here. That is to judge the model precision by relative error. The remainder error shows in Table 5.

<table>
<thead>
<tr>
<th>Table 5 The Remaider Error Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Logistics output value</strong></td>
</tr>
<tr>
<td>Actual value</td>
</tr>
<tr>
<td>Forecast value</td>
</tr>
<tr>
<td>Absolute error</td>
</tr>
<tr>
<td>Relative error %</td>
</tr>
<tr>
<td><strong>Value-added of textile</strong></td>
</tr>
<tr>
<td>Actual value</td>
</tr>
<tr>
<td>Forecast value</td>
</tr>
<tr>
<td>Absolute error</td>
</tr>
<tr>
<td>Relative error %</td>
</tr>
<tr>
<td><strong>Cotton yarn output</strong></td>
</tr>
<tr>
<td>Actual value</td>
</tr>
<tr>
<td>Forecast value</td>
</tr>
<tr>
<td>Absolute error</td>
</tr>
<tr>
<td>Relative error %</td>
</tr>
</tbody>
</table>

From Table 5, we may see, the relative error of logistics output value, value-added of textile and cotton yarn output is 0.21%, 0.28% and 0.51% respectively, which indicates the model is very well to forecast.
5 Conclusion

Studies on the relationship between logistics and other industries are important not only to logistics itself, but also to other industry development. From the analysis of degree of grey incidence between logistics industry and textile industry in Hebei province, we can see that they have close relationship. The grey forecast based on grey incidence produces good effect. The forecast results have reference value to the development of both industries.

References