Research on Export Toughness of Shandong Textile Industry Based on Data Analysis and Model Testing

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Abstract. In the context of big data, this paper takes the export toughness of the textile industry in Shandong Province as an example, and deeply discusses the application of data analysis in social and economic development. On the basis of constructing the theoretical logic of optimizing the evaluation of the export toughness level of the textile industry in Shandong Province, the operation data of the textile industry is collected and monitored. After normalizing the data and processing the entropy value, the entropy method is used to measure the export toughness. In the empirical analysis, a model of factors affecting the export toughness of the textile industry is established. And an empirical model is obtained through autocorrelation and heteroskedasticity correction. The study found that, compared with the traditional evaluation model, data analysis can improve the quality and efficiency of evaluation.

Keywords: Data Analysis · Textile Industry · Export Toughness

1 Introduction

Economic globalization has greatly developed Shandong's textile exports, and it has also brought fierce market competition [2]. Coupled with the negative effects of rising labor costs and trade frictions between countries, Shandong's textile industry has encountered numerous difficulties.

Export toughness is a measure of whether Shandong's export economy can develop steadily and whether it has a strong ability to deal with risks. The study on the export toughness of Shandong Province can accurately see the various indicators that affect the development of Shandong Province's export economy, and find the relevant strategies that are most suitable for the development of the export economy [3, 4]. These strategies can promote the more rapid and stable development of the textile industry in Shandong Province. At the same time, it can also promote the transformation and upgrading of the textile industry in Shandong Province [5].

This paper mainly builds an index system and an evaluation model through big data analysis to measure export resilience. Use econometric analysis methods to conduct empirical research on the factors affecting export toughness, and put forward countermeasures and suggestions for improving export toughness of the textile industry in Shandong province through the results of empirical research.

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2 Measurement of Export Toughness of Shandong Textile Industry

2.1 Construction of Indicator System

With reference to the country's economic toughness, export toughness is defined as the ability of the government and enterprises to adjust their strategies in a timely manner in the face of changes in the external and internal environments of export trade to prevent large ups and downs in product exports. Around the connotation of export toughness, combined with the design of the evaluation index system of relevant literatures, an index system covering the relevant factors of export toughness of Shandong textile industry has been constructed (Table 1).

2.2 Measurement Method

The entropy weight method is used to measure export toughness. The main implementation steps are as follows:

(1) Standardized processing
Let the evaluation matrix be $\overline{X} = (x_{ii})_{m\times n}, i = 1, 2, \ldots m; j = 1, 2, n \ldots,$ m represents the year, and n represents the evaluation index.
When the indicator is a positive indicator, its standardized formula is:

$$x'_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}} \tag{1}$$

When the indicator is a negative indicator, its standardized formula is:

$$x'_{ij} = \frac{x_j^{\max} - x_{ij}}{x_j^{\max} - x_j^{\min}} \tag{2}$$

Table 1. Index system for measuring export toughness of Shandong textile industry

Indicator type	Index connotation
Development indicators	Number of textile enterprises above designated size (X1)
	Cost and profit margin of textile enterprises above designated size (X2)
	Ex-factory price index of textile industry producers (X3)
Innovation index	Expenditure of textile enterprises above designated size (Y1)
	Number of testing and development personnel in textile enterprises above designated size (Y2)
	Number of new product developments of textile enterprises above designated size (Y3)
	New product development funds of textile enterprises above designated size (Y4)

Table 2. Comprehensive scores of indicators

	2012	2013	2014	2015	2016	2017	2018	2019
overall ratings	0.1211	0.1446	0.1426	0.1343	0.1221	0.1352	0.1043	0.0957

(2) Translation processing

$$x''_{ij} = 1 + x'_{ij} \tag{3}$$

(3) Dimensionless processing

$$y_{ij} = \frac{x''_{ij}}{\sum_{i=1}^{n} x'_{ij}} \tag{4}$$

(4) Entropy processing. Calculate the entropy value of the first indicator:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} y_{ij} \ln y_{ij} \tag{5}$$

(5) Coefficient of Difference Processing

$$g_j = 1 - e_j \tag{6}$$

(6) Calculate indicator weight. The weight of the first indicator is:

$$w_j = \frac{g_j}{\sum_{j=1}^{p} g_j} \tag{7}$$

(7) overall ratings: According to the above steps, the export toughness of the textile industry in Shandong Province is gradually calculated:

$$Z_j = \sum_{j=1}^{p} w_j x'_{ij} \tag{8}$$

3 Measurement Results and Evaluation Analysis of Export Toughness of Shandong Textile Industry

3.1 Comprehensive Evaluation of the Export Toughness Measurement of Shandong Textile Industry

Based on the calculation of entropy and weight, the comprehensive score of each index of the export toughness measurement of Shandong textile industry is calculated (Table 2).

From the above statistical results, it can be seen that the year with the highest comprehensive score for the export toughness of the textile industry in Shandong during the study period (2012–2019) was 2013, and the lowest year was 2019. Looking at the development trend from 2012 to 2019, The overall development is stable, with slight fluctuations and declining development characteristics.

Table 3. Comprehensive scores of the export toughness measurement indicators of the textile industry in various regions

area	Score	Rank
Shandong	0.143927067	5
Zhejiang	0.221304193	3
Jiangsu	0.228567598	2
Guangdong	0.24741119	1
Henan	0.158789952	4

3.2 Comparative Analysis of Export Toughness of Textile Industry Between Shandong Province and Other Provinces

In order to comprehensively evaluate the export toughness of the textile industry in Shandong Province, the export toughness measurement indicators of the textile industry in Shandong, Zhejiang, Jiangsu, Guangdong, and Henan are comprehensively calculated, and the results are shown in Table 3.

The statistical results show that among several cities with relatively developed textile industry in China, the comprehensive evaluation score of the export toughness of the textile industry in Shandong Province is obviously lagging behind. This is specifically reflected in the insufficient investment in technological innovation, the small R&D expenditures and research and experiment personnel of textile enterprises above designated size, the insufficient investment in new product development funds of textile enterprises above designated size, and the resulting small number of new product developments. In particular, the number of textile enterprises above designated size in Guangdong and Shandong is similar, while the R&D investment of textile enterprises above designated size in Guangdong far exceeds that of Shandong Province. Compared with Henan Province, the lower overall score is due to the low profit margin of the textile industry in Shandong Province. The main reason is that textile enterprises in Henan Province pay attention to the innovation of scientific management and production technology, effectively reducing production and operating costs.

4 An Empirical Study on the Influencing Factors of Export Toughness of Shandong Textile Industry

4.1 Influencing Factors of Export Toughness

This article studies the export toughness of the textile industry in Shandong Province, starting from the ability to export toughness, so the following variables are selected (Table 4).

Table 4. Influencing factors of export toughness of Shandong textile industry

variable	Index selection
X1	exchange rate
X2	Shandong Province's GDP
X3	Total foreign investment of textile enterprises above designated size
X4	Shandong Provincial Financial Expenditure on Science and Technology
X5	The proportion of the added value of the textile industry above designated size in the industrial added value
X6	Number of employees in Shandong textile industry

4.2 Model Establishment

According to the characteristics of variables and knowledge of econometrics, the following model is established:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu \tag{9}$$

Among them, Y is the export value of the textile industry in Shandong Province, β is a proxy parameter, and μ is a random interference item.

4.3 Modification of the Model

Least squares regression is performed on the explanatory variables, and the coefficients and related test data of each variable are initially obtained. The regression equation obtained is as follows:

$$\begin{gathered} Y = 532.58 - 0.3730X_1 - 0.0002X_2 \\ - 0.00000257X_3 - 0.0162X_4 - 2.5578X_5 - 0.7272X_6 \\ R^2 = 0.9199, \quad F = 5.745 \end{gathered} \tag{10}$$

1. Economic significance test
   The test results show that the coefficients of the variables X_2, X_3, X_4, X_5 are not in line with economic theory, only X_1andX_6 are in line.
2. Goodness of fit test
   It can be seen from the regression results that $R^2 = 0.9199$, indicating that the goodness of fit of the multiple regression model is good.
3. t test
   It can be seen from the regression results that the t values of the variables are all small and fail the t test.
4. Multicollinearity test and model correction (Table 5)
   From the correlation coefficient matrix, some variables in the equation are not significant, and there may be multicollinearity. The stepwise regression method is used

Table 5. Correlation coefficient matrix

	X1	X2	X3	X4	X5	X6
X1	1.0000	0.2727	−0.6415	0.4658	−0.4968	−0.4099
X2	0.2727	1.0000	−0.6178	0.8437	−0.7243	−0.9139
X3	−0.6415	−0.6178	1.0000	−0.6076	0.5387	0.6219
X4	0.4658	0.8437	−0.6076	1.0000	−0.9494	−0.9720
X5	−0.4968	−0.7243	0.5387	−0.9494	1.0000	0.9019
X6	−0.4099	−0.9139	0.6219	−0.9720	0.9019	1.0000

Table 6. White test output results

variable	Regression coefficients	Standard error	t	p
C	−14291.02	4320.522	−3.307706	0.0297
X6^2	0.007466	0.014944	0.499573	0.6436
X6 * X1	−0.033252	0.014565	−2.2831	0.0845
X6	21.25365	10.2929	2.064885	0.1079
X1^2	−0.030791	0.009788	−3.145705	0.0347
X1	42.02792	13.01123	3.230128	0.032

Table 7. Weighted least squares estimation output results

variable	Regression coefficients	Standard error	t	p	DW
X1	0.331627	0.003216	103.1046	0	1.109
X6	−0.391338	0.036953	−10.59023	0	

to modify the model, and the stepwise regression analysis is eliminated, and the final model becomes a binary linear regression model:

$$\begin{aligned} & \mathrm{Y} = 445.197 - 0.296\mathrm{X}_1 - 0.751\mathrm{X}_6 \\ & \mathrm{R}^2 = 0.869 \quad \mathrm{F} = 30.827 \quad \mathrm{DW} = 2.567 \end{aligned} \tag{11}$$

5. Heteroscedasticity test and model correction
First perform White's test, the following is the output (Table 6).
From the White test result, the White test statistic is 8.407, which is greater than the critical value of 7.851. It shows that the model has heteroscedasticity, and the model needs to be revised. The following uses the weighted least squares method to modify, and re-regress on the basis of the model to get the output result:

Table 8. The output results of the first-order generalized difference correction

variable	Regression coefficients	Standard error	t	p	DW
C	306.2863	70.11049	4.368623	0.0047	2.896275
DX6	−1.041925	0.358994	−2.902351	0.0273	
DX1	−0.433686	0.166808	−2.599915	0.0407	

Table 9. The output results of the second-order generalized difference correction

variable	Regression coefficients	Standard error	t	p	DW
C	424.8346	78.8215	5.389831	0.003	2.071139
D2X1	−0.401216	0.129836	−3.090176	0.0272	
D2X6	−1.016317	0.261861	−3.88113	0.0116	

6. Sequence correlation test and model modification
   In order to test whether the model has autocorrelation problems, the following sequence correlation test is performed. From Table 7, DW = 1.109, it is impossible to judge whether there is autocorrelation. Need to use the generalized difference method to modify.
   It can be seen from Table 8 that after the first correction, it is still not possible to see whether there is autocorrelation, so the second correction of the generalized difference method is carried out.
   It can be seen from Table 9 that DW = 2.071, $d_U < d < 4 - d_U$, there is no positive or negative correlation, and empirical analysis results can be obtained.

4.4 Analysis of Econometric Results

The empirical analysis results can be obtained from the analysis of the above models:

$$Y = 424.834 - 0.401X_1 - 1.016X_6 \tag{12}$$

If other conditions remain unchanged, the exchange rate will decrease by one yuan for every 100 U.S. dollars in RMB, and Shandong's textile exports will increase by an average of 40.01 million U.S. dollars.Under other conditions, the textile industry's employment population will decrease by 10,000, and Shandong's textile exports will increase by 110.6 million U.S. dollars on average.

The employed population studied in this paper is the domestic employed population in the textile industry of Shandong Province. In recent years, as labor costs in the textile industry have risen, some companies have opened factories in Southeast Asia to use local low-cost labor resources and scientific and technological development to promote production efficiency.

5 Strategies to Improve the Export Toughness of the Textile Industry in Shandong Province

5.1 Enhancing Investment in Innovation

Consumers' demand for new speed and personalized customization of textile products is constantly increasing, which puts forward higher requirements for product innovation of textile enterprises. Strengthening scientific and technological support and increasing investment in enterprise innovation are indispensable conditions for promoting the transformation and upgrading of the traditional textile industry.

5.2 Strengthen the Development of New Products

For textile companies, the development of new products is particularly important. Only by continuously developing new products can textile companies maintain their existing market share and open up new markets.

5.3 Improve Production Efficiency and Reduce Costs

The cost and profit margins of textile enterprises in Shandong Province have been declining. This requires companies to improve production efficiency and reduce costs from a technical perspective. Develop more high-end products to break the low price of textile products, and use advanced textile machinery to reduce the demand for human resources and reduce costs [6]. Use artificial intelligence to predict and analyze the market to avoid increased operating costs caused by decision errors [1].

6 Conclusion

This paper takes the export toughness of the Shandong textile industry as the research objective, constructs an evaluation index system for the export toughness of the textile industry, and constructs a multiple regression model to explore its influencing factors. Based on the evaluation results, this article draws the following conclusions: The lack of motivation for the development of the textile industry in Shandong Province is mainly due to insufficient innovation capabilities. To improve the export toughness of Shandong Province, we should start with increasing R&D personnel and funding, improving the profit margin of costs and expenses, and developing new products.

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