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Research on the Coupling Development of Hard Technology Industry and Traditional Industry

——Taking Xi'an as an Example

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Abstract

Based on the theory of grey correlation, an empirical analysis is carried out of the coupled development of hard technology industry and traditional industry in Xi'an.It studies the correlation between hard technology industry and regional economic development, and the relationship between hard technology industry and traditional industry. The results show that it is at a very high level of the correlation between hard technology industry and economic growth, and the hard technology industry has a significant effect on traditional industries. Therefore, it is necessary to strengthen the development of the hard technology industry in Xi'an and the coupling between the two industries so that they can carry out orderly and linkage development.

Keywords

hard technology industry,traditional industry,industrial coupling, grey correlation analysis.

1. Introduction

In 2010, Dr. Mi Lei put forward the concept of "hard technology". Hard technology is an original technology that is more core and more sophisticated than high technology. It consists of artificial intelligence, aerospace, biotechnology, optoelectronic chips, information technology, and new materials,New energy,intelligent manufacturing and other representative high-tech technology[1], has a very high technical threshold.The hard technology industry is an industry where the high-tech industry and emerging technology are deeply integrated, representing the direction of technological innovation and industrial development. In 2017, Xi'an's computer, communications and other electronic equipment manufacturing industry's total annual profits accounted for 32.2% of the total profits of industrial enterprises above designated size in the city, contributing 97.1% to the city's industries above designated size.It can be seen that the hard technology industry is an important driving force for economic growth[2]. More and more traditional industries are facing a dilemma due to their backward technology and low efficiency. Xi'an's traditional service industry and manufacturing industry have been impacted by the Internet and urgently need transformation. Emerging technologies in the hard technology industry can be gradually applied to traditional industries to accelerate the industry upgrade. Through the integration of AI and other intelligent logistics technologies and products, JD.com has strategically cooperated with China Unicom to establish China's first 5G intelligent logistics demonstration park to achieve high efficiency, low latency, and large connections.Wenqing Xiong.'s research results show that the simultaneous development of the hard technology industry and traditional industry can produce synergy[3]. Therefore, accelerating the coupling

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development between the hard technology industry and the traditional industry is a key task at present.

Coupling refers to the economic phenomenon associated with the interaction of respective elements in two or more systems with different properties. Industrial coupling includes factor coupling, structural coupling, and layout coupling[4], which has always been the focus of scholars' attention. Wei Guan.[5] summarized the coupling characteristics of energy efficiency and industrial structure in Liaoning Province by using the coupling degree scoring model, and found that except for Shenyang and Liaoning, the coupling of energy efficiency and industrial structure in Liaoning Province was low. Meifang Yao.[6] and others studied the impact of the information technology innovation of third-party payment on traditional finance in China in recent years, mainly the impact on the technological innovation of commercial bank payment. The results show that in China the value creativity is positively correlated, promotes each other, and the relationship is stable. Bingqiang Li.[7] analyzed the manufacturing industry and productive service industry in China using the degree of coordination index, and found that the overall degree of coupling was not high, and the degree of coupling in developed regions was significantly higher than that in less developed regions.Qiannan Zhang. based on the research on the coupling development of the electronic information industry and the textile industry in Guangdong Province, and found that the two have a strong coupling relationship and are in the stage of coordinated development[8].Xiaozhong Li. et al[9] studied the coupling between China's electronics and information industry and the automotive industry and found that the two are at a moderate coupling level. As the degree of coupling coordination increases, the efficiency of the automotive industry increases, energy consumption decreases, and exports increase.Xiaozhong Li. and Rongji Huang [10]studied the improvement of China's textile industry competitiveness from the perspective of the integration of the textile industry and the electronic information industry. Research has shown that the integration of the two major industries has a promoting effect on the textile industry, but has a lag in timeliness. Lei Zhou. and Chong Wang.[11] found that the coupling of tourism industry-regional economy-information industry system can be coordinated.

About research methods.Zhengchu He. [12] and others explored the industrial relationship between China's production and service industries and strategic emerging industries by designing input-output models, and theoretically deduced the industrial relationship between the two to develop "interaction and integration".Ying Zhao. [13] and others carried out an empirical analysis of the correlation between Liaoning's strategic emerging industries and traditional industries based on the gray correlation theory, and specifically studied the level of correlation between industries and the priority choice of traditional industries in industrial heritage.Xiaozhong Li. and Dan Yang.[9] established an industry coupling evaluation model by calculating the coupling degree and coupling coordination degree between the electronic information industry and the automotive industry.

From the above research, it can be seen that the hard technology industry and traditional industry will promote each other, but there are relatively few studies on the coupling development of the two, especially the degree of coupling between the two and the effect on economic development needs to be further studied. Based on the research of previous scholars, the coupling relationship between Xi'an's hard technology industry and traditional industry is discussed based on the grey relation theory, and the order of the degree of correlation between Xi'an's hard technology industry and economic development is given. The degree of correlation between the two; and provide policy recommendations for the coupling development between the two.

ISSN: 2688-9323

2. The Industry Coupling Evaluation Model

This paper takes the Xi'an hard technology industry and economic growth and the hard technology industry and corresponding traditional industries as the coupling system, and introduces the degree of correlation as an index to evaluate the coupling[9]. Grey correlation analysis [14,15] is a multi-factor statistical analysis method. The basic idea is to judge whether the connection is close based on the similarity of the geometric shapes of the sequence curves, and use the correlation to reflect the correlation between the two factors. The greater the degree of correlation, the degree of correlation between the hard technology industry and the indicator of economic growth can be ranked according to the degree of relevance for the appropriate development order of the hard technology industry, and the strength of the interaction between the hard technology industry and the traditional industry.

The steps of modeling the gray relation analysis[13] are as follows:

(1) Determine the reference and comparison sequences

The reference sequence is a data set that reflects the characteristic behavior of the system and is the benchmark of the system. The reference sequence is a data set that reflects the characteristic behavior of the system and is the benchmark of the system. X_0 refers to the characteristic behavior of the system, and X_0(k) refers to the value of the characteristic behavior of the system at the k -node. The reference sequence is $X_0(k) = (X_0(1), X_0(2), \dots, X_0(n))$. Here k is the year. The comparison sequence is a data set that reflects the behavior of system factors. X_i refers to the system factor behavior, and X_i(k) the value of the system factor behavior at the k-node. The comparison sequence is$X_i(k) = (X_i(1), X_i(2), \dots, X_i(n))$.

(2) Calculate the initial value image of each series (standardized processing)

$$X_i^{'} = \frac{X_i}{x_i(1)} = \left(X_i^{'}(1), X_i^{'}(2), \dots, X_i^{'}(n)\right) \quad , i = 0,1,2, \dots, m \tag{1}$$

i refers to the corresponding position of the comparison industry.

(3) Solve the difference sequence

$$\Delta_i(k) = \left|X_0^{'}(k) - X_i^{'}(k)\right|,\ \Delta_i = \left(\Delta_i(1), \Delta_i(2), \dots, \Delta_i(n)\right), i = 0,1,2, \dots, m; k = 1,2, \dots, n \tag{2}$$

(4) Find the maximum and minimum values in all difference sequences

$$\mathrm{M} = \max_i \max_k \Delta_i(k), m = \min_i \min_k \Delta_i(k) \tag{3}$$

(5) Find the correlation coefficient

$$\gamma_{0i}(k) = \frac{m + \xi M}{\Delta_i(k) + \xi M}, \xi \in (0,1), k = 1,2, \dots, n; i = 1,2, \dots m \tag{4}$$

(6) Find the degree of correlation (Gray Deng's degree of correlation)

$$\gamma_{0i} = \frac{1}{n}\sum_{k=1}^{n} \gamma_{0i}(k), i = 1,2, \dots, m \tag{5}$$

ξ is the resolution coefficient. The smaller the ξ, the greater the resolution. Its value is not unique, and ξ is generally 0.5. Relevance is positively correlated with relevance. Studies have concluded that if $\gamma_{0i} \in (0,0.35]$, the two indicate a low correlation, $\gamma_{0i} \in (0.35,0.65]$, a medium correlation; $\gamma_{0i} \in (0.65,0.85]$, a high correlation; $\gamma_{0i} \in (0.85,1]$, the correlation is very high.

ISSN: 2688-9323

3. Empirical Analysis

3.1. Choice and Data Source of Hard Technology Industry and Traditional Industry

The division of hard technology industry in this article is different from the industry in the original statistical yearbook, and there is no clear distinction between hard technology industries. Among the emerging industries, four industries matching the hard technology industry were selected, namely biopharmaceutical manufacturing, aerospace manufacturing, electronics and communication equipment manufacturing, and information chemical manufacturing. By consulting and summarizing the literature, we find that the traditional industries in the existing literature have the following characteristics. First, these industries are an important support for the development of high-tech industries. Second, the development of these industries is becoming more mature and encountering bottlenecks. Changing development strategies can get better development. Based on the above characteristics, this article selects eight traditional industries, namely rubber and plastic products industry, metal products industry, electrical machinery and equipment manufacturing industry, automobile manufacturing industry, postal industry, and textile industry.

The data selected in this article (2014-2017) mainly consists of two parts. First, Xi'an's biotechnology manufacturing industry, aerospace manufacturing industry, electronics and communication equipment manufacturing industry, and information chemical manufacturing industry's four hard technology industries, total profits and taxes, total profits, and Xi'an local fiscal revenue data. Second, the main business income data of the four hard science and technology industries in Xi'an, including industrial added value, Xi'an's gross domestic product, and traditional industries suitable for driving [14].

3.2. Construction of Evaluation Index System for Coupling of Hard Technology Industry and Economic Development and Analysis of Results

This article deals with the reference sequence as follows. We obtain the difference between the total profits and taxes and profits of the hard technology industry in Xi'an in the current year, and then compare with the financial revenue of Xi'an to obtain the highest ratio (sequence a), and finally multiply by the ratio of sequence a to the base year (2014) The highest value is then sorted by time, that is, the highest proportion of economic growth multiplied by the highest rate of development. We thus get the reference sequence. The comparison series is the ratio of the difference between the total profits and taxes of the hard technology industry in Xi'an and the financial revenue of Xi'an, multiplied by the ratio of the ratio to the base year (2014), and ranked by industry and time[16].

Table 1. Raw data of Xi'an hard technology industry from 2014 to 2016

Unit: 100 million yuan	2014	2015	2016	2017
	The difference between total profit and tax and profit			
Biomedical manufacturing	6.10	3.22	4.04	
Aerospace industry	7.27	5.14	7.23	9.32
Electronic and communication equipment manufacturing	3.80	4.07	7.48	7.47
Information Chemical Manufacturing	0.56	0.04	0.85	4.57
Xi'an Financial Revenue	583.79	650.99	641.07	654.5

Data source: Xi'an Statistical Yearbook

ISSN: 2688-9323

Table 2. Correlation between hard technology industry and economic growth in Xi'an , 2014-2016

	Biomedical manufacturing	Aerospace industry	Electronic and communication equipment manufacturing	Information Chemical Manufacturing
2014	1	1	1	1
2015	0.996	0.989	0.983	0.967
2016	0.946	0.952	0.926	0.997
2017	0.72	0.738	0.792	0.333
Average correlation	0.916	0.92	0.925	0.824

This paper uses the above processing methods to calculate the reference and comparison sequences for Xi'an's biomedical manufacturing, aerospace manufacturing, electronics and communications equipment manufacturing, and information chemical manufacturing. We use the gray correlation analysis model to calculate the gray correlation coefficient and gray correlation between the hard technology industry and Xi'an's economic growth. The grey correlation of biomedical manufacturing is 0.916. The grey correlation of the aerospace industry is 0.92. The grey correlation of the electronics and communications equipment manufacturing industry was 0.925. The information chemical manufacturing industry is 0.824. This shows that the hard technology industry has largely driven Xi'an's economic development, and the government and enterprises should give it the greatest attention and support [2].

3.3. The Construction of the Evaluation Index System for the Coupling between the Hard Technology Industry and the Traditional Industry and the Analysis of the Results

In the previous section, this article proved the impact of the hard technology industry on the actual existence of Xi'an's economy. In this section, we will use the data to clarify the role of the hard technology industry in driving the corresponding traditional industries.

First, the reference and comparison sequences are determined. The reference sequence is to compare the industrial added value of each hard technology industry in that year with the GDP of Xi'an, select the highest value, and sort by time. The comparison sequence is the ratio of the industrial added value of each hard technology industry in that year to the main business income of the traditional industry that it is suitable to drive, multiplied by the ratio to the base year (2015) ratio[14].

ISSN: 2688-9323

Table 3. Industrial Value Added and Gross Output Value of Hard Technology Industry in Xi'an, 2015-2016

Unit: 100 million yuan	2015	2016	2017
	Industrial added value		
Biomedical manufacturing	-1.89	1.05	-7.54
Aerospace industry	7.68	47	30.96
Electronic and communication equipment manufacturing	196.29	220.21	91.61
Information Chemical Manufacturing	9.78	55.73	104.57
Xi'an GDP	5801.2	6282.65	7471.89

Data source: Xi'an Statistical Yearbook

Table 4. Raw data related to traditional industries in Xi'an, 2015-2016

Industry (100 million yuan)		Rubber and plastic products	Metal products industry	Electrical machinery and equipment manufacturing	Automotive Manufacturing	Postal industry	Textile industry
Main business income	2015	62.5	112.61	473.95	677.56	43.09	17.33
	2016	63.05	117.24	541.68	844.37	55.6	19.45
	2017	83.14	146.63	608.13	993.1	67.55	20.83

Data source: Xi'an Statistical Yearbook

In this article, x1 (the leading role of the biomedical manufacturing industry in the rubber and plastic products industry), x2 (the leading role of the aerospace manufacturing industry in the metal products industry), and x3 (the leading role of the aerospace manufacturing industry in the electrical machinery and equipment manufacturing industry) Role), x3 (the leading role of the electronics and communications equipment manufacturing industry in the electrical machinery and equipment manufacturing industry), x4 (the leading role of the electronics and communications equipment manufacturing industry in the automotive industry), x5 (the electronics and communications equipment manufacturing industry in the post The leading role of the industry), x6 (the leading role of the information chemical manufacturing industry in the textile industry) indicates the relevance of the hard technology industry to the traditional industries that it is suitable to drive.

Table 5. Correlation coefficient between Xi'an hard technology industry and traditional industry, 2015-2016

	X1	X2	X3	X4	X5	X6
2015	1	1	1	1	1	1
2016	0.982	0.539	0.581	0.994	0.993	0.614
2017	0.818	0.809	0.832	0.994	0.993	0.333
Average correlation	0.933	0.783	0.804	0.996	0.995	0.649

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It can be concluded from Table 5 that the average correlations between the electronics and communication equipment manufacturing industry and the automobile manufacturing industry and the postal industry are the highest, being 0.996 and 0.995, respectively. And each year the correlation coefficient is close to 1. This shows that the electronics and communication equipment manufacturing industry is extremely coupled with the automobile manufacturing industry and the postal industry and can develop in a coordinated manner. The leading role of the biomedical manufacturing industry in the rubber and plastic products industry is also very obvious, with a correlation degree as high as 0.933. The aerospace manufacturing industry is secondarily related to the metal products industry and electrical machinery and equipment manufacturing industry, but it can be seen that the correlation coefficient is gradually increasing. The correlation degree of the information chemical manufacturing industry to the textile industry is the lowest, 0.649 [2]. With reference to other literatures, it is concluded that this correlation degree is at a stronger level.

4. Concluding Remarks

Based on the statistical yearbook data of Xi'an City from 2014 to 2017, the grey correlation analysis method was used to analyze the correlation between the hard technology industry and economic growth. At the same time, we conducted an empirical analysis of the coupling effect between the hard technology industry and the traditional industry, and reached the following conclusions.

First, the relationship between each hard technology industry and economic growth is relatively high. The correlations between electronics and communication equipment manufacturing, aerospace manufacturing, biomedical manufacturing, and information chemical manufacturing and economic growth are 0.925, 0.92, and 0.916, respectively. And 0.824. This shows that the electronics and communications equipment manufacturing industry, the aerospace manufacturing industry, the biomedical manufacturing industry, and the information chemical manufacturing industry in the hard technology industry have greatly promoted economic growth.

Second, the average correlation between the hard technology industry and the traditional industry is high, indicating a high coupling effect between the two. Specifically, first, the electronics and communication equipment manufacturing industry has the largest driving effect on the automobile manufacturing industry and the postal industry, and the correlation coefficients are close to one. We can conclude that industry coupling plays a vital role in the optimization and upgrading of the automobile manufacturing industry, the improvement of the efficiency of the postal service and the entire service industry, and the adjustment of the industrial structure. Second, the correlation coefficient between the bio-pharmaceutical manufacturing industry and the rubber and plastic products industry is 0.933, which is of great significance for the green and environmentally friendly and ecologically friendly development of the rubber and plastic products industry. Third, the aerospace manufacturing industry's correlation with the metal products industry is 0.783. The industrial coupling of the two can help the metal products industry to increase its utilization rate and explore other development directions. His correlation with the electrical machinery and equipment manufacturing industry is 0.804, indicating that the aerospace and aviation manufacturing industry cannot be separated from the support of basic industries. Fourth, the correlation degree of the leading role of the information chemical manufacturing industry in the textile industry is 0.649, which is at a relatively high level. The former can help the latter to upgrade its technology. Based on the above conclusions, the following policy recommendations are made:

ISSN: 2688-9323

(1) Vigorously develop the hard technology industry. In terms of the contribution of hard science and technology to economic development, Xi'an should vigorously develop the hard science and technology industry, and make the hard science and technology industry synonymous with Xi'an. On the one hand, the government needs to strengthen planning guidance, integrate resources, and effectively help the hard technology industry to cultivate and develop. On the other hand, the market must adhere to the basic functions of allocating resources, using competition and the laws of supply and demand, using interest induction to stimulate technological innovation activities, and promoting the coupling development of hard technology industries and traditional industries through market selection mechanisms.

(2) Diffusion and deepening the coupling effect between hard technology industries and traditional industries. Hard technology industry and traditional industry are the two basic points of Xi'an's economic development. The development of the economy must be based on the combination of the two: on the one hand, the hard technology industry cannot be separated from the support of traditional industries.

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