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Comprehensive Estimation of Industrial Security of High Technology Industry

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High technology industry has been a significant part of national economy, thus its development and industrial security is related to national economic security. This study elaborates on evaluation indicator system of industrial security of high technology industry and adopts the entropy method to assess the industrial security situation of China's high technology industry during the period of 2005 to 2014. The research results show that security state of China's high technology industry gradually improved during the observed years, and that it has kept the state of safe since 2011.Market control of foreign funded enterprises, labor quality and investment control of foreign funded enterprises are key indicators affecting industrial security of China's high technology industry.

Keywords: Industrial Security, High Technology Industry, Entropy Method

Introduction

The development of high technology industry has already become a significant and representative indicator to access a country's soft power and international competitiveness. In 2014, total industrial output value of China's high technology industry was 12.737 trillion RMB, and it realized 5.076 trillion RMB exports. Otherwise, whether excellent data means that China's high technology industry is safe remains a question. As we all know, since China's reform and opening up, great deal of foreign capital and technology has flowed into China's market, especially into China's high technology industry. Thus this paper comprehensively evaluates the industrial security of China's high technology industry under the above background. In the existing study, scholars established different industrial security evaluation index systems from different perspectives. He and He built an indicator system composed by four first level indicators, domestic industrial circumstances, competitive power of industries, dependence on foreign countries of industries and controlling power of industries.[1]Xu took into account industrial domestic operation efficiency and set up an indicator system for medicine industry.[2]Zhu and Wei added industrial ecological environment indicator into index system and established a five-factor model.[3]Jing and Li built an index system for financial industry from macro, middle and micro perspectives.[4]At the same time, many empirical methods are used in industrial security research. Shi *et al.* suggested that innovation and market are key indicators for industrial security evaluation. They adopted analytical hierarchy process(AHP) to access industrial security of China's high technology industry and found it was safe in 2012.[5]He *et al.* combined entropy method with grey relation method to assess the security situation of China's mineral mining industry from 2002 to 2009, and they found it was safe except 2002.[6]Zhu and Wei analyzed the safety situation of China's equipment manufacturing industry by efficacy coefficient method and concluded that it was at the critical state.[7]Xiao*et al.* used two-stage DEA method to estimate innovation efficiency of China's high technology industry and found that it showed U trend.[8] Feng *et al.* adopted factor analysis method and found that technology development capability affected the international competitiveness of high technology industry more than technology transfer capacity.[9] Hao *et al.* applied DEA model to estimate the security degree of China's logistics industry and built the index system from the view of input and output. [10]

Indicator System

Based on the existing research, we take into account characteristics of high technology industry and establish an indicator system constructed by four aspects, industrial domestic environment, industrial

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international competitiveness, industrial external dependence and industrial control-power, showed as Table 1 in appendix. In industrial domestic environment indicators, we use long-term interest rate as capital costs (B2), as long-term loans of commercial banks are usual financial source of most enterprises. And we take the proportion of R&D personnel in employed personnel as labor quality (B3) and annual sales growth as domestic demand growth (B4). In industrial international competitiveness indexes, we adopt the proportion of sales revenue of large and medium sized enterprises taking up in industrial total sales revenue as industrial concentration (B9). We don't choose traditional concentration ratio indicator such as CR4 to describe industrial concentration of high tech technology industry in this paper. Because high technology industry is a collective term and it contains five segment industries, traditional concentration ratio indicator is not measurable. We take the ratio between intramural expenditure on R&D and industrial total sales revenue as R&D intensity (B11). In industrial control-power indexes, we use the ratio between patent applications of foreign funded enterprises and industrial total patent applications as technology control of foreign funded enterprises (B15).

Material and Method

Data

We collect all original data in Table 2 in appendix from the following channels, China Statistics Year book on High Technology Industry[11], China Statistics Yearbook[12],China Statistics Yearbook on Science and Technology[13],World Development Indicators Database of World Bank and The People's Bank Of China.

Method

We choose entropy method to evaluate the security degree of high technology industry of China. Entropy method is a kind of objective weight determined method. It avoids the effects of subjective factors and human factors. It determines the weight based on the amount of information each indicator containing. An indicator contains more information, and then it owns smaller entropy and higher weight. The calculation steps of entropy method are as follow. Set i as evaluation object and $i=1, 2, 3…n$. Set j as evaluation indicator and $j=1, 2, 3…m$. Set X_{ij} as the value of evaluation object i in indicator j. Data standardization should be taken before detailed calculation, as different indicators have different units. We adopt maximum-minimum method to process original data. The standardization formulas for positive and negative indexes are respectively showed as equation (1) and (2).

Table 1—The indicator system for high technology industry

First level indicator	Second level indicator	Description
Industrial domestic environment (A1)	Capital costs (B1)	Long-term interest rate
	Labor costs (B2)	Labor costs
	Labor quality (B3)	The proportion of R&D personnel in employed personnel
	Domestic demand growth (B4)	Annual sales growth
Industrial international competitiveness (A2)	Revealed comparative advantage (B5)	Revealed comparative advantage
	International market share (B6)	International market share
	Trade competitiveness index (B7)	Trade competitiveness index
	Profit ratio of production (B8)	Profit ratio of production
	Industrial concentration (B9)	The proportion of sales revenue of large and medium sized enterprises taking up in industrial total sales revenue
	Labor productivity (B10)	Labor productivity
	R&D intensity (B11)	The ratio between intramural expenditure on R&D and industrial total sales revenue
Industrial external dependence (A3)	Import external dependence (B12)	Degree of dependence on imports
	Export external dependence (B13)	Degree of dependence on exports
Industrial control-power (A4)	Market control of foreign funded enterprises (B14)	The ratio between profits of foreign funded enterprises and industrial total profits
	Technology control of foreign funded enterprises (B15)	The ratio between patent applications of foreign funded enterprises and industrial total patent applications
	Investment control of foreign funded enterprises (B16)	The ratio between investment in fixed assets of foreign funded enterprises and industrial total investment in fixed assets

Table 2—The data of China's high technology industry

Year	B1	B2	B3	B4	B5	B6	B7	B8
2005	0.0576	15934	0.0362	0.2180	2.2660	0.1362	0.0494	0.0414
2006	0.0603	18225	0.0354	0.2261	2.2303	0.1495	0.0646	0.0423
2007	0.0689	21144	0.0408	0.1955	2.3539	0.1716	0.0958	0.0475
2008	0.0686	24404	0.0428	0.1210	2.4422	0.1846	0.0974	0.0477
2009	0.0540	26810	0.0496	0.0689	2.5014	0.1978	0.0977	0.0543
2010	0.0550	30916	0.0424	0.2504	2.6684	0.2281	0.0881	0.0653
2011	0.0638	36665	0.0539	0.1751	2.6128	0.2357	0.0846	0.0593
2012	0.0640	41650	0.0610	0.1686	2.6296	0.2535	0.0851	0.0605
2013	0.0615	46431	0.0650	0.1346	2.6270	0.2659	0.0838	0.0623
2014	0.0615	51369	0.0675	0.0975	2.5897	0.2709	0.0901	0.0636
Year	B9	B10	B11	B12	B13	B14	B15	B16
2005	0.8487	517995.0861	0.0107	0.4703	0.5133	0.6521	0.3588	0.2929
2006	0.8407	564091.3088	0.0110	0.4675	0.5590	0.6505	0.3628	0.2977
2007	0.8472	598620.4298	0.0110	0.4297	0.5633	0.6200	0.2975	0.2718
2008	0.8246	604246.5362	0.0118	0.4232	0.5519	0.5716	0.2965	0.2628
2009	0.8105	631099.7273	0.0130	0.3503	0.4882	0.4859	0.3484	0.1964
2010	0.8123	684147.4359	0.0130	0.3715	0.4953	0.3396	0.2723	0.1468
2011	0.8233	771002.6155	0.0141	0.3384	0.4591	0.3105	0.2434	0.1224
2012	0.8138	806228.7485	0.0146	0.3118	0.4566	0.2874	0.1972	0.0978
2013	0.7896	897040.0185	0.0149	0.2979	0.4247	0.2861	0.2325	0.0903
2014	0.8092	961265.4260	0.0151	0.2645	0.3986	0.2606	0.2007	03333

$$R_{ij}= (X_{ij}-minX_j)/ (Max\ X_j-Min\ X_j) \quad \ldots (1)$$

$$R_{ij}= (Max\ X_j-X_{ij})/ (Max\ X_j-Min\ X_j) \quad \ldots (2)$$

Firstly, calculate the proportion that R_{ij} takes up in the sum of the value of each object in indicator j, presented as equation (3).

$$P_{ij}=R_{ij}/ (\Sigma^{n}_{i=1}R_{ij}) \quad \ldots (3)$$

Secondly, calculate the entropy of indicator j as shown in the equation (4)

$$e_j= (-1/ln(n))\Sigma^{n}_{i=1}P_{ij.} \quad \ldots (4)$$

Thirdly, we can get variation coefficient g_j. The lower the entropy value, the higher the variation coefficient.

$$g_j=1-e_j \quad \ldots (5)$$

Then, determine w_j, the weight of indicator j. It is equal to the proportion that g_j accounts for in the sum of variation coefficient of all indicators.

$$w_j=g_j/ \Sigma^{m}_{j=1} g_{j.} \quad \ldots (6)$$

Finally, comprehensive evaluation result of object i can be given as equation (7) show.

$$v_i=\Sigma^{m}_{j=1} w_jR_{ij} \quad \ldots (7)$$

Table 3—Entropy weight of each indicator

Indicator	Weight	Indicator	Weight
A1	0.2428	B1	0.0622
		B2	0.0495
		B3	0.0826
		B4	0.0485
A2	0.3938	B5	0.0526
		B6	0.0561
		B7	0.0317
		B8	0.0643
		B9	0.0426
		B10	0.0709
		B11	0.0756
A3	0.1200	B12	0.0712
		B13	0.0488
A4	0.2434	B14	0.0864
		B15	0.0755
		B16	0.0815

Result Analysis

This paper chooses relevant data of China's high technology industry from 2005 to 2014 and adopts entropy method to determine the weight of each indicator and comprehensively evaluate the security degree. MATLAB R2012b is used to realize the above calculation processes. Weights of first level and second level indicators are presented in Table 3 in appendix and the evaluation results are showed in Table 4 and Fig. 1 in appendix. In first level indicators affecting industrial security, industrial international competitiveness has the largest weight, which means competitiveness is a decisive factor in industrial security assessment. And we argue that the key to improve security state of high technology industry is to raise its competitiveness. Besides, industrial control-power is another important indicator. Solid control of market, investment and technology, especially cutting-edge technology will contribute to industrial security. In second level indicators, market control of foreign funded enterprises owns the highest weight of 0.0864. The following are labor quality (0.0826) and Investment control of foreign funded enterprises (0.0815).We can find that second level indicators belonging to industrial control-power all have large weight, which implies domination of indigenous capital over market, technology and investment will improve security degree. This is consistent with the research findings of Yang *etal.*[14] and He*etal.*[15]. They all argue that, with the market opening up, the key part of industrial security is the control of indigenous capital to important sectors of national economy such as high technology in this paper. Evaluation results of industrial security will fall in the interval of [0, 1].

Table 4—The security evaluation results of china's high technolog

Year	Evaluation Result	Security St
2005	0.2231	Very Unsa
2006	0.2403	Very Unsa
2007	0.3353	Unsafe
2008	0.3468	Unsafe
2009	0.4801	Basically S
2010	0.6466	Basically S
2011	0.6597	Safe
2012	0.7328	Safe
2013	0.7313	Safe
2014	0.7805	Safe

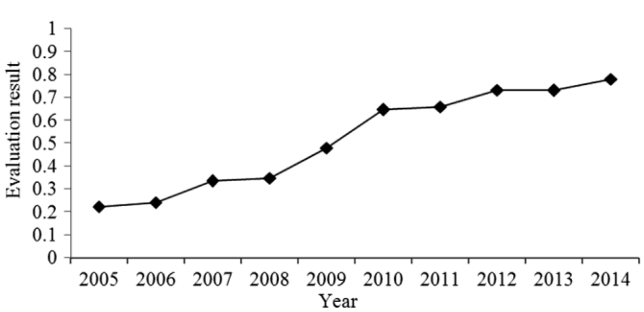

Fig. 1— The changes of security evaluation result

Referring to existing research, we define results falling in the interval of [0, 0.25) as very unsafe, [0.25, 0.45) as unsafe, [0.45, 0.65) as basically safe, [0.65, 0.85) as safe and [0.85, 1] as very safe. From Table 4 and Fig. 1, we can easily find that the security state of China's high technology industry gradually improved from 2005 to 2014. In 2005, the evaluation result was only 0.2231, dropping in the interval of very unsafe. And it had a bad performance in significant indicators. Market control of foreign funded enterprises reached 65.21% and investment control of foreign funded enterprises was 29.29%. R&D personnel only accounted for 3.62% in the total employed personnel of China's high technology industry. But situation changed in 2009, the evaluation result turned out to be basically safe and all indexes headed toward the positive direction. In 2011, the evaluation result was 0.6597, increasing by 0.4366 compared with 2005, and fell into the interval of safe. It has kept this security state since 2011. In 2014, the assessed result was 0.7805, beginning to approach to the interval of very safe.

Conclusion

This paper establishes an industrial security indicator system for high technology industry. And it measures the industrial security degree of China's high technology industry from 2005 to 2014 by entropy method. The research results show that security state of China's high technology industry gradually improved during the observed years, and has kept the state of safe since 2011. Industrial international competitiveness takes the largest weight among the four first level indicators. Market control of foreign funded enterprises, labor quality and investment control of foreign funded enterprises are key indicators in second level indicators.

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