

Available online at www.sciencedirect.com ScienceDirect

Energy Procedia 5 (2011) 1258–1263

Energy

Procedia

IACEED2010

The Empirical Analysis of enterprise Scientific and Technological Innovation Capability

Tan Heng

Zhongyuan Institute of Technology, Zhengzhou 450007, China

Abstract

The article has established a dynamic index system composed of scientific and technological innovation environment, investment and performance, and then made an empirical analysis to large and medium-sized industrial enterprises in Henan province by using non-linear weighted comprehensive evaluation method, eventually found out some key factors that affected scientific and technological innovation of enterprises, provided some references for improving the innovation ability.

© 2011 Published by Elsevier Ltd. Open access under [CC BY-NC-ND license](http://creativecommons.org/licenses/by-nc-nd/3.0/).

Selection and peer-review under responsibility of RIUDS

Keywords: large and medium-sized industrial enterprises; scientific and technological innovation; comprehensive evaluation.

Enterprise is the main holders of research and development funds in the process of technological innovation, and also the users of new technologies, new inventions, and enterprises' technology innovation will directly affect the level of regional scientific and technological innovation. Since "the Eleventh Five-Year", the technological innovation of the large and medium industrial enterprises in Henan has been improving increasingly, and the international competitiveness of high-tech products in some companies has increased significantly. However, most companies realize that they are not the main role of technological innovation and has not yet formed their own core technical capabilities, innovative organization mechanisms are inadequate, lack of input intensity, in all, their overall innovation capability is relatively weak. So how to make an accurate, scientific evaluation to enterprise scientific and technological innovation capability, analyzing its strengths and weaknesses so that enterprises can carry out targeted innovation activities, training a large number of enterprise groups with strong technological innovation capability and innovative activities has a critical role in promoting the economic development of Henan Province. This article has established a evaluate index system based on the characters of large and medium-sized industrial enterprises, and then made an empirical analysis to large and medium-sized industrial enterprises in Henan province by using non-linear weighted comprehensive evaluation method,

eventually found out some key factors that affected scientific and technological innovation of Henan’s large and medium-sized industrial enterprises, provided a reference for improving the innovation ability.

1. Index system of enterprise scientific and technological innovation capability

According to the bilateral dynamic recycled evaluation model, the article has established an evaluate index system of large and medium-sized industrial enterprises which is composed of scientific and technological innovation environment, investment and performance based on the science and the reality principle, the systematic principle, the comparable principle, the operational principle and the dynamic principle of continuity. (As shown in table 1)

Table 1 the evaluation index system of large and medium -sized industrial enterprises’ technological innovation capability

First grade index	Second grade index	Third grade index	metrological unit	
scientific and technological innovation environment	scientific and technological environment	Number of R&D personnel	People	
		Number of R&D personnel that large and medium -sized industrial enterprises of average per million personnel	People	
		Growth rate of R&D personnel	%	
		The proportion that the enterprises with technology institutions to the total number of enterprises.	%	
	economic environment	The proportion that financial funds to scientific and technological funds	%	
		The proportion that loans of financial institutions to scientific and technological funds	%	
	manufacturing environment	The price of equipment for production and operation	Billion	
		The price of equipment for production and operation average	Ten thousand	
	scientific and technological innovation investment	investment in scientific and technological	The amount of R&D investment	Ten thousand
			The proportion that amount of R&D investment to business income	%
The growth rate of R&D investment			%	
In investment in technological transformation		The amount of investment in technical transformation	Ten thousand	
		The amount of investment in technical transformation average	Ten thousand	
		The output value of new product	Ten thousand	
scientific and technological innovation performance	Economic performance	The growth rate of new products’ output value	%	
		The proportion that new products’ output value to business income	%	
	Developed performance	The labor productivity	%	
		The proportion number of invented patents to that of the whole province	%	

2. The comprehensive evaluation of enterprise scientific and technological innovation capability

2.1. The process of nondimensionalization.

This evaluation targets at scientific and technological innovation situation of the large and medium industrial enterprises in Henan, and using time-series data to trace and study its changes, the evaluation

period is determined to the year 2000-2008. The basic data selected to use in the article obtain from the 2001-2009“Statistical Yearbook of Henan”, which is compiled by Henan Bureau of Statistics, and the 2000-2008 years “Henan Statistical Yearbook of Science and Technology” which is compiled by Henan Bureau of Statistics, Henan Science and Technology Agency and Education Department of Henan Province and so on.

Because of the big dimensional differences among each index, we cannot make the comprehensive evaluation with each index directly; instead, after we entry the original data to SPSS17.0, the original data for evaluation index system of large and medium-sized industrial enterprises’ scientific and technological innovation capability should dimensionless firstly. In this paper, utility value method is used in the dimensionless processing. The interval that utility value method set is [0,100]. That is to say, optimal value of the index is 100, worst 0. Because all the indicators in the article are positive, standards act the maximum element is elected to use in the dimensionless to some relevant index processing. So:

$$x_{ij}^* = \frac{x_{ij}}{M_j} \times 100$$

x_{ij} 、 x_{ij}^* represent the original index value and index value after dimensionless respectively.
 $M_j = \max\{x_{ij}\}$.

The index value can be substituted into the non-linear weighted evaluation model only after they are dimensionless through the above formula.

2.2. The comprehensive evaluation.

The article makes an evaluation to large and medium-sized industrial enterprises in Henan province by using non-linear weighted comprehensive evaluation method. On the one hand, there has a strong association among the evaluation index which is selected to evaluate scientific and technological innovation ability of large and medium-sized industrial enterprises, and the non-linear weighted comprehensive evaluation method is used to some evaluation index which has a strong correlation between each other. On the other hand, the model of this evaluation method is a non-linear model, and it matches with evaluation model that large and medium-sized industrial enterprises’ scientific and technological innovation capability.

The non-linear weighted model is:

$$y_i = \prod_{j=1}^m x_{ij}^{w_j} \quad (x_{ij} \geq 1)$$

y_i : The comprehensive evaluated value of the object. x_{ij} : The original value of index. w_j : The weight of the corresponding index

2.3. Determination of weights.

Based on the non-linear weighted comprehensive evaluation method, in addition to dimensionless process of the evaluate index’ original value, the weight of each index also need to be determined and the purpose is to reflect the function and importance of evaluation index in the evaluation system. The method for the determination of weight can be grouped into two categories: one is the method to give weight subjectively. For example, Delphi method, AHP, etc. and they mostly determine the weight through the way of comprehensive consultation ratings, which has great subjectivity and tend to increase or decrease the role of some indicators, therefore, it would often lead to some evaluation results cannot truly reflect the reality relations between things. The other is the method to give weight objectively. That

is to determine the weight on the basis of the interrelation or the weight variation between the indexes, and it avoids some deviation may caused by human factors, for example, mean square method, entropy method, etc. Therefore, in order to avoid errors caused by the method to give weight subjectively, we select the mean square method of objective weight to distribute the indicators' weights. Suppose n objects are being evaluated, and then the first set of indexes j mean is:

$$\bar{x}_j = \frac{1}{n} \sum_{i=1}^n x_{ij} \quad j=1, 2, \dots, 18$$

Variance can be obtained:

$$s_j^2 = \frac{1}{n} \sum (x_{ij} - \bar{x}_j)^2 \quad j=1, 2, \dots, 18$$

Then the weight coefficient of J-index is:

$$w_j = \frac{s_j}{\sum_{j=1}^{18} s_j} \quad j=1, 2, \dots, 18$$

First we entry the original data into SPSS17.0, and the original data need to be normalized by the way of dimensionless, then we can get the indicators' mean and standard deviation through the descriptive statistical analysis of SPSS17.0, and get the weight coefficient of each evaluation index by the above formula.(As shown in table 2). Finally we put the weight coefficient and the normalized index value applied to the non-linear evaluation model, then what we obtain is the second grade index' scores and the comprehensive evaluation scores of scientific and technological innovation capability.

Table 2 the weight coefficient of evaluation index

index(x _{ij})	weight(w _j)	index(x _{ij})	weight(w _j)
X ₁₁₁	0.0556	X ₂₁₂	0.0243
X ₁₁₂	0.0432	X ₂₁₃	0.0713
X ₁₁₃	0.0809	X ₂₂₁	0.0765
X ₁₁₄	0.0249	X ₂₂₂	0.0691
X ₁₂₁	0.0487	X ₃₁₁	0.0873
X ₁₂₂	0.0571	X ₃₁₂	0.0763
X ₁₃₁	0.0481	X ₃₁₃	0.0216
X ₁₃₂	0.0261	X ₃₂₁	0.0751
X ₂₁₁	0.0836	X ₃₂₂	0.0303

Now, we can make a comprehensive evaluation to scientific and technological innovation capability of large and medium-sized industrial enterprises in Henan province 2000-2008 by using non-linear weighted comprehensive evaluation method, finally we can get its comprehensive evaluation scores and scores of 3 first grade indexes and 7 second grade indexes.(As shown in table 3,4)

Table 3 the evaluation scores of scientific and technological innovation capability

Year	score of technological environment	score of economic environment	score of manufacturing environment	technological funds investment score	technological transformation Investment score	score of economic performance	score of development performance
2000	2.2581	1.6197	1.3400	1.9238	1.5731	1.5991	1.4215
2001	2.1987	1.6102	1.3673	1.7245	1.6235	1.6547	1.4265
2002	1.9863	1.5691	1.3549	1.5871	1.6489	1.9206	1.4561
2003	2.0284	1.5140	1.3721	1.8203	1.6826	1.9489	1.4712
2004	2.2157	1.5238	1.3765	1.8708	1.8153	2.1302	1.5072
2005	2.4629	1.4992	1.3801	1.9817	1.8459	2.1130	1.5166
2006	2.4615	1.5198	1.3862	2.0611	1.8937	2.1743	1.5466
2007	2.4256	1.5703	1.3989	2.0678	1.9552	2.2301	1.5794
2008	2.3120	1.5025	1.4015	2.0525	1.8588	2.1452	1.6248

Table 4 the evaluation scores of scientific and technological innovation capability

Year	score of innovation environment	score of innovation investment	score of innovation performance	score of comprehensive evaluation
2000	4.9012	3.0263	2.2731	33.7155
2001	4.8409	2.7997	2.3605	31.9921
2002	4.2230	2.6171	2.7965	30.9063
2003	4.2136	3.0627	2.8673	37.0032
2004	4.6475	3.3960	3.2106	50.6717
2005	5.0958	3.6581	3.2047	59.7390
2006	5.1859	3.9031	3.3628	68.0665
2007	5.3284	4.0431	3.5224	75.8839
2008	4.8687	3.8151	3.4856	64.7423

3. Conclusions

From the nine years' evaluation data of enterprise scientific and technological innovation capability in Henan, we can draw the following conclusions: In the innovation environment, a serious drain exists on corporate R&D personnel and the R&D institutions are unstable, the proportion of financial funds and loans to the amount of R&D funding is decreasing constantly and the business investment in equipment increased very slowly. In the innovation investment, there has a significant growth in scientific and technological funds' investment, which plays an important role in promoting enterprises' technological innovation capability. The investment in technological transformation has been increasing steadily in these years, increased by 2% average annual, and there is still much room for its improvement. In the innovation performance, the economic performance of large and medium industrial enterprises in Henan shows an average annual quick relatively growth. The output value of new product and its proportion of total operating income are rising continuously but the labor productivity and the patent invented rise slowly, and there should be greater room for growth. Form the above three comparisons, we can know that the innovation environment is the key factor that impact innovation capability of medium-sized industrial enterprises, the innovation investment followed. From the perspective of enterprises' innovation

capability, it has experienced a relative stable growth period, also the best period of enhancing the enterprises' scientific and technological innovation. Compared with the comprehensive ability of technological innovation, its growth rate is more moderate. The above empirical analysis will offer some reference for improving the scientific and technological innovation capability of large and medium industrial enterprises in Henan Province.

References

- [1] Xiang Dongjin, Xie Mingyi. Comprehensive evaluation method of county economic development and its application [J]. Statistics and Decision, 2010(4) (in Chinese)
- [2] Zhang xin. The study on evaluation index system of innovative enterprises and methods [J]. Scientific Management, 2009(6) (in Chinese)
- [3] Zhang Keying. Comprehensive Evaluation Methods' applications in index analysis of technological innovation [J]. Technological Management, 2005(11) (in Chinese)
- [4] Zai Silei. The discussion about regional innovation capability in Henan [J]. Regional Research and Development, 2006(5) (in Chinese)
- [5] Lu Fangyuan, Jiao Keyan. Analysis of regional differences in technological innovation of large and medium-sized industrial enterprises in Henan[J]. Henan Science and technology, 2007(12) (in Chin Author Artwork)