

Knowledge Competitive Advantage Evaluation System of Listed Companies of Colleges and Universities

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Abstract

Based on the influencing factors, the evaluation index system of knowledge competitive advantage of listed companies of colleges and universities (LCCU) is constructed. Taking 16 LCCU as samples, this paper uses factor analysis method and comprehensive evaluation method to test the evaluation index system of LCCU' knowledge competitive advantage. The analysis results show that using this evaluation index system can scientifically get the position of the knowledge competitive advantage of LCCU, find the related factors leading to the poor knowledge competitive advantage, and help leaders and decision makers improve the knowledge competitive advantage, which has strong theoretical significance and practical promotion value.

Keywords

Listed Companies of Colleges and Universities; Knowledge Competitive Advantage; Factor Analysis.

1. Introduction

Because they rely on the background of universities, the LCCU are considered to represent the future direction of knowledge economy (Gu, 1999) [1]. The knowledge advantages of LCCU should provide impetus for the innovation and development of enterprises, but due to multiple influences such as knowledge value, social capital of knowledge transfer, interest distribution mechanism and external environment, there are many difficulties in the formation of knowledge advantages (Li et al., 2017) [2], which restricts the healthy development of enterprises' knowledge competitive advantages. The establishment of knowledge competitive advantage evaluation system, scientific evaluation of the status quo of knowledge competitive advantage of LCCU in colleges and universities, find out the key hindering factors, help decision makers improve the level of knowledge management, improve innovation efficiency, can effectively solve the problem of forming knowledge competitive advantage of listed companies in colleges and universities, improve the level of social scientific and technological innovation.

At present, in view of the operation problems of LCCU in China, scholars' research mainly focuses on a certain aspect of the LCCU, from the perspectives of independent innovation ability (Lin & Song, 2015) [3], school-enterprise relationship and R&D investment (Lin & Gu, 2016) [4], resource endowment (Su & Wang, 2010) [5] and so on.

At the same time, the research of knowledge competitive advantage in our country is relatively small. The existing literature mainly studies the knowledge advantage of knowledge chain (Zhang & Gu, 2012) [6] and the knowledge competitive advantage of enterprises (Xu & Hou, 2020; Yu, 2006) [7] [8], but does not pay attention to the special group of LCCU.

This study takes LCCU as the research object, studies the knowledge competitive advantages of LCCU, uses the factor analysis method to construct the knowledge competitive advantage evaluation system, scientifically evaluates the current situation of the knowledge competitive advantages of LCCU of universities, finds the key hindering factors, and helps the decision

makers to improve the knowledge management level, improve the innovation efficiency, and make effective decisions.

2. Construction of Knowledge Competitive Advantage Evaluation System of Listed Companies of Colleges and Universities

2.1. Influencing Factors

According to the existing literature, the dimensions of the evaluation system are mainly selected from the following three perspectives: first, starting from the concept itself, studying its connotation, characteristics, functions and composition, and separating quantitative or qualitative evaluation indicators from it; Second, from the concept extension consideration, analyze its source, influencing factors, mechanism of action, etc. extract the key elements; The third is the combination of the both (Li et al., 2018) [9]. This paper adopts the second method to construct the evaluation system of knowledge competitive advantage of LCCU and universities. In this paper, the collected influencing factors are divided into three aspects: human resources, enterprise size and Technical resources. As shown in Table 1 below.

Table 1. Influencing factors of knowledge advantage of listed universities

Influencing factors	index	Source of literature
Human resources	Average level of education	Laursen et al.(1999)[10]; Zhang et al.(2017)[11]
	Number of managers with senior titles	Daellenbach(1999)[12]; Lu et al.(2014)[13]
	Proportion of R&D personnel	Su et al.(2010)[错误,未定义书签。]
Size of enterprise	Ratio of intangible assets	Yu et al.(2010)[14]
	Number of employees	Xu(2021)[错误,未定义书签。]
Technical capital	Investment in training and education	Cen et al.(2008)[15]
	R&d investment	Yu et al.(2014)[错误,未定义书签。]
	Number of patents	Zhang Li(2009)[16]
	Government grants	Su et al.(2010)[错误,未定义书签。]

2.2. To Construct the Knowledge Competitive Advantage Evaluation System of University Listed Companies

It can be seen from Table 2 that the KMO statistic value is 0.705, which is significant in Bartlett's test of sphericity. The correlation in the correlation matrix is significant (space limitation is not shown), indicating that there is a high correlation between pairs of a certain group of items, indicating that the sample variables are suitable for factor analysis.

Table 2. Kmo and bartlett test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.705
Bartlett's Test of Sphericity	Approx.Chi-quare	293.760
	df	36
	Sig.	.000

The principal component analysis of nine factors was carried out by using the Kaiser standardized orthogonal rotation method, and the explained total variance as shown in Table 3 was obtained. After the total variance decomposition in factor analysis, three factors with eigenvalues greater than 1 were obtained, and their cumulative contribution rate to the total

variance was 80.92%. That is, the three factors extracted by factor analysis can resolve 80.92% of the variation of variables.

Table 3. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.123	45.813	45.813	4.123	45.813	45.813	3.731	41.459	41.459
2	1.763	19.588	65.401	1.763	19.588	65.401	1.806	20.067	61.526
3	1.397	15.518	80.920	1.397	15.518	80.920	1.745	19.393	80.920
4	.594	6.597	87.516						
5	.497	5.517	93.033						
6	.333	3.702	96.735						
7	.266	2.957	99.692						
8	.020	.218	99.910						
9	.008	.090	100.000						

Extraction Method: Principal Component Analysis.

After the rotation of maximum variation, the rotated component matrix (Table 4) is obtained. The three common factors exactly correspond to the three index layers of the knowledge competitive advantage evaluation system of LCCU mentioned above, and the nine influencing factors are classified into the three factors as sub-indicators. F1 includes Investment in training and education, R&D investment, Number of patents and Government grants. F2 includes Average level of education, Number of managers with senior titles and Proportion of R&D personnel. F3 includes Ratio of intangible assets and Number of employees.

Table 4. Rotated Component Matrix

	Component		
	1	2	3
Average level of education	.212	.773	-.108
R&D investment	.974	.177	.034
Proportion of R&D personnel	.219	.800	-.128
Number of managers with senior titles	.008	.622	.592
Number of employees	.324	-.254	.769
Ratio of intangible assets	-.061	-.035	.869
Investment in training and education	.917	.079	.098
Number of patents	.900	.204	.012
Government grants	.965	.195	.095

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

3. Comprehensive Evaluation of Knowledge Competitive Advantage of LCCU

3.1. Selection of Samples

The data in this paper come from the CSMAR database, the State Intellectual Property Office and the annual reports of each company. A total of 34 LCCU are manually collected as samples to obtain relevant annual data in 2021. The descriptive statistics are presented in the following table 5.

Table 5. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Proportion of R&D personnel	48	.250	68.890	28.164	15.516
Ratio of intangible assets	34	.000	.398	.063	.090
Government grants (Unit: ten thousand)	34	124.771	90248.235	8370.698	20373.234
R&d investment (Unit: ten thousand)	34	828.952	433773.080	35587.364	86183.865
Average level of education	48	12.870	17.690	15.660	.8379
Investment in training and education (Unit: ten thousand)	34	0.480	10649.535	667.881	1868.196
Number of managers with senior titles	34	0.000	13.000	6.470	3.351
Number of patents	34	0.000	1742.000	132.790	344.761
Number of employees	34	393.000	70638.000	5090.559	12412.009

3.2. Determine the Weight

Based on the sample data of 9 indexes of 34 listed companies of colleges and universities, each common factor and its corresponding weight are calculated according to the weighting of the total variance of the original variables explained by each factor and the factor score coefficient matrix. See Table 6 below for details.

Table 6. Public factor score and weight of LCCU

Abbreviation of the company	Human resources	ω_1	Size of enterprise	ω_2	Technical capital	ω_3
<i>PKU HealthCare Corp.,Ltd.</i>	1.271	24%	0.149	25%	3.054	51%
<i>Sinobioway Medicine</i>	1.271		0.149		3.054	
<i>FOUNDERTECH</i>	-0.157		0.163		0.736	
<i>CHINA HI-TECH</i>	1.950		0.488		-0.683	
<i>TUS- PHARMA</i>	0.342		2.202		-0.781	
<i>TUS-EST</i>	1.719		0.093		-0.599	
<i>UNIS</i>	1.719		0.093		-0.599	
<i>GUOXIN MICRO</i>	1.415		0.272		-0.639	
<i>TELLHOW</i>	1.491		-0.123		-0.493	
<i>Chipscreen</i>	1.491		-0.123		-0.493	
<i>BOSHI</i>	0.847		0.326		-0.505	
<i>iFLYTEK</i>	0.781		-0.255		-0.224	
<i>QuantumCTEK</i>	0.376		0.141		-0.366	
<i>Dareway</i>	0.376		0.141		-0.366	
<i>LANJIAN</i>	0.202		-0.330		-0.062	
<i>JINXD</i>	0.994		-0.252		-0.493	
<i>BOYUN NEW MATERIALS</i>	0.994		-0.252		-0.493	
<i>NJUAE</i>	-0.132		0.299		-0.413	
<i>SHANGHAIXINNANYANGONLYEDUCATION&TECHNOLOGYCO.,LTD</i>	-0.132		0.299		-0.413	
<i>INSIGMA</i>	0.257		-0.078		-0.420	
<i>DAJY</i>	0.173		-0.465		-0.263	
<i>Wisesoft</i>	-0.076		-0.359		-0.235	
<i>TMMT</i>	-0.076		-0.359		-0.235	
<i>JLU COMMUNICATION</i>	-0.523		-0.032		-0.211	
<i>Neusoft</i>	-0.512		0.067		-0.292	
<i>TJKJ</i>	-0.058		-0.572		-0.277	
<i>Keqian Biology</i>	-0.058		-0.572		-0.277	
<i>Changying Xinzhi</i>	-0.801		0.264		-0.357	
<i>WISCOM</i>	-0.422		-0.661		-0.174	
<i>KN</i>	-0.422		-0.661		-0.174	
<i>HQHB</i>	-1.180	-1.017	0.271			
<i>Huasun</i>	-0.882	-0.462	-0.221			
<i>SVG</i>	-0.911	-0.898	-0.091			
<i>Sunwin</i>	1.271	0.149	3.054			

3.3. Comprehensive Evaluation

According to the coefficient of each common factor and corresponding weight of each listed company in Table 6 above,the final score of each listed company in each university is calculated.Formula is as follows:

$$\bar{F} = \omega_1F_1 + \omega_2F_2 + \omega_3F_3$$

According to the above formula, the final scores of listed companies in each university are calculated and sorted from high to low in Table 7 below. Only FOUNDERTECH and Changying Xinzhi scored more than 1,which belongs to the category of better utilization of knowledge advantages.However,starting from Sinobioway Medicine,the scores are all negative.

Table 7. Comprehensive evaluation form of knowledge competitive advantage of listed companies in colleges and universities

Abbreviation of the company	score	Abbreviation of the company	score
<i>FOUNDERTECH</i>	1.900	<i>GUOXIN MICRO</i>	-0.168
<i>Changying Xinzhi</i>	1.900	<i>SVG</i>	-0.168
<i>JINXD</i>	0.378	<i>LANJIAN</i>	-0.172
<i>QuantumCTEK</i>	0.242	<i>INSIGMA</i>	-0.209
<i>Dareway</i>	0.234	<i>PKU HealthCare Corp.,Ltd.</i>	-0.228
<i>TUS- PHARMA</i>	0.130	<i>TJKJ</i>	-0.228
<i>KN</i>	0.130	<i>JLU COMMUNICATION</i>	-0.241
<i>NJUAE</i>	0.081	<i>BOYUN NEW MATERIALS</i>	-0.255
<i>CHINA HI-TECH</i>	0.076	<i>UNIS</i>	-0.298
<i>WISCOM</i>	0.076	<i>Huasun</i>	-0.298
<i>Neusoft</i>	0.027	<i>Wisesoft</i>	-0.308
<i>BOSHI</i>	0.009	<i>TUS-EST</i>	-0.355
<i>Sinobioway Medicine</i>	-0.061	<i>HQHB</i>	-0.355
<i>Keqian Biology</i>	-0.061	<i>DAJY</i>	-0.399
<i>iFLYTEK</i>	-0.065	<i>TMMT</i>	-0.440
<i>TELLHOW</i>	-0.076	<i>Chipscreen</i>	-0.490
<i>Sunwin</i>	-0.076	<i>SHANGHAIXINNANYANGONLYEDUCATION&TECHNOLOGYCO.,LTD</i>	-0.638

4. Conclusion

Through factor analysis, it is clear that human resources, technical resources and enterprise scale have become important influencing factors for the knowledge competitive advantage of LCCU. Among them, technical resources include Investment in training and education, R&D investment, Number of patents and Government grants. Enterprise size includes Ratio of intangible assets and Number of employees. Human resources include Average level of education, Number of managers with senior titles and Proportion of R&D personnel. According to the comprehensive evaluation results, forward for the formation of knowledge competitive advantages of listed companies of colleges and universities. The following implications are proposed:

We will increase investment in research and development. LCCU can increase the investment of R&D funds from two aspects: first, build or strengthen the construction of their own R&D institutions, add R&D personnel, set up special funds for R&D, and improve the incentive level for R&D personnel; Second, it should strengthen the collaborative development and innovation with universities, research institutes and other technology cooperation enterprises it relies on, and give full play to its innovation advantages of industry-university-research combination. In addition, the listed companies of colleges and universities should strengthen the introduction and application development of advanced scientific and technological achievements of the universities they rely on, and strengthen the investment in the transformation projects of scientific and technological achievements and new product research and development projects. LCCU should gradually get rid of the habit of basic research or application of basic research in scientific and technological innovation in colleges and universities. Instead, they should introduce process development technology, advanced management technology and marketing technology, and consider the feasibility and possible realization process of its transformation while developing patents. That is, process development and market development should also be included in the development plan. To realize the sustainable and innovative development of LCCU.

Strive to improve the wages and welfare of employees. A greater part of the employees of LCCU come from the universities they rely on, and even some LCCU themselves cooperate with universities to cultivate targeted talents or carry out secondary development and training of

their employees. In the case that listed companies of colleges and universities are similar to a large alumni association, the difficulty of management may be reduced or increased. It is very necessary to strengthen the management of employees, and to let employees serve them, especially some part-time employees from colleges and universities, we must give more favorable wages and welfare returns. In order to obtain the scientific and technological innovation achievements relying on universities, listed companies of colleges and universities often adopt the way of technology shareholding or employee shareholding to motivate employees. Salary, welfare and equity incentive have become important measures LCCU to strengthen the enthusiasm of employees.

Moderately increase the external introduction of the top management team. LCCU are famous for their talents and technological advantages, but they lack knowledge and experience in management, financing, investment and other aspects. Now that these enterprises have reached the operation level of a listed company, they should start to consider their professional operation and management, introduce professional management teams and senior consultants, increase investment in the standardization, institutionalization and informatization of management, and strive to build the enterprise into an efficient, high-level and professional management team. Of course, increasing the investment in management funds should also be moderate. Therefore, in the future, LCCU should increase the external introduction of management teams on the basis of ensuring management efficiency.

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