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Empirical Analysis of Low-Carbon Innovation System Construction from low-carbon Listed Companies

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Abstract. The low-carbon innovation factor system is a collection of many elements that affect the organization's low-carbon independent innovation activities, which form the organization's low-carbon innovation capacity through interaction, which is also a constituent element of organizational low-carbon innovation. By means of China's 225 listed low-carbon companies as samples, a low carbon innovation ability index system which uses factor analysis is built on the basis of theoretical analysis and comparison.

Introduction

With China's energy consumption is in a gradual upward trend, although per capita energy resources in the world at a relatively low level. China's energy consumption grew by 4.7 percent in 2013, down from 8.6 percent over the past decade, but still 22.4 percent of global energy consumption, making it the world's largest energy consumer. In 2014 China's primary energy consumption structure, coal still occupy a substantial proportion, up to 66%, while clean energy accounted for only a small proportion (8.1% of water and electricity, nuclear power accounted for 1%, 1.8% of renewable energy). This coal-based high-carbon energy structure not only poses a huge threat to the environment, but also restricts the transformation of China's economic development model. In the context of rapid growth of carbon emissions and unsustainable fossil fuels, it is imperative to develop low-carbon economy and accelerate the transformation of economic development model. Although China still has the advantage of developing low-carbon economy, there are still many unfavorable factors such as high energy consumption, high emission, low technological level and arduous energy-saving and emission reduction caused by the traditional economic development mode. It needs to adjust the industrial structure and accelerate the technological innovation And other relevant policies to deal with.

Low-Carbon Innovation Ability and Its Constituent Elements

The low-carbon innovation factor system is a collection of many elements that affect the low-carbon innovation activities of enterprises, which form the low-carbon innovation capability of enterprises through interaction. At present, low-carbon innovation is only reflected in the concept, there is no special study of low-carbon innovation capacity of the problem, mostly around the innovation ability to start.

Many scholars have analyzed the composition of innovation ability from different angles. First of all, some scholars from the perspective of technological innovation ability analysis, Gao Xia (2006) that the enterprise's technological innovation capability from the R & D manufacturing capacity, innovation input capacity and feedback control and innovation output capacity; some scholars use the gray comprehensive evaluation model The evaluation of enterprise technological innovation ability, the technological innovation ability is divided into four aspects of 15 indicators (Bai Yanzhuang, 2006). On the other hand, from the connotation of enterprise innovation, Zhang Ling (2007) uses BP neural network method to manually evaluate the innovation ability of small and medium-sized enterprises, decompose enterprise innovation ability into research and development ability and innovation management ability, innovation factor investment ability and innovation production capacity As well as

new product marketing ability, the same is the small and medium enterprises, some scholars to the innovation capacity of SMEs into innovation R & D, conversion and management capabilities (Gao Cuijuan, 2013), and from the structure, resources, The constituent factors of social capital of entrepreneurs, and explore the innovation ability of small and medium - sized enterprises (Jiang Weitao, 2012). Jiang Bing (2009) and so on that the enterprise's innovation ability should include innovation management ability, R & D investment, talent input, R & D ability and innovation output, the "uncertainty" information, using evidence reasoning (ER) evaluation method, The recursive evidence reasoning algorithm and the corresponding reasoning synthesis step.

Some scholars have another way, some from the enterprise's innovation consciousness, the innovation ability described as innovation consciousness, innovation way, innovation input and output ability, innovation management ability five dimensions (Cao Hongjun, 2009)and some scholars put forward the different dimensions of the enterprise innovation capacity and its index system(Mei Qiang et al., 2011; Zhu Weidong et al., 2012; Huang Youli, 2009). Some scholars point out that the enterprise's ability to innovate the technological innovation capability (Duan Yunlong, 2010).

Some scholars have noted the role of the internal and external environment in the innovation capacity, the innovation environment into the enterprise innovation ability index system (Zhu Kong to 2007; Luo Dengyue, 2010) or based on internal operations and external environment synergistic perspective, the establishment of multi-influencing factors Model (Li Xiangdong et al., 2014). Xu Rongrui et al. (2013) proposed that innovation ability is a dynamic accumulation process of the second innovation ability, the integrated innovation ability of the transition, the final innovation capability of the original innovation ability, and analyzes the driving factors of the evolution of innovation ability from the internal and external perspectives. And it is further recognized that the most important external environment affecting enterprise innovation is not the external environment itself, but the ability of enterprises to integrate through the external environment and their own resources (Wu Xianying, 2010). In addition, Cai Hongyu (2014) based on low-carbon economic background, the establishment of enterprise innovation ability evaluation index system.

The above discussion on the dimensions of innovation capacity is different, but most scholars focus on innovation resource input and output capacity, innovation management ability, research and development ability and manufacturing ability, and marketing ability. Most scholars in the selection of elements of innovation ability to experience the main selection, the lack of internal and external elements of the distinction between enterprises.

Analysis and Measurement of Low - Carbon Innovation Capability Elements

We use most of the scholars to use the enterprise innovation research and development capabilities and innovative investment capacity of the two internal elements of the most important. Combined with the actual situation of China's low-carbon innovation, the regional innovation environment as an external factor to be analyzed.

The Internal Elements of Low Carbon Innovation Capability. The internal elements of low-carbon innovation capability include low-carbon R & D capability and low-carbon innovation resources. First of all, low-carbon innovation is a high-input activities, therefore, to carry out low-carbon innovation, enhance low-carbon innovation capacity, the first thing to do is to have enough rich resources for innovation. Most of the innovative activities of the literature, including innovative funding (or financial) investment, management personnel investment, scientific and technological personnel into scientific and technological conditions, information, equipment investment, and these content is low-carbon talent investment and low-carbon capital investment. Second, low-carbon enterprise research and development capabilities and low-carbon innovation capacity is the embodiment of the comprehensive ability of enterprises. That R & D capabilities are the ability of enterprises to search, acquire and utilize existing knowledge to generate new knowledge, technology, and products (Nerkar, 2005). Which can be from the low-carbon knowledge accumulation and

low-carbon development potential in two aspects to measure low-carbon enterprise research and development capabilities.

The External Elements of Low Carbon Innovation. The external elements of low-carbon innovation include three aspects: low-carbon regional innovation environment, low-carbon regional financial environment and government policy guidance support. The low-carbon regional innovation environment includes regional resource environment, external market environment and innovative cooperative environment, low-carbon regional financial environment Including bank financial support and other financial support, government policy guidance support, including innovation subsidy guidance, tax guidance support and financial guidance support.

Measurement of Low - Carbon Innovation Capability Index. The four dimensions in Internal factors which are low-carbon knowledge accumulation, low-carbon development potential, low-carbon capital investment, low-carbon talent investment, respectively measure through the number of enterprise patent applications and the number of enterprise patents, enterprise technology, enterprise R & D investment, The number of technical staff.

The number of R & D personnel in regional research and development institutions, the number of R & D expenditure of regional research and development institutions, the internal expenditure of R & D expenditure in regional colleges and universities, and the number of R & D personnel of regional institutions of higher learning. The external market environment with the enterprise sales growth rate and the enterprise net assets yield two indicators to measure; regional resources and environment with the number of regional R & D personnel, regional large and medium-sized enterprises R & D expenditure internal expenses, regional R & D expenditure internal expenditure, regional invention patent number four The financial support and other financial support are borrowed by the corporate bank respectively, and the financial support and other financial support are respectively borrowed by the government bank, and the financial support and other financial support are respectively borrowed by the enterprise bank Amount and other financial institutions to borrow measurement.

Model Building

Sample Data Source. Selection of low-carbon industry enterprises as a sample. (35), low-carbon concept (58), new energy (106), solar (26), low-carbon (56), new energy (106), solar energy (26) , The new energy vehicles (27), lithium batteries (36), new materials (78) and other eight plates, a total of 225 low-carbon listed companies (Liang Yilin; Zhang Yuming; 2014); Second, the plate listed companies see the number of samples, Sample provinces are distributed in the table. Third, the data from the low-carbon listed companies company's annual report and prospectus and China Science and Technology Statistical Yearbook. Fourth, the use of the 2008 to 2012 arithmetic mean to eliminate the impact of transport multiple regression analysis with the 2008 to 2012 panel data.

Table 1 Low - carbon listed companies sample provinces and autonomous regions

Provinces	samples number	Provinces	samples number	Provinces	samples number	Provinces	samples number
Anhui	8	Liaoning	4	Hebei	3	Sichuan	8
Beijing	19	Neimenggu	5	Henan	3	Tianjin	3
Fujian	5	Ningxia	3	Heilongjiang	2	Xizang	2
Gansu	2	Qinghai	1	Hubei	9	Xinjiang	3
Guangdong	27	Shandong	11	Hunan	6	Yunnan	3
Guangxi	1	Shanxi	4	Jilin	5	Zhejiang	24
Guizhou	2	Shaanxi	3	Jiangsu	29	Chongqing	3
Hainan	2	Shanhai	20	Jiangxi	5	Total	225

Factor Analysis. In the external factors, the low-carbon regional innovation environment includes 11 indicators, the correlation is strong, there may be strong collinearity, so the first factor analysis, the remaining enterprises similar to low-carbon elements analysis.

First, KMO and Bartlett's spheres were tested for the relevant indicators. KMO statistic 0.752> 0.7, Bartlett's sphere test $p < 0.05$, can be factor analysis. Secondly, the variance maximized orthogonal rotation is used to analyze the 11 indexes.

Table 2 Analysis of Environmental Factors in Low - carbon Region Innovation

Related indicators	Common factor 1	Common factor 2	Common factor 3
	Cumulative contribution rate（89.95%）		
Regional large and medium sized enterprises R & D expenditure internal expenses	0. 981	−0. 167	−0. 016
Number of R & D Staff in Large and Medium sied	0. 975	−0. 122	−0. 013
Regional R & D expenditure internal expenses	0. 954	0. 218	−0. 011
Number of regional R & D personnel	0. 915	0. 392	−0. 005
Number of regional invention patent licenses	0. 826	0. 340	−0. 025
Regional research and development institutions R& D expenditure Internal expenditure	−0. 015	0. 989	0. 043
Expenditure on R & D of Regional Institutions of Higher Education	0. 345	0. 980	0. 048
Number of R & D personnel in regional research and development institutions	0. 001	0. 915	0. 039
Number of R & D Staff in Regional Colleges and Universities	0. 552	0. 801	0. 031
Return on net assets of enterprises	0. 086	0. 028	0. 778
Enterprise sales growth rate	−0. 058	−0. 106	0. 756

The cumulative contribution rate of the factor is greater than 80% for the critical value and the eigenvalue is greater than 1 in two dimensions to extract the variables. As can be seen from Table 2, the cumulative contribution rate of each factor is 89.95%, and the factor load is between 0.758 and 0.990, indicating that each factor has better explanatory ability. Low-carbon regional innovation environment can be divided into regional resources and environment, innovative cooperation environment, including and external market environment three factors.

Finally, the index system of low-carbon innovation model is as follows.

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Table 3 Low - carbon innovation ability index system

Target layer	Factor layer	Index layer	Index measurement
Internal innovation elements	Low-carbon research and development capabilities	knowledge accumulation	Number of patent applications
			Number of enterprise patent licenses
		Low carbon development potential	Enterprise technical level
	Low carbon innovation resources	Low-carbon capital investment	Enterprise R & D capital investment
		Low-carbon talent investment	Number of technical personnel
External innovation elements	Low - carbon regional innovation environment	Regional resources and environment	Number of regional R & D personnel
			Regional R & D expenditure internal expenses
			Number of regional invention patent licenses
			Regional large and medium - sized enterprises R & D expenditure internal expenses
		Innovation cooperation environment	Regional research and development institutions R & D expenditure Internal expenditure
			Number of R & D personnel in regional research and development institutions
			Expenditure on R & D of Regional Institutions of Higher Education
			Number of R & D Staff in Regional Colleges and Universities
		External market environment	Enterprise sales growth rate
			Return on net assets of enterprises
	Low - carbon regional financial environment	Bank financial support	Borrowing amount of corporate bank
		Other financial support	Borrowing from other financial institutions
	Government policy guidance support	Financial guidance support	Subsidy of financial subsidy
		Tax guidance support	Government tax incentives

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