

Literature Review on Regional Low-Carbon Competitiveness Evaluation Indicator System

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Abstract: Based on literature research, document calculation and frequency statistics methods, this paper systematically generalizes, combs and summarizes the researching features and developing tendency about regional low-carbon competitiveness recent years. Regarding “evaluating indicator system” and “evaluating method” as two research dimensions, this paper will make an all-round and deep literature review on the evaluation of the low-carbon competitiveness by taking both the qualitative review and quantitative review as the logic cogitation.

Keywords: Regional Low-carbon Competitiveness; Evaluation Indicator System; Literature Review

1. Introduction

As global warming and environmental deteriorating, innovation in science technology and change in people's thinking perception impel us to rethink about the grab for the natural resources. The development methods of low-carbon society, green economy and sustainable development have been put on the agenda which also attract mass scholars to make research on. Competition of future economy is under the low-carbon development model in which quality and speed of economy development are regarded as the main evaluation standards, and this change has brought each country not only a chance, but also an inevitable challenge. Hence, it's quite important to enhance country and regional low-carbon competitiveness as the low-carbon economy development model is widely promoted across the world. Based on this, this paper will make a deep review about the low-carbon competitiveness evaluation system and evaluation methods by setting foot on the conception and connotation of low-carbon competitiveness with the purpose of enriching the low-carbon economy theory and providing research basis to promote regional low-carbon competitiveness.

2. Literature Review of Concept and Cognition of Low-Carbon Competitiveness

The term “low-carbon economy” was firstly used in the Energy White Paper: Our Energy Future- to Create a Low-Carbon Economy declared by the English minister Tony Blair on Feb 24th, 2003 which means gaining more economy output by less resume of nature resources and environment pollution [1], and after that, scholars devote to the academic research low-carbon economy, low-

carbon industry and low-carbon competitiveness. The concept of low-carbon competitiveness is obvious, however, it is difficult to give a clear definition. Low-carbon competitiveness was firstly defined in the report “Low-Carbon Competitiveness of the G20”, released by the Australia Climate Institute and the English E3G Organization, in which low-carbon competitiveness was defined like this: low-carbon competitiveness means the ability of each country to create material prosperity for its people in the way of future low-carbon development [2]. Lee and MacGillivray (2010) thought low carbon competitiveness is the ability for economies to create constant economy value by low-carbon technology, products and service. They believed activities, such as, the lead of country, strategy and coordination, investment, and the involvement of civilians, would be helpful to the development and promotion of the low-carbon competitiveness [3].

Xu (2011) thought regional low-carbon competitiveness is the ability to promote regional economy to low-consumption, low-pollution and low-emission development model, to gain, attract and convert low-carbon resources, and to contest, occupy and control market under the guidance of sustainable development, by means of energy developing, technology innovating, industry converting and system reforming, which is a kind of comprehensive ability involving economy, society, culture and the environment system[4]. Li and Zhou (2011) regarded the low-carbon competitiveness as a responsibility to a country or region to reply to the change in climate, a comprehensive competition in which relative industries, enterprises and techniques take part in the process of developing low-carbon economy, and a kind of ability which can not only meet the need of low-carbon restric-

tion, but also keep the economic development [5]. Lu and Shi (2013) defined low-carbon competitiveness as the ability for a certain region to take low-carbon production and service, to create sustained prosperity, and to realize the promotion of people's welfare under the low-carbon future development model, in which the low-carbon productive capacity, sustained prosperity capacity, people's welfare promotion are strengthened [6]. Guo (2013) thought urban low-carbon competitiveness is the ability for a city to create material fortune for its residents and promote the sustainable development of the society by comparison with other cities under the restriction of low-carbon emission, the core of which is to reduce energy consumption and cut down carbon emission, and the aim of which is to balance the relationship between the development of economic society and the ecological environment [7].

Some conclusions can be drawn according to the literature listed before and other scholars' understandings about the concept and cognition of low-carbon competitiveness: although the focuses vary a lot for scholars to understand low-carbon competitiveness, most researchers think low-carbon competitiveness is a comprehensive competitiveness included in energy structure, economy development, industry layout, society process and ecological environment in a country or region under the low-carbon development model by reason that these five aspects play an important role in the development of a certain region. Low-carbon competitiveness in this paper is comprehended in this way: a kind of regional competitiveness can not only ensure the economy develops smoothly, but also realize low energy consumption, society smoothly development, little environment pollution to realize the "low pollution, low emission, low consumption" development model can be built while energy, economy, industry, society and environment can be harmoniously developed and mutually promoted.

3. Literature Review of Low-Carbon Competitiveness Evaluation Indicator System

Construction of evaluation indicator system is the core content to make research on low-carbon competitiveness evaluation, which also is the key to make a scientific, objective and reasonable evaluation to low-carbon competitiveness. Based on the analysis of literatures in which indicator system has been built, this paper summarizes the overall tendency and developing direction of the construction of low-carbon competitiveness evaluation indicator system to make a theory foundation for regional low-carbon competitiveness evaluation method. Throughout the literatures in low-carbon competitiveness field, this paper divides the indicator systems into three layers, objective layer, principal layer, index layer, and the research review will be organized on different layers.

3.1. Literature Review of Indexes on the Objective Layer

Aim to build low-carbon competitiveness evaluation indicator system is not only to evaluate the current situation of regional low-carbon economy, but also to evaluate the competitiveness to develop low-carbon economy. To analyze the low-carbon economy competitiveness from the sight of region is good to recognize the environment of regional low-carbon economy competition and tendency, and also plays an important role in taking the development emphasis and trend of regional low-carbon economy. Most scholars regard "regional low-carbon competitiveness" as the only index in the objective layer by reason that the objectivity and clarity of regional low-carbon competitiveness evaluation can be clearly expressed. Although scholars construct different evaluation systems based on different backgrounds, some evaluation systems are built on national levels [8-9], on provincial levels [10-12], on urban levels [13-14], and some are based on certain industry levels [15-18], nearly most of these papers with high consistency regarded "regional low-carbon competitiveness" as the only index on objective layers which is conducive to make a direct and objective evaluation on regional low-carbon competitiveness.

3.2. Literature Review of Indexes on the Principal Layer

Evaluation indexes on principal level are established based on the objective level and on different understandings of the scholars, which reflect the conditions of the region, such as economy, society and environment, etc. Indexes on principal level are vital to the construction of the index system by reason that principal level mirrors the angle and starting point of the scholars to understand the evaluation system.

Chen (2010) made an overall evaluation on low-carbon competitiveness on the principal layer from six aspects, energy structure, consume requirement, industry structure, strategy plan, policy guidance and attendance chance, based on Michael Porter's Diamond Model. Zhu and Chen (2011) divided urban low-carbon competitiveness into low-carbon environment competitiveness, low-carbon production competitiveness and low-carbon society competitiveness on the principal payer according to the "Three Baseline" theory model. Pan and Wang (2012) built a principal layer which included the low-carbon development potential sub-system, reflecting the amount of money put by a country in developing low-carbon economy and the potential of competitiveness, and low-carbon development efficiency sub-system, reflecting the achievements due to the transformation of low-carbon economy [19]. Wu and Hua (2013) principally evaluated the low-carbon competitiveness among Midwest cities

tiveness. From Table 1, several conclusions can be easily got. Energy resume intensity is most widely used because it is the ratio of energy provided total and GDP which reflects the efficiency of energy utilizing and is vital to evaluate the low-carbon competitiveness of economies. After that, other indexes, like, total amount of energy consumption, coal's share of energy consumption, ratio of clear energy in total consumption are all with high used-frequency by reason that these three indexes are much objective to be used to calculate the carbon emission amount. Therefore, indexes related to energy resume are widely used in regional low-carbon competitiveness. Economy condition has been widely used to evaluate the overall development condition of a particular region, and for this reason, it is also important to evaluate the low-carbon competitiveness. The indexes related to economy have been listed in Table 2.

The frequency of indexes related to economy development condition used in literature is 62.1%, and all indexes are qualitative. Several conclusions can be got from Table 2. GDP per capita is the most used index in all economy indexes because it directly reflects the economy development level of certain region. And, indexes, such as, foreign trade turnover, economy increase rapid, capital consumption rate, are also widely used in the system to evaluate because these indexes are objective and measurable to be used to evaluate the economy development. Low-carbon industry system is core to evaluating low-carbon competitiveness, and which also shows the development condition of low-carbon competitiveness. While the proportion of low-carbon industry output value was used to measure low-carbon competitiveness to a certain region, the higher level of low-carbon industry in GDP, the higher level of low-carbon development and the stronger the low-carbon competitiveness a region is generally thought to be. However, according to the different understandings on the connotation, scholars select different indexes when constructing industry evaluation system in Table 3.

The frequency of low-carbon industry layout indexes used in literatures is 83.3%, and most of which are qualitative. From Table 3, some conclusions can be got. The portion of the tertiary industry in GDP is with great quoted frequency by reason that tertiary industry is low-carbon industry which is much important to the promotion of low-carbon competitiveness. And, indexes, such as, the development level of new and high-tech, the proportion of R&D expenditure in GDP, the proportion of education expenditure in GNI, are quoted with high frequency because Science & technology and education are all important means to promote the regional low-carbon competitiveness which play significant role in promotion. Therefore, indexes used to evaluate science & technology and the level of education have attracted many scholars to study the industrious index evaluation system.

Due to the fact that environment is another driving factor in promoting national or regional low-carbon competitiveness, indexes related to environmental amelioration must be taken into consideration in evaluating.

By indexing all literatures, we found that all of which have established indexes related to environment, and all of the indexes are qualitative which plays an important role in constructing evaluation system. Some conclusions can be got from Table 4. Carbon emission per unit GDP, carbon emission per capita, and carbon emission amount are the most top three quoted indexes because carbon emission directly reflects regional energy use and environmental protection efforts which evaluate the environment from the aspect of economic efficiency. Forest coverage rate and landscaping area per capita also are significant evaluation indexes because they evaluate the environment from the aspect of environmental protection. Sewage treatment rate and annual growth rate of greenhouse gas are also with high used frequency by reason that these indexes evaluate the environment from the aspect of daily life. Environmental evaluation indexes have attracted widely attention in constructing index system, and constructing which from the aspect of economy development, green resources and daily life to make an all-round and comprehensive appraisal on the environment is vital to promote regional low-carbon competitiveness.

The frequency of indexes used to evaluate social development condition in all literatures is 85%. Even though the quoted frequency is quite high, however, these indexes are with little representation so that the frequency table is not listed here. By analyzing the property of these indexes, we found that the indexes related to social evaluation used in literatures are with great difference because most of which are quantitative.

4. Literature Review of Regional Low-Carbon Competitiveness Evaluation Method

At present, methods used to evaluate regional low carbon competitiveness mainly include linear weighing method, fuzzy comprehensive evaluation method, data envelopment analysis method and gray relation analysis method, etc. The common point among linear weighing method, fuzzy comprehensive evaluation method, and gray relation analysis method is measuring index weighs in which methods, like Delphi, AHP, expert scoring method and entropy method are used. Due to the fact that all these methods need to measure the weighs of indexes, the conclusions got by using these methods are generally subjective. Besides, some special models [21-25] have been used to evaluate regional low-carbon competitiveness. Pan and Wang (2012) calculated and analyzed the coordinated degree between the low-carbon potential subsystem and the low-carbon efficiency subsystem which have been constructed to evaluate China's low-carbon

development condition to ascertain its low-carbon competitiveness and put forward countermeasures and suggestions to improve low-carbon condition in China. Lu and Wang (2013) regarded PLS-SEM model as the basic method to construct and empirically test the driving factors of low-carbon competitiveness in 30 provinces [26]. Zhu and Chen (2011) used individual indicators scoring method to score the indexes by introducing gray entropy model to evaluate urban low-carbon competitiveness, and used entropy method to calculate the weights of indexes. Jin and Du (2013) took PCA, EM, and clustering methodology to evaluate the low-carbon competitiveness of 12 provinces (district, city) on the basis of constructed indicator system.

From the aspects of data procession and analysis, scholars mainly concentrate on dealing with those indexes which can be objectively analyzed, and hence, the amount of objective indexes directly determines how objective the evaluation system will be. To index weigh determination, the method which has been chose to weigh the index has certain influence on the evaluation result. The data which will be processed and analyzed have close connection to construction of evaluation system, and the scale of which and the math methodology have great effect to the promotion of objectivity of the system. For this reason, there still exists much room for the promotion of evaluation methodology to scholars who have engaged in low-carbon competitiveness research field.

5. Conclusions

In summary, due to the fact that the construction of index system is the key in studying low-carbon competitiveness, and as the deep and further studies go on, large quantities of obvious achievements have been gained in this field. Scholars can select different indexes to analyze and demonstrate bases on various research fields, however, some indexes in the system mainly depend on subjective judgment and choice which lacks certain objective evaluation standards. Data procession and model construction need to be improved by reason that the imperfection of data collection, shortage of data procession so that scholars could calculate and analyze based on the mathematic models and analysis methods which have been built. There is some room for the promotion of the construction of whole system and the analysis process due to the imperfection of data collection, error in data procession, imprecise analytic method which may lead to the lack of science and preciseness of the whole system.

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References

- [1] DTI (Department of Trade and Industry), Energy WhitePaper: Our Energy Future Create a Low Carbon Economy [M]. London: TSO, 2003.
- [2] The Climate Institute and E3G. G20 Low Carbon Competitiveness Report [Z]. 2009, (12).
- [3] Lee, H., MacGillivray, A., Begley, P., Zayakova, E. The Climate Competitiveness Index 2010 [J]. Account Ability, 2010, (44).
- [4] XU J Z, YUAN X L. Study on System Structure of Regional Low Carbon Competitiveness [J]. Science & Technology Process and Policy, 2011(12): 26-29.
- [5] LI J J, ZHOU L M. Evaluation and Promotion Countermeasures of Fujian Low Carbon Economy Competitiveness [J]. Comprehensive Competition, 2011(3):75-80.
- [6] LU Y Q, SHI J. Construction of Low Carbon Competitiveness Evaluation Index System [J]. Statistics and Decision, 2013 (1): 63-65.
- [7] GUO Q. Connotation, Model and Evaluation System of Urban Low Carbon Competitiveness [J]. Tribune of Social Science, 2013(1):100-102.
- [8] LI J J. Evaluation of Low Carbon Competitiveness in G20 and Implications to China [J]. Journal of Guangdong Institute of Public Administration, 2010, 22(6): 79-83.
- [9] CHEN X C, CHEN S G. On the promotion of Low Carbon Competitiveness in China [J]. Journal of Xiangtan University (Philosophy and Social Science), 2010, 34(5): 50-54.
- [10] CHENG D X, CHEN J. Evaluation of Low-Carbon Competitiveness in Jiangsu Province [J]. Environmental Pollution and Control, 2013, 35(9):88-100.
- [11] JIN X Q, DU S H. Evaluation of Low-Carbon Competitiveness in Western China [J]. Acta Ecologica Sinica, 2013, 33(4): 1260-1267.
- [12] ZHAO Y L. Comparison of Low-Carbon Economy Development Competitiveness among Major Cities in Bohai Economic Circle [J]. Economic Outlook of Bohai Sea, 2012 (2): 21-24.
- [13] ZHU D J, CHEN J. Evaluation Model of Urban Low-Carbon Competitiveness and Empirical Research of Shanghai [J]. Modern Urban Research, 2011 (11): 10-14.
- [14] CHEN J, CHENG D X, ZHU D J. Evaluation of Urban Low-Carbon Competitiveness in China Using Grey Relational Analysis [J]. Resource Science, 2012, 34(9): 1726-1731.
- [15] LU J C, LIU L, ZHANG J J. Evaluation for Low-Carbon Competitiveness of Construction Industry Based in Interval Number [J]. Technique Economy, 2012, 31 (4): 61-65.
- [16] LI C B. Construction of Index System for Forestry Low-Carbon Competitiveness and Its Empirical Evaluation [J]. Journal of Anhui Agriculture Science, 2012, 40(12): 7207-7211.
- [17] WANG X Y. Research and Analysis of China Agriculture Competitiveness under the Perspective of Low Carbon-Regarding Michael Porter Diamond Theory as Model [J]. World Agriculture, 2011(4): 30-33.
- [18] XU J Z, YUAN X L. Research on the Network Operational Mechanism of Enterprise Low-Carbon Competitiveness Based on Dissipative Structure [J]. Science & Technology Process and Policy, 2011, 28(24): 92-95.
- [19] PAN W Y, WANG Z J. Research on the Evaluation Index System of Low-carbon Competitiveness Based on the Model of Coordinated Degree [J]. Journal of Intelligence, 2012 (10): 77-81.

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- [20] Wu Q Y, Hua H Y. Comprehensive Evaluation Model of Midwestern Cities' Low Carbon Competitiveness Based on Through Set Theory [J]. *Regional Economy*, 2013 (24): 130-131.
- [21] Seidl I, Tisdell C A. Carrying Capacity Reconsidered: From Malthus' Popularity Theory to Cultural Carrying Capacity [J]. *Ecological Economics*, 1999, 31: 395-408.
- [22] Meyers PS, Yung J W, Ausubel J H. A Primer on Logistic Growth and Substitution: The Mathematics of the loglet Lab Software [J]. *Technological Forecasting and Social Change*, 1999, 61(3): 247-271.
- [23] Michael E. Porter. *The Competitive Advantage of Nations* [M]. The Free Press, 1990.
- [24] Yoichi Kaya. Impact of Carbon Dioxide Emission on GNP Growth: Interpretation of Proposed Scenarios[R]. Paris: Presentation to the Energy and Industry Subgroup. Response Strategies Working Group, IPCC, 1999.
- [25] Common M. Measuring national economic performance without using prices [J]. *Ecological Economics*, 2007 (64): 92-102.
- [26] LU Y Q, HUANG F. Driving Factors and Mechanism of Low Carbon Competitiveness -Based on the Analysis of PLS-SEM Model [J]. *Science & Technology Process and Policy*, 2013(9): 15-18.