Evaluation on Core Competitiveness of Wholesale Market of Agricultural Products Based on CWAA Operator

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Abstract According to relevant data, we select five indices, namely management ability, organization and management capability, enterprise culture, development ability and technical equipment ability, to establish the index system of core competitiveness of wholesale market of agricultural products. Based on combination weight arithmetic average (CWAA) operator, we advance an evaluation model of core competitiveness of wholesale market of agricultural products which involves participation of many people. By inviting five exerts, we conduct evaluation in terms of management ability of wholesale market of agricultural products, organization and management capability of leadership, enterprise culture of wholesale market of agricultural products, future development ability of wholesale market of agricultural products, and exiting technical equipment ability of wholesale market of agricultural products. We adopt hundred-mark system to grade and evaluate core competitiveness of wholesale market of agricultural products. The results show that the experts' evaluation score of core competitiveness of wholesale market of agricultural products is high. The evaluation result is reasonable and authentic and this model is feasible.

Key words Wholesale market of agricultural products, Competitiveness, CWAA operator, China

China's wholesale market of agricultural products was established in the mid 1980s, and through nearly 30 years of development, wholesale market of agricultural products in China has become the key building object in the process of building China's wholesale market system and the core of circulation field of agricultural products. The wholesale of the agricultural products can not only promote the process of agricultural industrialization, but also play significant role in boosting entire national economy of China, thereby increasing the core competitiveness of wholesale market of agricultural products is the fundamental need for economic research on market main body and competing for market. The elevation of core competitiveness of wholesale market of agricultural products plays an important role in promoting development of wholesale market of agricultural products. Effective evaluation on the core competitiveness of wholesale market of agricultural products, can not only rectify the shortcoming of core competitiveness of wholesale market of agricultural products with pertinency in order to effectively improve the core competitiveness of wholesale market of agricultural products[1,2], but also summarize and popularize effective experience in core competitiveness of wholesale market of agricultural products, so as to promote the operating ability of China's wholesale market of agricultural products, increase farmers' income and effectively solves the issues concerning agriculture, farmer and countryside. There are few studies on core competitiveness of wholesale market of agricultural products at home and abroad, especially there are few evaluation models of core competitiveness of wholesale market of agricultural products involving participation of many people. On the basis of analyzing major influencing factors impacting core competitiveness of wholesale market of agricultural products, and combined weight arithmetic average (CWAA) operator, this paper advances an evaluation model of core competitiveness of wholesale market of agricultural products which involves participation of many people.

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1 Data source, index selection and model establishment

1.1 Data source The research data are from our field investigation.

1.2 Index selection of core competitiveness of wholesale market of agricultural products The prerequisite of enhancing the core competitiveness of wholesale market of agricultural products is to evaluate the core competitiveness of wholesale market of agricultural products, and the prerequisite of evaluating the core competitiveness of wholesale market of agricultural products is to determine how to evaluate the core competitiveness of wholesale market of agricultural products from what aspects, namely to determine the evaluation index of core competitiveness evaluation of core competitiveness of wholesale market of agricultural products. According to the researches at home on model of core competitiveness evaluation, the main evaluation index of the core competitiveness of wholesale market of agricultural products can be divided into the following aspects[2]:

1.2.1 Management ability. It mainly reflects the size of the wholesale market, the impact of the surrounding agricultural products, and the management performance of market. It

takes some aspects into consideration as follows: construction area of wholesale market, total area of wholesale market, monthly trading volume of wholesale market, trading coverage of wholesale market and so on.

1.2.2 Organization and management ability. It mainly reflects the managers' ability in planning, organizing, leading and controlling. It mainly takes some aspects into consideration as follows: decision-making ability of leaders, coordination ability of leaders, administrative power of leaders, execution ability of leaders, public relations abilities of leaders and so on.

1.2.3 Enterprise culture. The wholesale market of agricultural products should also have its industrial characteristics in order to attract customers, so we should conduct survey on enterprise culture, and take some aspects into consideration as follows: customer guidance, market management idea, value, spirit of enterprise operation, quality of employees, consciousness of service and so on.

1.2.4 Development ability. It mainly means that the impact of internal development and external environment of wholesale market on development of wholesale market of agricultural products. We can conduct investigations from the following aspects: growth rate of transaction size, operating profit growth, investment increase, government support degree, industrial operating environment and so on.

1.2.5 Technical equipment ability. The quality of technology and equipment is an important index of measuring the status of the wholesale market, and also an important index of attracting more customers. The technical equipment ability mainly includes ways and means of trade, quality inspection and safety system, degree and inputs of informatization construction, acceptability of safety test and inputs of safety test and so on.

1.3 The evaluation model of core competitiveness of wholesale market of agricultural products involving participation of many people With the progress and technological development, the single man's participation in decision making has not fully answered the real need, because of the individual preference. In most cases, we select the evaluation involving many people's participation in decision making at the same time, namely the problem of group decision making[3,4]. As random factors and fuzziness in the process of evaluating core competitiveness of wholesale market of agricultural products increase, and the experience, data and information in the process of evaluation are insufficient, only by depending on evaluation model of core competitiveness of wholesale market of agricultural products which involves the participation of the experts, scholars and decision-makers from different fields, different disciplines and different majors can we increase the level and efficiency of competitiveness evaluation of wholesale market of agricultural products, and avoid the mistakes of single decision-maker which may result in wrong decision making and adverse consequences.

1.3.1 Definition and theorem.

Definition 1[3]: we call $WAA_{\omega}(a_1, \cdots, a_n) = \sum_{j=1}^{n} \omega_j a_j$ as weight arithmetic average operator (WAA), where $\omega = (\omega_1, \cdots, \omega_n)^T$ is weighted vector and $\omega_j \in [0, 1]$, $\sum_{j=1}^{n} \omega_j = 1$.

Definition 2[3]: we call $OWA_w(a_1, \cdots, a_n) = \sum_{j=1}^{n} \omega_j b_j$ as orderly weighted average operator (OWA), where $w = (w_1, \cdots, w_n)^T$ is the weighted average vector correlated with OWA, $w_j \in [0, 1]$, $\sum_{j=1}^{n} w_j = 1$, b_j is the jth maximum factor of $a_i (i = 1, 2, \cdots, n)$. The weighted vector w_j generally can be determined by the following form beforehand[5]:

$$w_j = Q(j/(n-1)) - Q[(j-1)/(n-1)],$$

$$Q(r) = \begin{cases} 0 & \text{if } r < a \\ (r-a)/(b-a) & \text{if } a \leqslant r \leqslant b \\ 1 & \text{if } r > b \end{cases}$$

In the form, a, b, $r \in [0, 1]$.

The corresponding quantitative criteria of fuzzy linguistic: the parameter couples of operator Q of "the majority", "at least half" and "as many as possible" are $(a, b) = (0.3, 0.8)$, $(0, 0.5)$, $(0.5, 1)$ respectively.

Definition 3[3]: we call $CWAA_{\omega, w}(a_1, \cdots, a_n) = \sum_{j=1}^{n} \omega_j b_j$ as the nth dimensional combined weighted arithmetic average operator (CWAA), where $\omega = (\omega_1, \cdots, \omega_n)^T$ is the weighted vector correlated with OWA, b_j is the jth maximum factor in a group of data $nw_i a_i (i = 1, \cdots, n)$, $w = (w_1, \cdots, w_n)^T$, is the weighted vector of data group $(a_1, \cdots, a_n)$, and n is balance factor.

1.3.2 The evaluation model based on CWAA operator. In the process of conducting evaluation on core competitiveness of wholesale market of agricultural products, we invite m experts to conduct evaluation on core competitiveness of wholesale market of agricultural products from management ability, organization and management ability, enterprise culture, development ability and technical equipment ability respectively. We assume the m experts' weight $H = (h_1, h_2, \cdots, h_m)$, the weight of 5 evaluation indices $W = (w_1, \cdots, w_5)$. The process of evaluation on core competitiveness of wholesale market of agricultural products which involves many people's participation on the basis of CWAA operator is as follows:

First, we obtain evaluation information: m experts conduct evaluation on core competitiveness of wholesale market of agricultural products, so as to get evaluation matrix $X = (x_{ij})_{m \times 5}$.

Second, we determine the comprehensive evaluation score of single expert: we summarize the evaluation information of all experts, so as to get comprehensive evaluation score of experts, namely $E_i = \sum_{j=1}^{5} w_j x_{ij}$.

Third, we gather the evaluation information of all groups of experts.

In the process of summarizing the comprehensive evaluation opinions of all experts in order to get holistic opinion, we generally adopt simple weighted arithmetic average operator to conduct simple weighted method on comprehensive evaluation scores of all experts, but the fundamental characteristic of WAA is just the weighted gathering according to the importance of comprehensive evaluation information of all experts, which merely focuses on the importance of evaluation information of all experts; OWA operator only re-sequences the comprehensive evaluation information of all experts from big to small, weights the place the data in and then conduct gathering, which

merely focuses on the place all data in, so the WAA operator and OWA operator both have certain one sidedness, while CWAA operator combines the characteristics of the preceding two operators, which not only considers the importance of evaluation information of every expert, but also considers the position of evaluation information of every expert in evaluation information of whole group of experts, so using CWAA operator to gather the evaluation information involving many people's participation is more rational, therefore the evaluation model of core competitiveness of wholesale market of agricultural products involving many people's participation based on CWAA operator we get as follows:

$$Compete = \sum_{i=1}^{m} \omega_i \lambda_i$$

In the above expression, λ_i is the ith biggest number in ξ_1, ξ_2, $\cdots$, ξ_m, $\xi_i = mh_iE_i$, the weight of experts $H = (h_1, h_2, \cdots, h_m)$, and parameter $\omega = (\omega_1, \cdots, \omega_m)$ is place-weight, which are obtained by calculating that

$$Q(r) = \begin{cases} 0 & \text{if } r < a \\ (r-a)/(b-a) & \text{if } a \leqslant r \leqslant b \\ 1 & \text{if } r > b \end{cases}$$

. The group evaluation result of core competitiveness of wholesale market of agricultural products we finally get is *Compete*.

2 Analysis of calculating example

In order to elevate the core competitiveness of wholesale market of agricultural products in northwestern region, we need to conduct effective evaluation on core competitiveness of wholesale market of agricultural products, and propose improvement strategies according to the evaluation results. By inviting five exerts, we conduct evaluation in terms of management ability of wholesale market of agricultural products, organization and management capability of leadership, enterprise culture of wholesale market of agricultural products, future development ability of wholesale market of agricultural products, and exiting technical equipment ability of wholesale market of agricultural products. We adopt hundred-mark system to grade and evaluate core competitiveness of wholesale market of agricultural products, so as to get the following evaluation results:

According to the knowledge of 5 experts and the understanding of industry of 5 experts, we assume the weight of 5 experts $H = (0.1, 0.25, 0.35, 0.1, 0.2)$, and by using method of index weight determination, we get the weight of 5 evaluation indices $w = (0.288\ 6, 0.167\ 8, 0.100\ 7, 0.234\ 9, 0.208\ 1)$. Now we use CWAA operator to evaluate core competitiveness of wholesale market of agricultural products.

We calculate the comprehensive evaluation score of the first expert as follows:

Table 1 Evaluation result of core competitiveness

Method	Management ability	Organization and management capacity	Enterprise culture	Development ability	Technical equipment ability
Expert 1	63	82	90	81	72
Expert 2	72	71	82	90	84
Expert 3	80	77	84	71	69
Expert 4	67	83	92	83	69
Expert 5	89	78	80	83	74

$$E_1 = 63 \times 0.288\ 6 + 82 \times 0.167\ 8 + 90 \times 0.100\ 7 + 81 \times 0.234\ 9 + 72 \times 0.208\ 1 = 75.014\ 5$$

By the similar manner and rationale, we calculate the comprehensive evaluation score of core competitiveness of wholesale market of agricultural products of another 5 experts as follows:

$E_2 = 79.571\ 8$, $E_3 = 75.504\ 2$, $E_4 = 76.383\ 6$, $E_5 = 81.725\ 9$

Then we use CWAA operator to gather group evaluation information. Firstly according to the corresponding fuzzy linguistic quantitative criteria " the majority", we calculate that the place-weight $\omega = (0, 0.400\ 0, 0.500\ 0, 0.100\ 0, 0)$. We calculate that $\xi_1 = 5 \times 0.10 \times 75.014\ 5 = 37.507\ 2$. In a similar manner, we calculate that $\xi_2 = 99.464\ 7$, $\xi_3 = 132.132\ 4$, $\xi_4 = 38.191\ 8$, $\xi_5 = 81.725\ 9$ respectively. By sequencing $\xi_1, \xi_2, \cdots, \xi_m$, we get that $\lambda_1 = 132.132\ 4$, $\lambda_2 = 99.464\ 7$, $\lambda_3 = 81.725\ 9$, $\lambda_4 = 38.191\ 8$, $\lambda_5 = 37.507\ 2$, so that we get the comprehensive evaluation score of core competitiveness of wholesale market of agricultural products by calculation as follows:

$$Compete = 0 \times 132.132\ 4 + 0.400\ 0 \times 99.464\ 7 + 0.500\ 0 \times 81.725\ 9 + 0.100\ 0 \times 38.191\ 8 + 0 \times 37.507\ 2 = 84.468\ 0.$$

By using CWAA operator to gather the evaluation results of all experts, we can find that the comprehensive evaluation score of core competitiveness of wholesale market of agricultural products is 84.468 0. We adopt hundred-mark system to grade and evaluate core competitiveness of wholesale market of agricultural products, and the results show that the experts' evaluation score of core competitiveness of wholesale market of agricultural products is high. Through the evaluation information of all experts, we can find that all experts' evaluation scores of core competitiveness of wholesale market of agricultural products are high, and the scores of some indices even reach more than 90, therefore the evaluation result is reasonable and authentic and this model is feasible.

3 Analysis and conclusion

China is a large agricultural country and farmers account for a large proportion in the country. Issues concerning agriculture, farmer and countryside are always the national concern. Wholesale market of agricultural products is an important base which can effectively increase farmers' income. Only by strengthening the wholesale of agricultural products can we ensure that farmers can sell the products they produce as quickly as possible, and increase income. The wholesale market of agricultural products expand its influence by strengthening its core competitiveness, so as to attract more merchants naturally to come into this wholesale market for purchasing agricultural products, therefore the core competitiveness of the wholesale

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