ISSN : 0974 - 7435 Volume 10 Issue 18

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(18), 2014 [10305-10310]

Evaluation of AHP-based agricultural products circulation efficiency index

Dan Lv, Qihong Zhou*, Mingmei Yang, Qian Chen
Wuhan Donghu University, Hubei Provincial Collaborative Innovation Centre of Agricultural E-Commerce, Hubei Wuhan 430212, (CHINA)
E-mail : zhouhong3583@126.com

ABSTRACT

Unsound agricultural product market system and poor market circulation in China is a restraining factor in the course of agricultural modernization, which can not be ignored. By using analytic hierarchy process (AHP) and fuzzy evaluation, this paper conducts a quantitative analysis against weight of various agricultural products circulation efficiency index and the influence evaluation to dig out the most influential factors of agricultural products circulation efficiency and provide a theoretical basis for the decision makers to targetedly develop policies for agricultural products circulation efficiency.

KEYWORDS

AHP; Agricultural products; Circulation efficiency; Index evaluation; Fuzzy evaluation.

INTRODUCTION

Circulation efficiency is a complex and multidimensional concept of generality. The agricultural products circulation efficiency is the direct or indirect comparison of the input and output in the whole process of circulation of agricultural products and the efficiency collection of the main body and the entirety in each step of the process[1]. To sum up, the agricultural products circulation should also include four factors, namely business flow, logistics, capital flow and information flow. Fragmentation of such four factors will restrict the improvement of agricultural products circulation efficiency. To promote the agricultural products circulation efficiency is an important step to accelerate the development of modern agriculture.

Research on commodity circulation is a hot topic of scholars. Currently, both overseas and domestic scholars hold different views towards the circulation concept and circulation efficiency. Song Ze[2] held the belief that the circulation referred to a sum or a collection of economic activities including business flow, logistics, information flow and capital flow, which were directly incurred by, directly related to or derived from commodity circulation. Li Huihua[3] considered, the so-called commodity circulation efficiency was a concept which was used to measure the overall quality of commodity circulation and was the difference between the magnitude of value of the commodity incurred through circulation in unit time and the circulation costs. Hong Tao and Zheng Qiang[4] constructed the comprehensive evaluation index system for China's urban circulation force and pointed out that the circulation efficiency index includes labor productivity, distribution company chain and organization scale. Yao Liming[5] adopted circulation productivity, gross margin of circulation and stock-sales ratio to express the circulation efficiency when comparing American and Japanese circulation efficiency. Li Fei and Liu Mingwei[6] said in their created commodity circulation modernization evaluation index system that the indexes related to circulation efficiency included rate of return of circulation industry on total assets, and fixed asset turnover of circulation industry. Tang Yuqing[7] believed that from an external perspective, separation happened to three components of circulation, namely business flow, information flow and logistics; in the business flow, wholesale space and retail space tended to split and the information flow and physical commodity circulation formed two interrelated systems. Anrooy[8] thought that the factors impacting the circulation efficiency included market control, externality and information availability.

Most of literatures related to circulation efficiency just explain the evaluation index of circulation efficiency from one single perspective and a complete circulation efficiency evaluation index system has still not yet been created, there are still many studies where comprehensive and multidimensional quantitative analysis is conducted against the agricultural products circulation efficiency index.

WEIGHT DETERMINATION OF EACH AGRICULTURAL PRODUCTS CIRCULATION EFFICIENCY INDEX

Improvement of agricultural products circulation efficiency is subject to the influential factors of efficiency improvement. In order to find out the factors which have larger influence in agricultural products circulation efficiency, indexes of agricultural products circulation efficiency shall be firstly determined to construct an agricultural products circulation efficiency index system. However, due to complexity and multidimensionality of agricultural products circulation itself, there are actually a lot of influential factors of agricultural products circulation efficiency. However, the index of agricultural products circulation efficiency can not be determined by simply taking one aspect as the starting point, no matter from the perspective of "input-output ratio" or from "business flow, capital flow, logistics, information flow". Selection of each index should be based on comprehensive comparison and removal of the repeated and related index of each factor considered. For example, the index market integration can have an impact in all four factors, namely "business flow, capital flow, logistics, information flow", and the loss rate can not be evaluated just under an environment. Furthermore, there is still lack of an authoritative index system to comprehensively interpret and judge the circulation efficiency. Thus, the most suitable way should be to invite the experts via “Delphi Method” or “Brain-Storming” for comprehensive judgment against the index system. However, due to objective factors, this paper temporarily concludes the following evaluation index system by combing, arranging and selecting the existing theories and literatures of overseas and domestic experts and scholars. (as shown in TABLE 1)

In the TABLE 1, the evaluation index of agricultural products circulation efficiency can be divided into five aspects, namely market efficiency, production efficiency, turnover efficiency, cost efficiency and information efficiency, which are categorized as second-level index to longitudinally and horizontally evaluate the agricultural products circulation efficiency. Under the second-level indexes, there are 25 third-level indexes, including circulation productivity, gross margin and evaluation of velocity of circulation and judgment of informationization indexes to multidimensionally exhibit the influential factors of agricultural products circulation efficiency as much as possible.

The idea of index weight evaluation goes: to firstly construct the index system of agricultural products circulation efficiency and determine the weight of each second-level index by using the AHP method (as shown in TABLE 2); secondly to establish the comparison matrix of each index with paired comparison to get the pairwise comparison matrix of indexes at each level; at last to establish fuzzy weight set and evaluation set of indexes at each level with the fuzzy analysis method. As for some indexes, the data of which is difficultly obtained, the qualitative analysis is shifted to the quantitative analysis.

TABLE 1 : Agricultural products circulation efficiency evaluation index system

First-level index	Second-level index	Third-level index
Agricultural products circulation efficiency F	Production efficiency F1	Production standardized F11
		Rate of qualified products F12
		Production scale F13
		Production technology F14
	Market efficiency F2	Market access restriction F21
		Market integration F22
		Market concentration F23
		Quality of market players F24
		Degree of organization F25
	Turnover efficiency F3	Loss rate F31
		Velocity of circulation F32
		Stock-sales ratio F33
		Inventory turnover F34
		Turnaround time F35
		Logistics technology F36
	Cost efficiency F4	Circulation cost ratio F41
		Circulation gross margin F42
		Ratio of sales to cost F43
		Circulation price difference F44
		Sales-output ratio F45
	Information efficiency F5	Information technology F51
		Effectiveness of information transmission F52
		Information timeliness F53
		Information penetration rate F54
		Public credit system F55

TABLE 2 : Comparison matrix of second-level indexes

Index	F1	F2	F3	F4	F5	PV value
F1	1	1:2	1:7	1:5	1:5	0.302
F2	2	1	1:4	1:3	1:3	0.425
F3	7	4	1	2	1:3	1.458
F4	5	3	1:2	1	1	1.183
F5	5	3	3	1	1	1.694
Total	20	11.5	4.893	4.533	2.866	\

It can be seen from TABLE 2 that the weight of each second-level index with respect to the first-level index goes as follows: production efficiency F1=0.302, market efficiency F2=0.425, turnover efficiency F3=1.458, cost efficiency F4=1.183, information efficiency F5=1.694.

$\lambda \max (F) = \sum FW / nW = 5.192$

Consistency test must be passed, if the maximum designated value is larger than the order number and the pairwise comparison matrix is inconsistent.

Consistency index calculation formula: $CI = (\lambda \max - n) / (n-1) = 0.048$

Consistency ratio calculation formula: $CR = CI / RI$

Where RI refers to the random consistency index value. RI values of different orders are shown in TABLE 3:

TABLE 3 : RI values of different orders

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

According to the n value in the matrix, the corresponding RI value is 1.12.

CR = CI / RI = 0.048 / 1.12 = 0.042 ＜ 0.1

Conclusion: although F is not a consistent matrix, its consistency is satisfactory. Its inconsistency is acceptable. Therefore, the matrix passes the satisfactory consistency test.

Similarly, weight of each third-level index with respect to second-level index is shown in TABLE 4:

TABLE 4 : Weight table of each third-level index with respect to second-level index

Third-level index	Weight
Production standardized F11	0.235
Rate of qualified products F12	0.224
Production scale F13	0.298
Production technology F14	0.243
Market access restriction F21	0.296
Market integration F22	0.198
Market concentration F23	0.181
Quality of market players F24	0.097
Degree of organization F25	0.228
Loss rate F31	0.067
Velocity of circulation F32	0.056
Stock-sales ratio F33	0.210
Inventory turnover F34	0.072
Turnaround time F35	0.375
Logistics technology F36	0.220
Circulation cost ratio F41	0.231
Circulation gross margin F42	0.198
Ratio of sales to cost F43	0.109
Circulation price difference F44	0.243
Sales-output ratio F45	0.219
Information technology F51	0.101
Effectiveness of information transmission F52	0.377
Information timeliness F53	0.259
Information penetration rate F54	0.137
Public credit system F55	0.126

FUZZY COMPREHENSIVE EVALUATION AGAINST INFLUENTIAL FACTORS OF AGRICULTURAL PRODUCTS CIRCULATION EFFICIENCY

Establishment of comments set and fuzzy weight set

Establishment of comments set

V={V1, V2, V3, V4, V5} respectively represents for {Important, relatively important, ordinary, relatively minor, minor}, to show the importance of each influential factor of agricultural products circulation efficiency.

Determination of fuzzy weight set

Fuzzy weight set of production efficiency F1:F1= (0.135, 0.115, 0.165, 0.085) ; Fuzzy weight set of market efficiency F2: F2= (0.296, 0.198, 0.181, 0.097, 0.228) ; Fuzzy weight set of turnover efficiency F3= (0.067, 0.056, 0.210,

0.072, 0.375, 0.220) ;Fuzzy weight set of cost efficiency F4= (0.231, 0.198, 0.109, 0.243, 0.219) ;Fuzzy weight set of information efficiency F5= (0.101, 0.377, 0.259, 0.137, 0.126).

Determination of fuzzy comprehensive evaluation matrix

18 experts are invited to assess each factor of third-level index according to five rating scales divided, Namely F11-F14, F21-F25, F31-F36, F41-F45 and F51-F55. Take F11 as an example. 6 of 18 experts rate F11 as "important" and 3 rate it as "relatively important", 6 as "ordinary", 3 as "relatively minor" and 0 as "minor". Thus, evaluation against F11 is Y11= (1/3, 1/6, 1/3, 1/6, 0). Similarly, evaluation degree of the rest 24 influential factors can be obtained.

Fuzzy comprehensive evaluation

According to the evaluation model B = F×Y, the second-level indexes are categorized as a group to normalize the weight of its subordinate third-level index F_{ij} (where, i refers to serial number of second-level index; j refers to serial number of third-level index. For example, F13 refers to the third item of third-level index which is subordinate to the first item of the second-level index.) and the evaluation Y_{ij} corresponding to the index via ordinary matrix multiplication, to obtain the influence evaluation value of each third-level index B_{ij}. The fuzzy evaluation of each second-level index can be got after third-level index fuzzy evaluation and second- level index fuzzy evaluation are completed in succession (process omitted).

B1 = (0.11,0.23,0.36,0.18,0.07) ; B2 = (0.17,0.45,0.26,0.12,0.03); B3 = (0.23,0.57,0.14,0.27,0.08)
B4 = (0.47,0.13,0.17,0.30,0.28) ; B5 = (0.33,0.30,0.25,0.18,0.32)

Determination of the most influential index

The final evaluation result will be determined via rating principle. The so-called rating principle means to firstly express the comments set with a group of Figures, then to sum up weight of each evaluation index after they have different levels and finally to get conclusion about the most influential index via comparison.

As mentioned above, the comments set is assumed as V={V1, V2, V3, V4, V5}, which respectively represent {Important, relatively important, ordinary, relatively minor, minor}. Now, Figures from 1-9 are selected to quantize the comments set V={9, 8, 5, 3, 2}. The result of the most influential index H is respectively "Important" when H∈[8,9]; "relatively important" when H∈[7,8]; "ordinary" when H∈[5,7]; "relatively minor" when H∈[3,5] and "minor" when H∈[2,3]. Based on the above, the influence evaluation of each second-level index goes:

$H1= \sum b_1 \times v_1$ = (0.14,0.225,0.29,0.24,0.09) ×(9,8,5,3,2)
=0.14×9+0.225×8+0.29×5+0.24×3+0.09×2=5.41
$H2= \sum b_2 \times v_2$ = (0.17,0.45,0.26,0.12,0.03) ×(9,8,5,3,2)= 6.85
$H3= \sum b_3 \times v_3$ = (0.23,0.57,0.14,0.27,0.08) ×(9,8,5,3,2)= 8.30
$H4= \sum b_4 \times v_4$ = (0.47,0.13,0.17,0.30,0.28) ×(9,8,5,3,2)= 7.58
$H5= \sum b_5 \times v_5$ = (0.33,0.30,0.25,0.18,0.32) ×(9,8,5,3,2)= 7.81

CONCLUSIONS

Evaluation result analysis

Based on the above fuzzy evaluation analysis, the influence evaluation of the agricultural products circulation efficiency index is manifested as:

Among second-level indexes, the index turnover efficiency F3 has the greatest influence, with its value of H3∈[8,9], which corresponds to "important"; the next comes to information efficiency F5 and cost efficiency F4, both of which have the value of ∈[7,8], corresponding to "relatively important"; the next is the market efficiency F2, with its value of H2∈[5,7], corresponding to "ordinary"; the minimal influential index is the production efficiency F1.

It can be seen from the index evaluation that besides the turnover efficiency F3 and cost efficiency F4, both of which have always important influence in circulation efficiency, the information efficiency F5 is proven to be a factor which can not be ignored in terms of circulation efficiency improvement.

In addition, it can be found from fuzzy evaluation against each third-level index, that the market access restriction F21, circulation cost ratio F41, circulation gross margin F42, turnaround time F35, circulation price difference F44, effectiveness of information transmission F52, and information timeliness F53 have relatively high weight and great influence in second-level indexes. The index turnaround time has the largest weight under the item turnover efficiency; The index effectiveness of information transmission has the largest weight under the item information efficiency, accounting for 1/3 of the totals; Under the item cost efficiency, weights of various indexes look almost the same, with the largest weight coming to the index circulation price difference; under the index market efficiency, the most influential index is the market access restriction; as for production efficiency, weights of its subordinate indexes are more equitable.

In the entire efficiency index evaluation, effectiveness of information transmission F52 is the factor which has the greatest influence in circulation efficiency among all third-level indexes. In reality, low price elasticity of agricultural products and seasonal characteristic of production result in large fluctuation of agricultural products supply and price, and the

phenomenon of " price of agricultural products strikingly vary from abundant years and leap years" happens very often. According to a large survey on "agricultural information needs" conducted by China Agricultural University, the final statistic result showed that: Among the need options with more than one half of the options, the option about farmers' need for agricultural products market information has the greatest proportion, far higher from other information need options. In the agricultural economy, understanding and control of information by both the decision makers and producers is the first condition to achieve the optimal resource allocation. Lack of market information will cause the market circulation to produce limitations and blindness.

In summary, the agricultural products circulation efficiency index evaluation result based on AHP and fuzzy evaluation is highly consistent with the actual situation in the circulation market, which demonstrates science of this evaluation method and correctness of evaluation result.

Relevant suggestions

1. To build the agricultural products circulation market which is mainly based on local enterprises. Economic development form of the circulation market should take the large circulation companies with state-owned shares as the leading factors and the private capital as the main body.

2. Do not ignore the important role of informationization in agricultural products circulation. The first core point to improve the circulation efficiency is information flow integration, which is designed to establish an authoritative agricultural information network platform which can provide information database, domestic and overseas agricultural products market information, agricultural climate information, logistics information and medium and long term market analysis and forecasting through the integration. Meanwhile, integration of information flow should also include timely and accurate provision of corporate integrity information or fair credit system and elimination of circulation body with poor market reputation to disrupt the market order. In addition, it should regulate food safety fundamentally to truly reflect the role of the circulation in connecting the production and consumption.

3. To develop e-commerce to reduce intermediate links during agricultural products circulation. To some extent, Trading of agricultural products through e-commerce can overcome the weakness of traditional market which has several intermediate links with price increase from one link to another. Therefore, actively guiding and training agricultural producers to do e-commerce transactions can promote effective circulation of agricultural products. Besides the e-commerce mode, other channels can be expanded and developed, such as docking of farmers and catering, direct transport to community, weekend market, order production, linking the production with sales, etc.

4. To build the standardized agricultural products circulation market with legal framework. Improving laws and regulations of China's agricultural products circulation industry, establishing effective and strict supervision system and creating reasonable and orderly circulation order are urgent. Meanwhile, a sound agricultural products traceability system should be built to create the image of "Green credible agricultural products".

ACKNOWLEDGEMENT

This research was supported by the Hubei province science and technology support program of the soft science project funding, and Wuhan Donghu Institute Youth Social Science Fund Project, and Hubei Provincial Collaborative Innovation Centre of Agricultural E-Commerce Science Fund Project, all support is gratefully acknowledged.

REFERENCES

[1] Kou Rong, Tan Xiangyong; Framework for Analyzing Efficiency of Agricultural Product Marketing and Distribution [J]. China Business and Market, **5,** 12 **(2008)**.

[2] Song Ze; Research on Circulation Modernization and Competitiveness of Circulation Industry (First Volume) [J]. Commercial Times, **4**, 11-13 **(2006)**.

[3] Li Huihua, He Shu; Analysis on the Efficiency of Commodity Circulation Under Current Buyer's Market of Our Country [J]. Journal of Shanxi University of Finance and Economics, 58-62 **(2005)**.

[4] Hong Tao, Zheng Qiang; Facing with Risks, Who "Insure" the Agriculture?[J]. China Business Herald, **25(11) (2002)**.

[5] Yao Liming; Modern Japanese Circulation Structure and Circulation Efficiency and Comparison with European and American Countries [J]. Japanese Studies, **2**, 46-56 **(1992)**.

[6] Li Fei, Liu Mingwei; Evaluation Index Framework of China's Commodity Circulation Modernization.[J]. Marketing Herald, **2**, 58-62 **(2005)**.

[7] Tang Yuqing; Fragmentation of Circulation Space and Its Influence on Urban Development [J]. Urban Planning Forum, **6**, 40-43 **(2000)**.

[8] R.V..Anrooy; Vertical Cooperation and Marketing Efficiency in the Aquaculture Products Marketing Chain: a National Perspective from Vietnam[R/OL]. FAO working paper, **(2003)**.