A Study on Efficiency of Agricultural Product Logistics Based on Factor Analysis — An Example from Hubei Province

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Abstract. The agricultural economy is still a critical component for the development of national economy in modern China; therefore, the efficiency of agricultural product logistics has huge impact on the development of agricultural economy and the industrial competition. Moreover, scientifically and systematically establishing an evaluation index system in logistical efficiency is the basis of efficiency evaluation in agricultural product logistics, and hence an important strategy to pinpoint factors which may enhance efficiency. This paper discusses the evaluation index system of efficiency of agricultural product logistics, and the results will be analyzed through factor analysis. Some recommendations will be made in order to improve the efficiency of agricultural product logistics.

Introduction

The efficiency of logistics is defined as the ratio of input to output of logistics. The goal of the logistical efficiency is using less resource input to obtain faster and better logistical output [1]. For a long time, the overall loss of China's agricultural products reaches 35%, and the loss has reached 20% to 30% even in economically-developed areas [2]. While Hubei is a large agricultural province, however, the annual production is unstable due to restrictions on natural environments and their impact on agricultural products. The requirements are somewhat higher in distributor channels and the circulation of agricultural products. Besides, the circulation capacity and competitiveness of agricultural products are directly affected by the efficiency of logistics. Therefore, it has practical significance to seek the main factors affecting the efficiency of agricultural logistics, in order to provide ~~a~~ theoretical basis and amend the efficiency of agricultural logistics.

The conclusion of the index system logistics efficiency in Hubei Province

Establish a rational, goal-directed index system of strong operability, is the basis and key for further scientific evaluation. The establishment of an index system features multi-dimension, multi-variable, and multi-angle. In this paper, we designed an evaluation index system for efficiency of agricultural product logistics in Hubei, based on scientific, systematic, objective, and practicable principles. We also combined the research findings from some domestic and foreign scholars on the logistics-efficiency evaluation index system, and the actual situation of agricultural product logistics in Hubei. We weighed it from the following four dimensions: the capability of logistical output, the capability of logistical input, the capability of logistical activity, as well as the capability of logistical support. According to this basic frame, we then further expanded these first-order indexes into a system of 23 subcategories.

In the criteria layer, there are four factors: the capability of logistical output; the capability of logistical input; the capability of logistical activity, and the capability of logistical support.

In the indicators layer, there are five factors under the capability of logistical output: total agriculture output value; GDP; CPI; added value of logistical industry, and the total volume of imports and exports. Five factors under the capability of logistical input, there are research and development (R&D) expenditure, local fiscal expenditure on education, local fiscal expenditure in transportation, investment in fixed assets in logistics, and logistical personnel. Seven factors under the capability of logistical activity, there are population, number of logistics enterprises, quantity of shipments, turnover of freight traffic, express-delivery service volume, amount of post and telecommunications services, and carbon emission. Last but not the least, four under the capability of logistical support: total distance of transport lines, number of logistical nodes, telecommunication service level, post and telecommunication service level, energy consumption, and network coverage.

Analysis on the efficiency factor of agricultural product logistics in Hubei Province

The basic rationale of factor analysis

Factor analysis translates many correlated data indexes to fewer, independent indexes by researching the internal structure of the correlation matrix of the initial data[3]. In this passage, we built a factor analysis model as follows:

$$C1 = A11\,F1 + A12F2 + \cdots + A1m\,Fm + e1$$

$$C2 = A21F1 + A22\,F2 + \cdots + A2mFm + e2$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$Cp = Ap1F1 + Ap2F2 + \cdots + ApmFm + ep$$

Ci（i=1，2，…，p）is primitive values which contains ei, the residual value of xi. fj（j=1,2，…，m, m<p）denotes common factor. aij is called factor loading, showing the relative importance of internal structure i in number j variables [4].

Data sources

We have selected 23 indicators from the relevant data of agricultural product logistics efficiency in Hubei Province, from 2010 to 2014. All the data are obtained from China National Bureau of Statistics, Hubei Provincial Bureau of Statistics, and Statistical Yearbook of Hubei Province. The data selected are supposedly true and reliable.

Process of factor analysis

Factor analysis aims at using a few latent factors to represent the multi-variables and to simplify research workload. There is no linear relation among variables that have a variance equals to 1 and zero in average. The residual values can be ignored since it has little effect on the results. SPSS22.0 is utilized for data processing in this research. Our results showed that the KMO is near 0.6 and S' p 'Bartlett value for spherical inspection is about 0, so the variables to be analyzed are suitable for factor analysis [5].

We used the principal component analysis (PCA) in SPSS to extract principal component. According to the principle of selection of principal components, the cumulative contribution rate of the first 3 principal components reached 99.259% (Table Ⅱ), indicating that the 3 principal components have reflected the information of 95% of the original data obtained from 23 subcategories.

Table I： Explanation for total variance

major constituent	Initial Eigenvalues			principal divisor			principal divisor after revolving		
	characteristic value	variance contribution %	Cumulative variance contribution rate %	characteristic value	variance contribution %	Cumulative variance contribution rate %	characteristic value	variance contribution %	Cumulative variance contribution rate %
1	20.579	85.478	85.478	20.579	85.478	85.478	12.333	51.388	51.388
2	2.231	9.297	95.044	2.231	9.297	95.044	8.106	33.776	85.164
3	1.012	4.215	99.295	1.012	4.215	99.259	3.383	14.095	99.259
4	.178	.741	100.000						
5	1.193	4.972	100.000						

In order to facilitate the analysis and explanation of the common factor to the actual problem, we used the maximum variance method to conduct the orthogonal rotation to the factor load value. Rotating factor load table shown in the following:

Table II: Rotating factor load table

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
F1	0.007	-0.185	0.260	0.030	0.108	0.090	0.064	0.286	0.042	0.211	0.080	-0.056
F2	0.097	0.275	-0.172	0.053	-0.046	-0.058	0.018	-0.290	0.037	-0.103	-0.012	0.128
F3	-0.055	0.085	-0.188	-0.021	-0.025	0.050	-0.043	-0.019	-0.019	-0.461	-0.017	0.056
	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	
F1	0.231	0.087	0.172	0.104	-0.027	-0.226	0.134	0.032	0.024	0.053	031	
F2	-0.146	-0.284	-0.149	-0.053	0.104	0.351	-0.173	0.032	0.052	-0.003	0.046	
F3	-0.165	0.318	0.013	0.002	0.025	0.022	-0.168	0.019	-0.002	-0.287	-0.010	

The formulas for calculating the factor score are:

F1=0.007C1-0.185C2+.260C3⋯=0.031C23

F2=0.097CI+0.275C2-0.172C3⋯+0.046C23

F3=-0.055C1+0.085C2-0.188C3+ ⋯ -0.010C23

The summated score is:

ZF=51.388%F1+33.776%F2+14.095F3

By calculation, score of 3 factors about logistical efficiency of agricultural product in Hubei from 2010 to 2014 are showed in Table Ⅳ:

Table III factor score of logistics efficiencies in years

years	F1	F2	F3	Average score
2010	2804638	-1137497	-646147	965972
2011	3633298	-1672738	-838760	1183872
2012	3463303	-1420041	-801836	1187070
2013	3944425	-1627972	-914092	1348256
2014	4670241	-1939939	-1083703	1591962
rates	60. 51%	25. 49%	14%	

Analytical result and suggestion

According to Table III and discussion above, the common factor F1 has big load value on C3, C5-7, C9, C11, C13, C15, and C16. Among them, C3 and C5-7 are the external economic environment index of agricultural logistical efficiency, and C9, C11, C13, C15, and C16 are the external environmental demand index. Thus, F1 is a common factor that reflects the external environment of agricultural product logistical efficiency. The indexes of C1, C2, C4, C8, C12, C17-21, and C23 have larger load value in the public factor F2, Among them, C1, C2, C4, C8, C12, and C17 are the capital level of agricultural product logistical efficiency. C18-21, and C23 are the facility level. So F2 is the common factor of the service level of agricultural product logistical efficiency. C10, C14, and C22 are the main evaluation indexes of resources, so F3 is a common factor in evaluating the efficiency of agricultural product logistics.

Generally speaking, the index scores increased year by year from 2010 to 2014, and the data showed a positive correlation whose fitting level closes to 1, indicating that efficiency of agricultural logistics in Hubei Province is increasing year by year. From the score of F1, the external environment of logistical efficiency of agricultural products in Hubei Province is also improving, that creates a favorable external environment for the improvement of agricultural logistics efficiency in Hubei Province. Compared with F1, F3 progresses slowly, only 23.53% growth rate of F1. It is possible that insufficient resources of logistics would gradually become the constraints of logistical efficiency in Hubei.

Through the data analysis discussed above, among the main contributive factors, we argue F1 is more robust in enhancing efficiency. Meanwhile, the growth of F3 is slow in these years, and it becomes the bottleneck in promoting the efficiency of agricultural products logistic in Hubei. The way to break this bottleneck is to improve the F3. Based on the actual situation in efficiency of agricultural products logistics in Hubei Province, we would give the following suggestions:

First, the external environment is an important index to affect the efficiency of agricultural products logistics in Hubei Province, so it should be enhanced to promote the efficiency of agricultural products logistics in Hubei, such as increasing investment in public facilities and infrastructures. Second, increase education expenditure to strengthen the training of high-quality professionals, increase the construction of logistics facilities, as well as reasonably arrange logistical nodes in accordance with the social needs. More human resources and material resources will be helpful for the advancement of efficiency of agricultural products logistics.

Conclusion

In summary, combined with the research of domestic and foreign scholars, and the actual situation of efficiency of agricultural products logistics in Hubei Province, this paper provides the index system of evaluation by factor analysis by using SPSS. Our paper makes an objective evaluation on the actual situation in efficiency of agricultural products logistics in Hubei Province, and gives some advice according to the evaluation findings. The results of this research provide the basis for the improvement of the efficiency of agricultural products logistics in Hubei Province in the future.

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