Evaluation and Study on influencing factors of agricultural products logistics efficiency based on DEA-Tobit model -- from panel data from 2010 to 2019

Hongshen Yu¹, Yundi Dai¹ and Lihong Zhao²
¹Changchun University of Finance and Economics, Changchun, China
²Jilin Engineering Normal University, Changchun, China

Corresponding author and e-mail: Lihong Zhao, ccsandy@jlenu.edu.cn

Abstract. This paper is to evaluate the agricultural products logistics efficiency in China by means of the software Deap2.1 on the basis of the panel data of agricultural products logistics related indicators from 2010 to 2019; analyze the influencing factors of agricultural products logistics efficiency by means of Tobit model. The results of the study show that: It’s low of the comprehensive efficiency of agricultural products logistics, which is significantly affected by the economic development level, location advantages and the utilization efficiency of agricultural products resources. There are still deficiencies in the input of professional talents, etc. and the scale effect has not yet been realized, and the overall logistics capacity of agricultural products is weak; This paper puts forward the reasonable allocation of input resources from three levels of government, industry and logistics subjects, to improve the logistics efficiency and realize the cost reduction and efficiency increase of agricultural products.

1. Introduction

The document No. 1 of the central government in 2020 takes the issue of effectively protecting the supply of important agricultural products and continuing to increase farmers' income as the foremost problem of "agriculture, rural areas, and farmers" work. The central government will allocate special funds for the construction of cold chain logistics base, and give preferential price of electricity for agricultural production to logistics entities which can raise funds to construct fresh-keeping warehousing and other facilities in agricultural production areas. This is the seventeenth consecutive year of the document No. 1 of central government giving important attention to agricultural products logistics. It can be seen that the improvement of agricultural products logistics is important for solving the problem of "agriculture, rural areas, and farmers". Although China has initially built a modern three-dimensional transportation network with comprehensive development of "sea, land and air" by the end of 2019, the quality of transportation service has been greatly improved. However, compared with the United States and other developed countries, China's agricultural products logistics infrastructure construction is still relatively backward, with an annual grain loss of about 35 million tons, which is equivalent to the annual output of Jilin Province ranking fifth in national grain output, and the loss rate of fresh agricultural products is as high as 25%. Therefore, it is greatly helpful to evaluate the logistics efficiency of agricultural products in China, find out the key factors affecting the
agricultural products logistics efficiency, and seek ways to improve the efficiency, promote the long-
term and sustainable development of China's agricultural products logistics industry, realize the 
rational allocation of agricultural resources, speed up the development of agricultural economy, and 
ensure the national food security in the post epidemic era.

From the existing research, it can be seen that the improvement of agricultural products logistics 
efficiency is a systematic project, which is a hot and difficult problem that domestic and foreign 
academic circles and governments are committed to study and solve (Fang Kai, 2013; Fan Junhua, 
2019; Sharma et al., 2007; Kuzman, 2017) [1-2]. In terms of the evaluation of agricultural products 
logistics efficiency, the idea for the design of Mark Hammer & Klaus Hubacek (2003) logistics 
environmental efficiency accounting indicator was used for reference by later scholars in the 
evaluation of agricultural product logistics efficiency. Kou Rong (2008) and Sun Jian (2011) thought 
that the agricultural product logistics evaluation indicator system could be formed from the external 
environment, internal organization and overall profit, etc. [3]. At present, the analytic hierarchy process 
(AHP), balanced scorecard (Sharma et al., 2007), fuzzy analytical method and DEA analysis are 
widely used to evaluate the agricultural products logistics efficiency (Chen Ling, 2014; Zhou Xiong, 
2018; Jia Shengqiang, 2019) [4-6]. In terms of influencing factors, Rong-TsuWang (2010), Yang Jun 
(2011), Kuzman.B (2017) believe that management and institutional factors and rural urbanization 
level play an obvious role in promoting the development of agricultural products logistics, meanwhile 
the government plays an important role as well [7-9].

Although there are a certain number of literatures on the evaluation and influencing factors of 
agricultural products logistics efficiency at home and abroad, methods used by scholars to evaluate the 
agricultural products logistics efficiency is relatively concentrated, and there is no unified view on the 
selection of evaluation and influencing factor indicators. In addition, the literatures on the detailed 
analysis of China's overall agricultural product logistics efficiency are few. Referring to the views of 
scholars, this paper, based on the panel data from 2009 to 2018 is to analyze the agricultural products 
logistics efficiency and influencing factors in China, verify the key factors affecting the agricultural 
products logistics efficiency, and explores solutions to further improve the agricultural products 
logistics efficiency, which has important theoretical and practical significance in improving the 
research theory of agricultural products logistics, ensuring food security and sustainable increase of 
farmers' income.

2. Research methods

2.1. DEA model

DEA model is an analysis method to compare the relative efficiency of multiple decision-making units 
(DMU) through the measurement of multiple input and multiple output indicators. This paper uses 
BCC model which is the most commonly used in DEA model system to measure the agricultural 
products logistics efficiency in China

Decision-making unit is denoted as DMUj[10], j=1,2,…,n; Input vector is denoted as xij,i=1,2,…,m; 
Output vector is denoted as yrj,r=1,2,…,s; Vector weight is denoted as λ j,j=1,2,…,n; The input 
relaxation variable is denoted as s-, the output relaxation variable is denoted as s+, and the technical 
efficiency is denoted as θ.

\[
\min \theta \\
\text{s.t.} \\
\sum_{j=1}^{n} \lambda^j x_{ij} + s^- = 0, \quad i=1,2,…,m. \\
\sum_{j=1}^{n} \lambda^j y_{rj} + s^+ = 0, \quad r=1,2,…,s.
\]
\[
\sum_{j=1}^{n} \lambda_j \geq 0; \quad s^- \geq 0; \quad s^+ \geq 0; \quad \lambda_j \geq 0; \quad j = 1,2,\ldots,n
\]

When \( \theta = 1 \) and \( s^+ = 0, s^- = 0 \), DEA of decision-making unit is effective, and the technical efficiency is optimal. When \( \theta = 1 \) and \( s^+ \neq 0, s^- \neq 0 \), decision-making unit is weak and DEA is effective, and technical efficiency is not optimal. When \( \theta < 1 \), the DEA of decision-making unit is invalid and the technical efficiency is invalid [11].

2.2. Tobit model
The calculation results of software Deap2.1 which this paper uses show that the agricultural products logistics level of about 61.3% of the provinces is lower than the national average level, which shows that the agricultural products logistics efficiency in most areas of China is not high, and there is a large space for development. Based on the existing literature, this study is to analyze the influencing factors of agricultural products logistics efficiency by means of Tobit model [12], and the construction model is as follows:

\[
Y_t = \alpha_i + \beta_i \sum_{i=1}^{n} x_{it} + \epsilon_{it}
\]

where \( n \) is the number of factors that affect the agricultural products logistics efficiency; \( t \) is the year of observation; \( Y_t \) is the comprehensive efficiency of agricultural products logistics in different regions in the \( t \)th year; \( x_{it} \) is the situation in the \( t \)th year of the \( i \)th influencing factor of agricultural products logistics efficiency, \( \beta_i \) is the parameter of influencing factors to be estimated, \( \alpha_i \) is a constant and \( \epsilon_{it} \) is a random disturbance term.

3. Empirical study on the measurement of agricultural products logistics efficiency in China

3.1. Selection of logistics efficiency measurement indicators
Based on the research of scholars, this paper selects the number of agricultural products logistics practitioners, fixed assets investment amount and transportation mileage of agricultural products logistics as input indicators; Take the added value of agricultural products logistics and the turnover of agricultural products as output indicators [13].

3.2. Data source
This paper uses DEA model to conduct the empirical analysis for the agricultural products logistics efficiency in Jilin Province, taking 2010 to 2019 as the observation period and ten years as the DMU in the model. The data are mainly from the national and provincial statistical yearbooks and statistical bulletins from 2010 to 2019. In addition, it is impossible to directly obtain the relevant data of the number of employees in agricultural products logistics, fixed assets investment amount and added value of agricultural products logistics due to the lack of professional data statistics of agricultural products logistics industry [14]. Referring to the method of data processing in the existing literature, the relevant data of transportation, warehousing and postal industry multiplied by the proportion of residents' consumption to total consumption (N) instead of agricultural products logistics related data [15].

3.3. Evaluation on agricultural products logistics efficiency in China
The comprehensive efficiency in this study represents the value of agricultural products logistics efficiency in China under the current technical and economic conditions. As shown in Figure 1 and Table 1, the comprehensive efficiency of agricultural products logistics in most provinces and cities in China shows a downward trend first and upward trend second, but the northwest region shows a
downward trend. The data in Table 1 show that the comprehensive efficiency of agricultural products logistics in North China is the highest, especially in Tianjin and Hebei Province, which is 1 during the observation period, in DEA efficiency; The comprehensive efficiency value of Shanxi Province and Inner Mongolia in the first few years of the observation period was less than 1, did not reach the production frontier and was in non-DEA efficiency. However, the comprehensive efficiency value reached 1 through continuous adjustment in 2019. In the western region, the comprehensive efficiency of agricultural products logistics was the lowest during the observation period, especially in Yunnan and Qinghai Provinces. The comprehensive efficiency of agricultural products logistics was maintained between 0.2 and 0.3 during the whole observation period, which was in severe non-DEA efficiency. The data show that the agricultural products logistics in more than 31 provinces and cities in China is in the extensive development, and the utilization efficiency of agricultural product logistics resources is not enough. Therefore, it is necessary to develop new technologies, change the logistics development mode, maximize the use efficiency of resources, achieve DEA efficiency, and realize the intensive development of agricultural products logistics [16].

Table 1. Comprehensive efficiency of agricultural products logistics in 31 Provinces and Cities in China from 2010 to 2019.

| Region            | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  |
|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Beijing           | 0.999 | 0.794 | 0.952 | 0.603 | 0.740 | 0.685 | 0.965 | 1.000 | 0.745 | 0.777 |
| Tianjin           | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Hebei             | 0.487 | 0.535 | 0.493 | 0.507 | 0.665 | 0.698 | 0.739 | 0.751 | 1.000 | 1.000 |
| Shanxi            | 0.844 | 0.794 | 0.774 | 0.785 | 0.841 | 0.822 | 0.742 | 0.681 | 0.653 | 1.000 |
| Inner Mongolia    | 0.866 | 0.825 | 0.844 | 0.779 | 0.849 | 0.841 | 0.889 | 0.886 | 0.880 | 0.955 |
| Average value     |       |       |       |       |       |       |       |       |       |       |
| North China Region|       |       |       |       |       |       |       |       |       |       |
| Liaoning          | 0.808 | 0.651 | 0.764 | 0.761 | 0.821 | 0.834 | 1.000 | 1.000 | 1.000 | 1.000 |
| Jilin             | 0.506 | 0.443 | 0.487 | 0.491 | 0.551 | 0.532 | 0.466 | 0.422 | 0.405 | 0.452 |
| Heilongjiang      | 0.460 | 0.397 | 0.547 | 0.638 | 0.697 | 0.648 | 0.533 | 0.518 | 0.470 | 0.518 |
| Average value     | 0.591 | 0.497 | 0.599 | 0.630 | 0.690 | 0.671 | 0.666 | 0.647 | 0.625 | 0.657 |
| Northeast China Region|     |       |       |       |       |       |       |       |       |       |
| Shanghai          | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Jiangsu           | 0.932 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.948 | 0.765 |
| Zhejiang          | 0.778 | 0.814 | 0.750 | 0.766 | 0.832 | 0.858 | 0.950 | 0.974 | 0.925 | 0.761 |
| Anhui             | 0.828 | 0.869 | 0.867 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.888 | 0.857 |
| Fujian            | 0.903 | 0.886 | 0.772 | 0.802 | 0.690 | 0.816 | 0.948 | 1.000 | 1.000 | 0.768 |
| Jiangxi           | 0.616 | 0.619 | 0.655 | 0.784 | 0.879 | 0.751 | 0.685 | 0.649 | 0.716 | 0.695 |
| Shandong          | 1.000 | 1.000 | 0.988 | 0.927 | 0.953 | 0.836 | 0.759 | 0.817 | 0.863 | 0.689 |
| Average value     | 0.865 | 0.884 | 0.862 | 0.897 | 0.908 | 0.894 | 0.906 | 0.920 | 0.906 | 0.791 |
| East China Region |       |       |       |       |       |       |       |       |       |       |
| Henan             | 0.886 | 0.762 | 0.710 | 0.735 | 0.711 | 0.862 | 0.734 | 0.753 | 0.654 | 0.635 |
| Hubei             | 0.557 | 0.537 | 0.506 | 0.483 | 0.509 | 0.516 | 0.474 | 0.464 | 0.444 | 0.401 |
| Hunan             | 0.599 | 0.591 | 0.530 | 0.586 | 0.734 | 0.725 | 0.663 | 0.685 | 0.650 | 0.611 |
| Average value     | 0.681 | 0.630 | 0.582 | 0.601 | 0.651 | 0.701 | 0.624 | 0.634 | 0.583 | 0.549 |
| Central China Region|     |       |       |       |       |       |       |       |       |       |
| Guangdong         | 0.872 | 0.783 | 0.815 | 0.917 | 0.774 | 0.834 | 0.841 | 0.912 | 0.883 | 0.763 |
Figure 1. Analysis diagram of agricultural products logistics efficiency from 2009 to 2018.
4. Analysis of the influencing factors in agricultural products' logistics efficiency

4.1. Select the factors that affect the agricultural products logistics efficiency

The factors that influence the agricultural products logistics efficiency include subjective and objective factors, such as agricultural products logistics subject ability, industry development and government policy support. This Paper Has Summarized the Existing Literatures and Selected Five Quantifiable Factors, Including Economic Development Level (XA), Utilization Rate of Agricultural Products Logistics Resources (XB), Location Advantages (XC), Agricultural Products Logistics Professionals (XD) and Industrial Structure (XE), To Analyze the Influence on Agricultural Products Logistics Efficiency (Y) in China.

In order to ensure the scientificity of the analysis on the influencing factors of agricultural products logistics efficiency, this paper has made the correlation analysis of each variable, as shown in Table 2.

| Table 2. Correlation coefficient matrix. |
|-----------------------------------------|
| Y  | lnXA | XB | XC | lnXD | XE |
|----|------|----|----|------|----|
| Y  | 1    | 0.432*** | 0.703*** | 0.010 | 0.249*** | 0.182*** |
| lnXA| 0.426*** | 1    | 0.548*** | -0.436*** | 0.290*** | 0.517*** |
| XB | 0.612*** | 0.546*** | 1    | -0.161*** | 0.398*** | 0.164*** |
| XC | 0.093 | -0.441*** | -0.065 | 1    | -0.271*** | 0.146*** |
| lnXD| 0.282*** | 0.259*** | 0.304*** | -0.097* | 1    | -0.038 |
| XE | 0.221*** | 0.542*** | 0.352*** | 0.094 | -0.036 | 1    |

*** p<0.01, ** p<0.05, * p<0.1

The correlation coefficient matrix is used to describe the correlation between two variables. The upper triangular matrix represents the Spearman correlation coefficient, and the lower triangular matrix represents the Pearson correlation coefficient. Pearson correlation coefficient is mainly used to describe the correlation of continuous variables, and it requires the data to comply with the normal distribution. However, we usually cannot know the overall distribution of the data in the actual process. Therefore, this paper mainly uses the Spearman correlation results of nonparametric test, and only takes Pearson as a reference for mutual verification. According to the data in the table, most of the variables have significant correlation.

4.2. Data source

There are a total of 310 samples collected from the panel data from 2010 to 2019 of China Statistical Yearbook in this study. The data processing of agricultural products logistics professionals, utilization rate of agricultural products logistics resources and location advantages are the same as above. The statistical information of each variable is shown in the table below.

| Table 3. Statistical information. |
|-----------------------------------|
| VarName | Obs | Mean | SD | Min | Median | Max |
| Y       | 310 | 0.681 | 0.237 | 0.198 | 0.697 | 1.000 |
| lnXA    | 310 | 10.645 | 0.500 | 8.882 | 10.615 | 11.851 |
| XB      | 310 | 0.807 | 0.608 | 0.003 | 0.686 | 3.532 |
| XC      | 310 | 1.077 | 0.712 | 0.208 | 0.969 | 9.926 |
| lnXD    | 310 | 8.899 | 1.020 | 4.597 | 9.191 | 10.454 |
| XE      | 310 | 44.767 | 9.492 | 28.600 | 43.350 | 81.000 |

4.3. Analysis on the influencing factors

4.3.1. Analysis on the factor of economic development level. It can be seen from Table 4 that the regression coefficient of lnXA is 0.146, t = 1.71, P = 0.088 < 0.1. lnXA and Y are positively correlated at the level of 0.1, that is, the economic development level (XA) show a positive correlation to the
agricultural products logistics efficiency (Y) at the level of 0.01, XA has a positive influence on Y. The agricultural products logistics efficiency will increase by 0.146 units when the economic development level increases by 1%. The continuous improvement of people's quality of life is continuously improved mainly due to the improvement of the economic development level, so as to give birth to people's demand for high-quality agricultural products, and promote the rapid development of agricultural products logistics.

Table 4. Tobit regression results.

|   | Coef.    | Std.Err. | t  | P>|t| |
|---|----------|----------|----|-----|
| Y | lnXA     | 0.1460616| 0.0854337| 1.71| 0.088 |
|   | XB       | 0.393037 | 0.0699887| 5.62| 0.000 |
|   | XC       | 0.097023 | 0.0569564| 1.70| 0.090 |
|   | lnXD     | -0.0051445| 0.0196319| -0.26| 0.793 |
|   | XE       | 0.0026643| 0.0027292| -0.98| 0.330 |
|   | _cons    | -1.08615 | 0.8176944| -1.33| 0.185 |

4.3.2. Analysis on the factor of utilization rate of agricultural products logistics resources. It can be seen from Table 4 that the regression coefficient of XB is 0.393, which is positively correlated with Y at the level of 0.01. XB has a positive influence on Y, that is, for every unit increase in the utilization rate of agricultural products logistics resources (XB), the agricultural products logistics efficiency (Y) will increase by 0.393 units. It indicates that the utilization rate of agricultural products logistics resources is the key factor, and the utilization degree has a great influence on the agricultural products logistics efficiency, so we should strive to improve it.

4.3.3. Analysis on the factor of location advantages. The regression coefficient of XC is 0.097, which is positively correlated with Y at the level of 0.01. XC has a positive influence on Y, that is, for each unit increase of location advantages (XC), the agricultural products logistics efficiency (Y) will increase by 0.097 units. It indicates that the promotion of location advantages has a significant effect on the improvement of agricultural products logistics efficiency in corresponding regions, but its positive promotion effect is slightly weaker than the first two influencing factors. This is due to the fact that many areas in China mainly rely on independent operation, are in small and scattered scale, with low degree of specialization, and in serious lack of development of modern third-party logistics of agricultural products.

4.3.4. Analysis on the factor of logistics professionals of agricultural products. The regression coefficient of XD is -0.005, the significance test is not passed, that is, agricultural products logistics professionals (XD) has no significant influence on agricultural products logistics efficiency (Y). It indicates that in our country, there are few agricultural products logistics professionals and the level of agricultural product logistics management technology is low, which cannot promote the agricultural products logistics efficiency.

4.3.5. Analysis on the factor of industrial structure. The regression coefficient of XE is -0.003, the significance test is not passed, that is, industrial structure (XE) has no significant influence on agricultural products logistics efficiency (Y). It indicates that linkage promotion has not been formed in China's industrial structure which still needs to be adjusted, transformed and upgraded to improve the agricultural products logistics efficiency.
5. Conclusion and enlightenment

Based on the panel data from 2010 to 2019, this paper is to evaluate the agricultural products’ logistics efficiency in China by means of DEA-Tobit model, and analyzes the influencing factors in depth, and has come to conclusions as follows: (1) The agricultural products logistics efficiency in more than half of the country is lower than the national average, which indicates that there is a great space for improvement in the agricultural products logistics efficiency in China; (2) It is found that the level of agricultural products logistics efficiency is significantly influenced by the economic development level, location advantages and the utilization rate of agricultural products logistics resources; (3) The role of agricultural products logistics professionals and industrial structure in improving the agricultural products logistics efficiency has not yet been played due to the shortage of professional agricultural products logistics talents and the lack of industrial structure optimization and other reasons. This paper provides a new idea and method for quantitative evaluation and optimization of agricultural products logistics efficiency, further enriches the theoretical framework system of agricultural product logistics, and provides support for the operators of agricultural product logistics to make scientific decision in warehousing, transportation and other links. This paper puts forward the following countermeasures and suggestions, in order to promote the deepening of agricultural supply side reform, promote the intensive development of agricultural products logistics industry, and realize the effective docking between the quantity and quality of agricultural products and consumer demand:

First of all, we should further optimize the agricultural industrial structure. By adjusting and upgrading the internal agricultural products logistics industry, we should actively respond to the changes in demand structure and transportation mode, and form linkage with other industries, so as to improve the agricultural products logistics efficiency.

Secondly, we should accelerate the construction of public information platform of agricultural products logistics. Governments at all levels should make overall planning, build agricultural products logistics information sharing platform with the help of big data, cloud computing and other information technology, and upload the information of relevant government affairs activities of transportation, industry and commerce, taxation and other departments, so as to provide convenience for relevant decision-making of all walks of life. Each region should be encouraged to establish logistics information sharing, promote the exchange of regional logistics information, and promote the coordinated development of agricultural products logistics industry in all regions.

Thirdly, we should accelerate the improvement of logistics infrastructure. Relying on the infrastructure construction plans of various regions, we should focus on renovating the rural roads with "poor capability", take the lead in solving the "first kilometer" problem in rural areas, and ensure the smooth upward flow of agricultural products; We should cultivate a number of pilot logistics enterprises, provide special funds and preferential policies to support them to build moderate scale cold chain facilities in agricultural production areas or farmland markets, and ensure the quantity and quality of agricultural products warehousing and transportation [17].

Fourthly, we should enhance the cultivation of the professional logistics personnel. We should encourage colleges and universities and enterprises to cultivate a group of agricultural products logistics professionals, and optimize the structure of agricultural products logistics talents; We should encourage regions to make preferential policies based on local conditions, attract logistics technology professionals, and improve the management technology level of agricultural products logistics industry in China.

Fifthly, we should give full play to the role of industry associations as a bridge in the research and formulation of logistics standards, and work together with the government, research institutions and enterprises to formulate and apply mandatory industry standards. Industry associations should cooperate with governments at all levels, link the preceding with the following, actively promote the implementation of cold-chain logistics standard projects of fresh agricultural products, and guide enterprises to develop into regular cold-chain logistics of agricultural products. We should encourage individual enterprises to carry out operation management in the level higher than the current standard, promote the promotion and application of agricultural products cold-chain logistics standards through
pilot demonstration, and enhance the service standardization awareness of agricultural products logistics enterprises.

Sixthly, we should strengthen large-scale operation and cultivate leading enterprises. The first is to optimize the organization mode of agricultural products supply chain, cultivate agricultural cooperatives, Internet platform and supply and marketing cooperatives to become the subjects of agricultural products circulation, and realize the integrated operation of "marketing + production" or "production + marketing". The second is to integrate the existing rural convenience stores, postal and other resources, establish a rural logistics cooperation platform, implement the collection and delivery management in a concentrated manner, and open the "agricultural products upward" road. The third is to apply digital information technology to the supply chain management of agricultural products logistics, to draw up a picture for customers, to accurately match the market demand, to scientifically formulate the plan of goods storage in separate warehouses, to reasonably make the logistics route planning, to reduce the logistics cost and to improve the overall efficiency of the agricultural products logistics chain.

Acknowledgement
Fund project: “Research on performance evaluation and optimization path of ‘Farmer-supermarket direct supply’ supply chain in Jilin Province”, Jilin Science and technology development plan in 2021; "Research on Supply Chain Mode of Fresh Agricultural Products in Jilin Province under the Background of Big Data" (2020C047), Jilin Social Science Fund Project in 2020; Scientific research project of Jilin Provincial Department of Education, Project number JJKH20200188SK and Research Project of Jilin Engineering Normal University, Project number:XYBS202012

References
[1] Fang Kai. Research on the development issues of cold-chain logistics of agricultural products in China [D]. Huazhong Agricultural University, 2013.
[2] Fan Junhua. Research on the construction of agricultural products logistics efficiency evaluation indicator system [J]. Agricultural Economy, 2019(02).
[3] Xie Xiaoliang. Review on the Logistics Efficiency in Fresh Agricultural Products [J] Management for Economy in Agricultural Scientific, 2015(02).
[4] Chen Ling. Measurement of Provincial Agricultural Products Logistics Efficiency Based on Improved DEA [J]. Logistics Technology, 2014, 33(21).
[5] Zhou Xiong, Zheng Fang. Evaluation on the Logistics Efficiency of Agricultural Products in Fujian [J]. Journal of Fujian Agriculture and Forestry University (Philosophy and Social Sciences), 2018, 21(03).
[6] Jia Shengqiang. Analysis on the efficiency of agricultural products logistics in Central China and its influencing factors -- Empirical Study Based on super efficiency and Tobit model [J] Journal of Commercial Economics, 2019(11).
[7] Yang Jun, Wang Houjun, Yangchun. Influence on the Agricultural Products Logistics Efficiency of Urbanization in China [J] Journal of Agrotechnical Economics, 2011(10).
[8] He Xiaoguang. Constraints and Upgrading Approaches of Cloud Logistics Platform Service Development of Agricultural Products in China [J] Foreign Economic Relations and Trade, 2016(06).
[9] Wang Lei. Research on Optimization of Agricultural Products Logistics System Based Supply Chain of Northern Xinjiang [D]. Shihezi University 2014.
[10] Pu Song, Lv Hongxia Dynamic Evaluation for Train Line Planning in High Speed Railway Based on Improved Data Envelopment Analysis [J] Computer Application, 2015,35(05).
[11] Dong Qiaozhen Analysis on Input and Output Efficiency of Cultural Industry in 31 Provinces and Cities of China Based on DEA [J]. Times Finance, 2017(17).
[12] Zheng Danqing Study on Agricultural Products Logistics Efficiency in Yunnan Province [D]. Yunnan Normal University, 2018.
[13] Zhang Fengli. Analysis on Industrial Efficiency in Shanxi Province Based on Super Efficiency DEA [J] Economist, 2015(05).
[14] Xu Meng. Study on agricultural products logistics efficiency in Central China and influencing factors [D] Henan Agricultural University, 2018.
[15] Zhang Shuang. Evaluation and Study on Influencing Factors of Agricultural Products Logistics Efficiency [D]. Central South University of Forestry and Technology, 2019.
[16] Gong Xue, Jing Linbo Efficiency Evaluation and Study on Spatiotemporal Differences of China's Logistics Industry under the Background of Cost Reduction and Efficiency Increase [J]. Journal of Commercial Economics, 2020(14).
[17] Zhang Tao. Research on Logistics Efficiency of Fresh Agricultural Products in China from the Perspective of Mobile Internet [J] Agricultural Economy, 2018(10).