

Study on Agricultural Industry Chain in Ningxia Hui Autonomous Region based on Average Influence Distance

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Abstract: With the rapid development of China's economy, agriculture has increasingly highlighted its role in economic growth. In this paper, through the processing of the input-output ratio table of Ningxia hui autonomous region in 2012, the average transmission length (apls) matrix between different departments was introduced, and the theory of economic distance, industrial correlation and minimum support tree was combined to present the agricultural industry chain of Ningxia hui autonomous region more comprehensively from multiple dimensions. Among them, the input coefficient matrix and output coefficient matrix are mainly used to comprehensively evaluate the forward and backward correlation between agriculture and other industries from the perspective of demand and supply. The complete correlation between industries is cumulative, and the economic distance reflects the speed of this cumulative effect. Minimum support tree is an important concept in graph theory, which can make the structure of agricultural industry chain clearer. At the same time, this paper introduces the above three theories to comprehensively and specifically study the problems and advantages existing in the development of the agricultural industry chain of Ningxia hui autonomous region, and accordingly puts forward corresponding industrial policies to promote the agricultural development of Ningxia hui autonomous region and enhance its competitiveness in the whole country.

Keywords: Agricultural industry chain; Input-output table; Average economic distance; Theory of minimum spanning game

1. Introduction

Agriculture has always played an important role in the rapid development of China's economy. The development of modern agriculture gradually tends to industrial integration and is more and more closely related to other industries. From the perspective of input and output, the integration of agricultural industry is mainly due to the economic and technological interconnections among various industries, forming a complete industrial chain. The characteristics of input-output analysis are that the interdependence of the production structure is fully considered. If department I buys input products from department j and department j buys input products from department k, the product profile produced by production department I depends on the input department k. This applies to all sectors of the economy, so that each sector is directly or indirectly dependent on the other. A large number of scholars used qualitative input-output analysis or Leontief matrix to study how to properly measure the correlation between departments. In this paper, 42 departments were roughly combined into 7 departments according to the production methods and product characteristics, and the horizontal correlation between the in-

fluencing factors of agricultural industry chain and other sectors was studied through economic distance.

Many Chinese scholars have also used a large number of quantitative and statistical methods to carry out empirical research and analysis on China's agricultural industry chain. Ye Anning and Zhang Min used the interdepartmental connection and economic distance to clarify the information about the industrial chain and identify the agricultural industrial chain in Heilongjiang province.[1]Wang Weisen and Hu Desheng made a specific analysis of the agricultural industry chain and explored the model of agricultural product brand building based on it.[2]Zhu Weiwei, Zhang Weitao et al. studied the relationship between agriculture in He Bei province and other industries in the national economy by using input-output analysis method based on the input-output table of He Bei province in 2015.[3]Based on the input-output tables of the United States, Japan and China from 1995 to 2011, Li Tianjiao used the input-output model to predict the agricultural development trend in China.[4]Based on the input and output tables of Jiangsu province in 1997, 2002, 2007 and 2012, Li Mao optimized the contact rules between nodes, constructed the Jiangsu agricultural association network model, and systematically compared their layout evolution, degree value and clustering coeffi-

cient changes of agricultural nodes, and evolution of agricultural strong association subnet [5]. To sum up, domestic scholars mainly use input-output model to study the development of agricultural industrial chain from the simple correlation level, while few scholars introduce the dimension of "economic distance" to study agricultural industrial chain from the regional level. In this paper, on the basis of the research at home and abroad, with the Ningxia hui autonomous region in 2012 the input-output table inputs can be divided into the region competitive production and regional production, the introduction of economic distance and minimum support tree method to study the current situation of the development of the Ningxia hui autonomous region agricultural industrial chain and features, accordingly for the Ningxia hui autonomous region agricultural development policies and Suggestions, improve the core competitiveness of the Ningxia hui autonomous region agriculture, also send a reference for other areas to the agricultural industry [6].

2. Research Objects and Methods

2.1. The research object

This paper studies the development of agriculture and related industries from the perspective of agricultural basic industrial chain and extended industrial chain. Compared with other related industry correlation studies, this paper comprehensively studies the development of the agricultural industry chain from three aspects: the strength of industry correlation, the economic distance between industries and the minimum supporting tree of the agricultural industry chain. Due to the time lag in compiling the input-output table, this paper adopts the input-output table of Ningxia hui autonomous region in 2012 for analysis. Ningxia is located in the plains, mineral and large-scale industrial enterprises less, regional development is mainly dependent on agriculture and services, according to 2017 statistical yearbook and found the Ningxia hui autonomous region in 2017 statistical yearbook 2017, Ningxia hui autonomous region agricultural production value of 51.74168 billion yuan, the total ratio of 23.8% of GDP, up 13.6% from a year earlier, while Ningxia agricultural development compared with elsewhere in the same period in terms of total amount is less, but in a larger share of GDP in Ningxia region. According to the statistical data of Ningxia region agricultural development the paper studies the location quotient in Ningxia region agricultural location quotient is 1.1, although Ningxia region location daqo in 1, but on the whole Ningxia region agricultural development is relatively backward, short industry chain extension, the low level of mechanization and specialization, so the development of Ningxia agricultural industry chain in terms of

comprehensive strength of ascension has very strong practical significance.

2.2. The research methods

Input-output analysis is a quantitative method to study the interdependence among industries, which can well show the correlation between industries and play a unique role in the study of the industrial chain. Since this paper focuses on the agricultural industry chain between regions, this paper only analyzes the agricultural industry chain of Ningxia, and there is a lag in compiling time. Here, the input and output table of Ningxia in 2012 is selected to only analyze the agricultural industry chain in 2012.

According to the differences between demand-driven and supply-driven models, input-output models include Leontief model and Ghosh model. The Leontief model reflects the relationship between total output and final demand:

$$X = (I - A)^{-1} f \tag{1}$$

In formula (1), X is the column vector of total output of each department; A is the input coefficient matrix, also known as the direct consumption coefficient matrix f is the final demand column vector. (I-A) is the famous Leontief inverse matrix, denoted as L, whose ij element represents the change in the output of the ith sector when the final demand of the jth sector increases by one unit.

Ghosh model reflects the relationship between total output and initial input:

$$X^{\wedge} = v(i - b)^{-1} \tag{2}$$

In formula (2), v is the initial input row vector of each department; B is the output coefficient matrix, also known as the direct distribution coefficient matrix, and $[I - B]^{-1}$ is the Ghosh inverse matrix, denoted as G. The L matrix and the G matrix reflect the size of the complete industrial correlation, including both direct correlation and indirect correlation, but the position of direct correlation and indirect correlation in the total correlation is not considered. The demand-driven model is taken as an example to illustrate how the inter-industry pull effect accumulates into a complete effect, which is expressed by the average cumulative step size, also known as the economic distance:

$$v_{ij} = \{1A_{ij} + 2[A^2]_{ij} + 3[A^3]_{ij} + \dots\} / \{A_{ij} + [A^2]_{ij} + [A^3]_{ij} + \dots\} \tag{3}$$

Formula (3) represents the economic distance of the impact of the final demand of industry j on the total output of industry I. Obviously, $V_{ij} \geq 1$. A large economic distance indicates that the correlation between two sectors is dominated by indirect correlation, whereas it is dominated by direct influence. The left side of formula (3) is the ijth element of the following distance matrix V.

$$V = L(1 - i) / (1 - i) = G(g - i) / (g - i) \tag{4}$$

In formula (4), I is the unit matrix, which can also be defined by Ghosh inverse matrix. In this case, the ij element represents the impact distance of the cost change of i industry on the cost of j industry. In addition to the economic distance matrix, an industry correlation matrix F:

$$F = [(L - I) + (G - I)] / 2 \tag{5}$$

In formula (5), F matrix includes Leontief inverse matrix and Ghosh inverse matrix, indicating that the industry correlation includes both the demand side and the supply side. The unit matrix I is subtracted from both moment matrices to eliminate the effect of the initial injection. Then a threshold value is introduced, which can exclude the links with small total correlation effect between industries. On this basis, a matrix S is constructed, and the ij element of the matrix is:

$$S_{ij} = \begin{cases} \text{int}(V_{ij}) f_{ij} \geq a \\ 0 & f_{ij} < a \end{cases} \tag{6}$$

In formula (6), int is an integer symbol, which can be rounded. In this study, downward rounding is adopted. a is the threshold.

Data source: the data source of this paper is the input-output table of Ningxia hui autonomous region in 2012. The present situation and characteristics of agricultural

industry chain in Ningxia were analyzed with the detailed input-output table of 42 sectors.

3. Results and Analysis

3.1. Research results and analysis of the data in the seven departments' input and output tables

The input-output table of 7 departments of Ningxia hui autonomous region in 2012 was used to calculate inter-industry correlation. The settlement results are shown in table 1. As can be seen from the table, the forward correlation between agriculture and other industries is 0.52, and the backward correlation with other industries is 0.45. The ratio of forward correlation and backward correlation is greater than 1, indicating that agriculture plays a stronger role in promoting economy supply than demand, and it is a supply-driven industry. The ratio of forward correlation and backward correlation of mining, manufacturing, transportation, post and telecommunications, commercial catering and other service industries is greater than 1, belonging to supply-driven industry, while the ratio of forward correlation and backward correlation of construction industry is less than 1, belonging to demand-driven industry, which is stronger than supply-driven economy.

Table 1. Industry Correlation of Seven Sectors In Ningxia Hui Autonomous Region

Analyze project	Agricultural	The Mining Industry	Manufacturing	The Construction Industry	Transportation, Post and Telecommunications	Commercial Catering Industry	Other Services	Rows and	The Rows And/Columns Are The Sum
Agricultural	0.13	0.01	0.25	0.05	0.02	0.04	0.02	0.52	1.16
The mining industry	0.02	0.05	0.23	0.05	0.01	0.01	0.02	0.39	1.18
Manufacturing	0.21	0.10	0.47	0.36	0.20	0.12	0.14	1.60	1.03
The construction industry	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01
Transportation, Post and Telecommunications	0.03	0.07	0.28	0.20	0.11	0.04	0.07	0.80	1.70
Commercial catering industry	0.04	0.03	0.16	0.24	0.03	0.03	0.15	0.68	2.13
Other services	0.02	0.07	0.16	0.08	0.10	0.08	0.21	0.72	1.18
Column	0.45	0.33	1.55	0.99	0.47	0.32	0.61		

As can be seen from the table, agriculture and manufacturing have the closest interdepartmental correlation, while the sector with the greatest agricultural forward correlation is manufacturing, with the former correlation being 0.25, and the former correlation being 0.21, indicating that agriculture and manufacturing have a two-way dependency relationship and are intermediate inputs to each other.

The economic distance between departments is calculated by formula (3) and (4), and the results are shown in table 2. It can be seen from the table that: first, among the 49 economic distances, 33 are less than 2, accounting for 67.35, indicating that the inter-departmental dependence is mainly direct dependence, and the economic distance of the department itself is also mainly direct dependence. Second, the economic distance of the manufacturing industry itself is 2.64, which is the only industry whose

economic distance is greater than 2.0 on the diagonal, indicating that the correlation of the manufacturing industry itself is mainly indirect, indicating that the indirect correlation means that the manufacturing industry has an impact on the industry through the feedback of other industries. Third, the economic distance between business diets is less than 2.0, indicating that the feedback effect between service industries through other industries is lower than the intra-industry multiplier effect.

The longest forward economic distances for agriculture are mainly in the following sectors, from agriculture to transportation, post and telecommunications, and from agriculture to other services; The longest backward economic distance in agriculture consists mainly of the following sectors, from agriculture to construction and from agriculture to other services. Through the ranks of the average to determine the effect of each department, said the average of every line to the average economic distance and the mean of the mining industry, agriculture,

followed by suggesting that the mining industry and agriculture in the regional economic production chain head end, before mining and agriculture to the dependence of the associated main is indirect. Of the backward-economic distance averages for each sector, the largest are for agriculture and transport posts and telecommunications, while the backward-related dependence of mining and transport posts and telecommunications is also indirect. Due to the weak correlation between some industries, this paper deletes the industrial correlation and economic distance between some industries for the convenience of research. In order to make the results of economic distance between industries clearer, this paper introduces a new matrix whose element is 0 or positive integer. Using V matrix, F matrix and threshold, the S matrix is obtained (table 2), and the threshold a is 1/7. According to the S matrix in table 2, the industrial network of seven departments in Liao Ning province is obtained (figure 1).

Table 2. Average Influencing Distance and S-Matrix of Seven Sectors in Ningxia Hui Autonomous Region (In Brackets)

Analyze Project	Agricultural	The Mining Industry	Manufacturing	The Construction Industry	Transportation, Post and Telecommunications	Commercial Catering Industry	Other Services	Line Average
Agricultural	1.33 (0)	2.5 (0)	1.67 (1)	2.7 (0)	2.81 (0)	1.45 (0)	2.71 (0)	2.17
The mining industry	2.7 (0)	1.33 (0)	1.57 (1)	2.32 (0)	2.71 (0)	1.82 (0)	2.71 (0)	2.31
Manufacturing	1.67 (1)	1.83 (0)	2.64 (2)	1.65 (0)	1.71 (1)	1.78 (1)	1.84 (1)	1.87
The construction industry	3.05 (0)	1.34 (0)	2.13 (0)	1.14 (0)	1.72 (0)	1.38 (0)	1.34 (0)	1.73
Transportation, post and telecommunications	2.12 (0)	1.42 (0)	1.74 (1)	1.55 (1)	1.39 (0)	1.67 (0)	1.79 (0)	1.67
Commercial catering industry	1.53 (0)	1.66 (0)	1.88 (1)	1.28 (1)	1.88 (0)	1.64 (0)	1.36 (0)	1.60
Other services	2.7 (0)	1.54 (0)	1.93 (1)	2.16 (0)	1.56 (0)	1.45 (0)	1.36 (0)	1.81
The column, on average,	2.16	1.66	1.94	1.83	1.97	1.74	1.87	

Figure 1 shows that "" represents an economic distance of 1.0,"... "Represents an economic distance of 2.0. Figure 1 shows the manufacturing industry chain. This kind of industrial chain has the following characteristics. First, with the exception of the two-step dependence of manufacturing itself, all dependence is one-step dependence, and this dependence is also direct dependence. Second, agriculture and manufacturing are bidirectional dependencies, so are transportation, post and telecommunications, while mining and manufacturing, construction and manufacturing are demand-type one-way correlations, while commercial catering and manufacturing are supply-type one-way correlations. Third, manufacturing and transportation post and telecommunications are mainly intra-industry dependence.

4. Research Results and Analysis of the Data in the Input-Output Table of 42 Departments

Figure 1 can only roughly reflect the relationship of the industrial correlation network of Ningxia hui autonomous region's economic system, while for agriculture, it does not reflect very detailed information. In order to explore the details of the industrial correlation and economic distance of agriculture, this paper introduced the input-output table of 42 sectors to subdivide manufacturing and service industries to examine the detailed links between agriculture and subsectors.

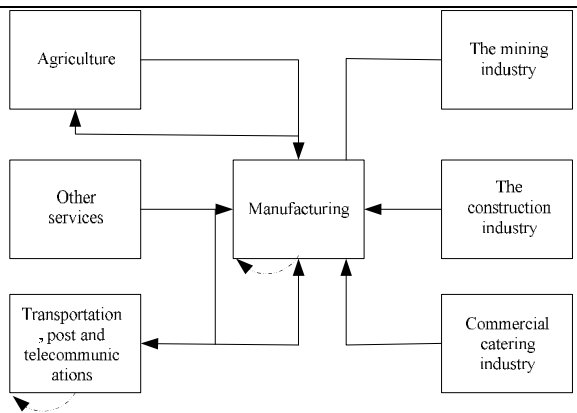


Figure 1. Industrial network of seven sectors in Ningxia hui autonomous region

Using the input-output table of 42 sectors to analyze the correlation between specific industries can make the inter-industry information more detailed, but at the same time, due to more information, the economic chart of industrial correlation is more complex, so it is difficult to study the nature of the correlation between agriculture and other industries. So let's figure out the F and V matrix of 42 by 42. Then the threshold $a=3/42$ is introduced to calculate the S matrix, and then the i th element in the first row and the first column is marked with 0, and then the i th row and the i th column are deleted to get the matrix, which is the sub-matrix of the S matrix. S_{new} Industries retained in the matrix are agriculture, food and tobacco, chemical industry, water production and supply, accommodation and catering, paper, printing and recreational and educational supplies, petroleum and coal products, and nuclear fuel processing. According to the new S matrix draw a detailed diagram of the agricultural industry chain. In order to study the position of agriculture in the whole industry chain and the relationship between agriculture and other industries in detail, this paper only

keeps the relationship between agriculture and other industries, ignoring the relationship between other industries in the industry chain diagram. This industry chain has the following characteristics: first, the economic distance between most industries is 2.0, the inter-industry correlation is indirect correlation, the indirect impact is greater than the direct impact. Second, the economic distance of agriculture is greater than 2.0, indicating that the multiplier effect is smaller than the feedback effect. The economic distance between water production and supply is less than 2.0, indicating that the multiplier effect is greater than the feedback effect. Third, the chemical industry, the production and supply of water and agriculture are backward related; Manufacturing printing and recreational and educational supplies. The correlation between accommodation catering, petroleum coke and nuclear fuel processing industry and agriculture is backward correlation. The influence between food and tobacco industry and agriculture is bidirectional, and it is a interrelated industry.

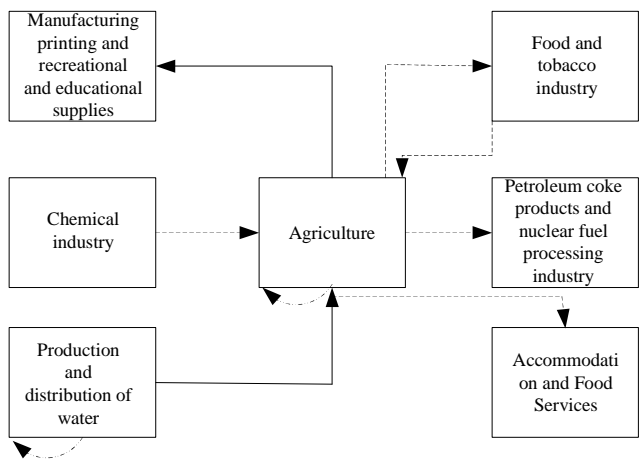


Figure 2. Agricultural industry chain of Ningxia hui autonomous region

Figure 2 shows the central position of agriculture in the whole industrial chain, but it is difficult to show the position of other industries. In order to explore the relationship, this paper USES the minimum support tree theory to build a relatively complete industrial chain. The specific construction method is as follows: First, the threshold value is used to calculate the 8-order sub-matrix \bar{F} of F matrix.

Second, by \bar{F} calculation $\tilde{F} = \bar{F} + \bar{F}^T$, \tilde{F} is the symmetric matrix. Third, you take all the entries to the \tilde{F} matrix

and you get the \hat{F} matrix. Fourth, according to the matrix using the broken ring method to construct the agricultural industry chain. \hat{F} The position of the agricultural and chemical industries in the whole industrial chain is shown by the minimum support tree of the agricultural industrial chain. Agricultural industrial chain can be extended through chemical process.

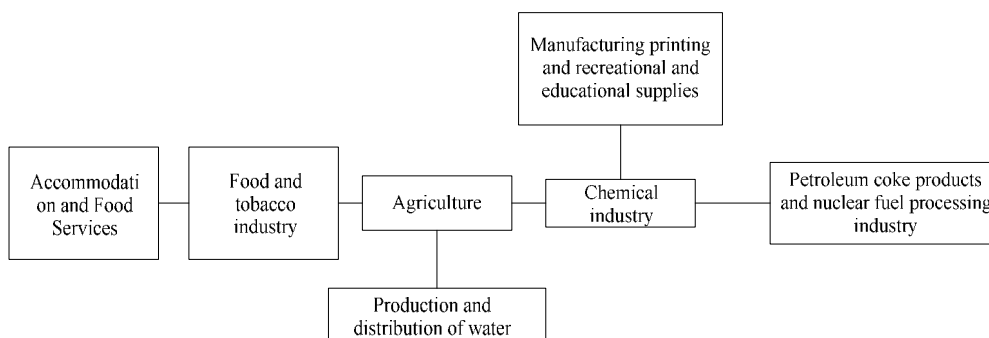


Figure 3. Minimum support tree of agricultural industry chain in the agricultural hui autonomous region

5. Conclusions and Countermeasures

5.1. Research conclusions

Judging from the identification process of the whole agricultural industry chain in Ningxia hui autonomous region, the economic distance between departments, industrial correlation and minimum support tree play an important role. In order to have a clear understanding of Ningxia hui autonomous region agriculture industry chain, this paper use 2012 input-output table of Ningxia hui autonomous region are analyzed, and found that manufacturing in the center position in the economic system, manufacturing and other industries of economic distance is 1, mostly is directly affect each other, which is the cumulative effect of industrial connection faster.

Through the analysis of the input-output table of 42 sectors, there are mainly three forms of industrial correlation, which are forward dependence, backward dependence and mutual dependence. The forward dependent industries of agriculture are accommodation and catering, manufacturing, printing and recreational and educational supplies, petroleum and coal coking industries, and nuclear fuel processing industries. The backward dependent industries of agriculture are chemical industry, water supply and production. Food and tobacco industry and agriculture are interdependent. On the one hand, agriculture provides raw materials for food and tobacco industry; on the other hand, feed industry of food and tobacco in-

dustry provides intermediate input for animal husbandry in agriculture and also provides financial support for agriculture. The two industries promote each other's development. Among the 7 inter-industry communication paths, economic distance is greater than 2 in 5. Among the 8 intra-industry transmission paths, only 2 are retained due to threshold operation. Of the two paths, the one whose economic distance is greater than 1 is agriculture itself; The economic distance is less than 2, for the supply and production of water, Ningxia region compared to the drought water supply and production for agricultural production to provide a great help, greatly promoted the increase of agricultural production and agricultural output.

It is found that food tobacco industry and chemical industry play an important role in the agricultural industry chain by using the theory of minimum support tree and the broken circle method to simplify the industrial chain.

6. Policy Suggestions

First, in the whole industrial chain, agriculture is the key, while water resources are the lifeblood for agriculture. Only the development of agricultural industry can make the pre-agricultural, post-agricultural and inter-related industries develop faster. Reducing the cost of water can not only reduce the cost of agricultural industry, but also extend the industrial chain.

Second, we will strengthen the integrated development of manufacturing, agriculture and chemical industries. No

matter from the perspective of the agricultural industry chain of 7 sectors or 42 sectors, these three industries have the closest relationship with each other. The integrated development can not only promote the interconnection among them. Chemical industry provides fertilizers, seeds and pesticides to agriculture, improves agricultural quality, and drives the rapid development of agriculture from the supply side. Meanwhile, manufacturing industry and chemical industry also have great demand for agriculture, which drives the development of agricultural industry from the demand side. The integrated development of these three industries will significantly improve the core competitiveness of agricultural industry in Ningxia hui autonomous region.

Third, the government should implement different industrial agglomeration policies for different industries. For industries with an economic distance of less than 2.0, it indicates that they can achieve coordinated development through agglomeration industrial policies because of their direct influence on each other. For industries with an economic distance greater than 2.0, it indicates that they have an indirect influence on each other and should im-

plement a decentralized industrial policy so that they can drive the industrial development of the whole region from multiple levels and perspectives.

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