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Research Article

Research on the Construction of Food Industrial Correlation Network Model

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Abstract: As the objective existence of economy, the relational and spatial structure of Industrial correlation not only determines the quality and level of economic growth, but is regarded as the important source of gaining competitive advantages. Based on the input-output model and network model of food industry, this study focuses on the method and application of the construction of food industrial correlation network model. Analyzing the connotation of food industrial correlation, the article finds the way to describe it with graphs. What's more, these graphs and network theory are used to design the index coefficient of industrial correlation to show the food industrial correlation and its structure feature.

Keywords: Food industrial, modeling, network

INTRODUCTION

With the rapid development of Internet information technology, the way to generate strategies from the perspective of globalization based on the industry/product correlation, has become the main form for nations, regions and enterprises to participate in the competition. At the national and regional level, they give the priority to the development of key industries or key industrial clusters (chain) to form the leading industry or industrial cluster on the basis of industrial correlation, in order to enhance its competitiveness and realize sustainable development. For these enterprises, they employ the strategy that with the foundation of industrial correlation, the value chains (global value chains) are formed through strategic alliance or integration to maintain a competitive advantage (Perobelli *et al*., 2010).

In this study, the industrial correlation network is set as the example to analyze. So the connotation of industrial correlation should be made clear first. Its meaning mainly lies in three levels. The first level mainly refers to the relationship between single industries, of their dependency and influence, which is the foundation of describing the food industrial correlation. The second level refers to the relationship between the single industries and the whole industry system (or subsystem), focusing on the status and influence of a specific industry in the industry system. In fact the first level of correlation can be regarded as a special case of this level. The third level refers to the structure of industrial relationship, showing the overall characteristics and its nature, including the features of some industrial subsystems and the interaction between industrial subsystems.

The input-output method is considered as the classic method of studying industrial correlation. In 1936, Leontief for the first time put forward the input-output model, quantitatively describing the relationship between the industries. In 1958, the concept of backward linkage and forward linkage was raised by Hirschman and used as the basis of making strategies for unbalanced development in formulating regions. After that, many scholars have made series of improvement to meet different research needs (Slater, 1977; Czayka and Krauch, 1972; Cai and Leung, 2004). These achievements have made great progress in describing the feature and effect of food industrial correlation. Moreover, the study based on input-output model of analyzing the feature and effect is called as "input-output correlation analysis". This kind of analysis method in essence belongs to the category of binary relation analysis, only dealing with the first two levels of food industrial correlation. In such analysis, the direct consumption coefficient, complete consumption coefficients and direct distribution coefficient can be used to study the relationship between any two industries; Induction degree coefficient and influence coefficient used to research the relationship between the industry and the whole system (subsystems). Presently, the input-output correlation analysis mainly is about the study of the strength of the food industrial correlation, which has not yet involved the structure. Therefore, the input-output correlation analysis can't serve for the third level of food industrial correlation.

The above analysis shows that the food industrial correlation analysis includes input-output correlation analysis and industry network linkage analysis. The former is about analyzing the characteristics and effect

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of the food industrial correlation with the help of input-output model, while the industry network correlation analysis is based on the industry network and empowerment industry network to do research on the food industrial correlation.

MATERIALS AND METHODS

Materials:

- The objective relationship between industries forms the industry network which has double meanings. Firstly, it has ontological significance, that is to say, the industry network is a kind of objective existence. From the level of products, it is the total of the product and product relationship; from the organizational level, it is related to the total of the behavior of objects associated with products. Secondly it has methodological significance, namely the industry network refers to the model and method of describing industrial correlations, in which the model for product and product relationship is called as industry correlation network, while the model for the relation of objects is known as the network of industrial organization (Ye, 2014).
- Industry network can be described with the network model and can explain industry correlations and structures in some specific indicators in the network.
- Industry network can be shown with the graph and network in which the peak stands for industry and the line between points for industrial correlation. If two industries do have relations, the points will join together, otherwise they don't.

There are many types of modeling for the industrial network. The principles can be roughly divided into the following.

Campbell-Model, MFA-Model, ICA-Model (Aroche-Reyes, 1996), ECA-Model, Morillas-Model and Zhao-Model (Zhao, 1996).

Basic model: Zhao-Model based on the consumption coefficient and distribution coefficient uses Weaver-Thomas index to make sure the industrial correlations. Zhao-Model, which is the way of endogeny, uses simple calculation to get significant input-output relationship with a scientific consideration of the indirect relationship. It is a simple and effective way to build industry network model. So it is most suitable to establish model between the food industry and the specific ideas and steps are as follows.

The key to set up industrial network model is to determine the inflection point of the correlation between industries, which is to identify their significant input-output relationship based on Weaver Thomas index. Weaver-Thomas, first put forward by Weaver, has been improved by Thomas. It is very effective to determine the significant array from the uneven arrays. The basic principle is to establish a closest approximation distribution through comparing the observation and assumptions, so as to identify the key elements in numerical sequence. The steps of setting up food industrial network model in Zhao-model (Zhao, 1996) are shown as follows.

The first step is to select the coefficient of modeling. Network model is built based on input-output numerical matrix. Different numerical matrix refers to the food industrial network model under different meaning, in which the consumption coefficient reflects the backward-pulling relationship and distribution coefficient reflects forward promotion.

The determination of the critical value is the second step. Suppose that there are N food industries in food industry system and E (i, m) is the coefficient of the I item in the M industry. If we array E (1, j), E (2, j), …, E (n, j) (j = 1, 2, …, n) from big to small, Weaver-Thomas index should be:

$$Wij = \sum_{k=1}^{N} \left[s(k,i) - 100 \times \frac{E(k,j)}{\sum_{k=1}^{N} E(k,j)} \right]^2$$

$$s(k,i) = \begin{cases} \frac{100}{i} & k \le i \\ 0 & k > i \end{cases}$$

Matrix W is weaver-Thomas matrix. If k = min $k = \min\{W(1,j), W(2,j), \cdots, W(n,j)\}$ will be the critical value associated with industry k. Calculating the Weaver-Thomas index with the row n helps to obtain independent critical values $\alpha_1, \alpha_2, \ldots, \alpha_n$; similarly, in the group of column n we will get independent critical values $\beta_1, \beta_2, \ldots, \beta_n$.

The third point comes to the construction of matrix 0-1. In each row or column of matrix W, the element, greater than (or equal to) the critical value, is defined as 1 which refer to the corresponding edges between nodes, while the element less than the critical value is defined as 0 which means there is no edge between corresponding nodes. Then, by restoring food industries to the original order, 0-1 matrix M of industry network model will be got finally.

The last step is to draw the map of industrial network. On the basis of matrix 0-1, if Mij = 1, the edge does exist which means industry i to j have correlation, if Mij = 0, it doesn't.

The above four steps can build the food industrial network model. Zhao-model can effectively identify significant input-output relationship between industries.

Building food industrial network model: The above model-building theory is on the basis of the input-output

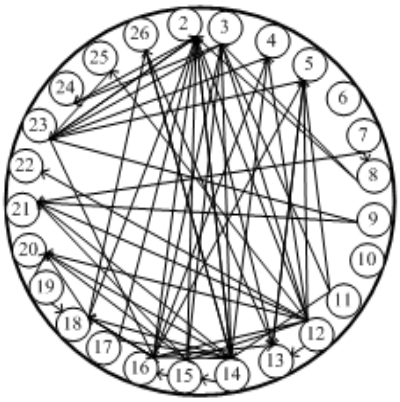

Fig. 1: The food industry external network

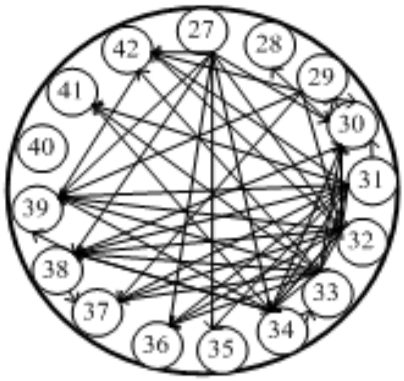

Fig. 2: The food industry internal network

table of 42 food industries of Shandong province in 2010, in which the points refer to various industries numbered 1~42 using and the edge is for the relationship between industries, Using the software Pajek and Ucinet get this Fig. 1.

The two food industrial networks can be established with direct coefficient matrix. The two supply network for local industry chain of industry structure and demand structure is analyzed, such as identifiable impact industry the main upstream industry product categories and the main downstream industry affecting the industry product demand category; While in the network as a whole to analyze the demand of industry system cost or relationship in major industry decentralized or centralized degree and the trend. They can be used to analyze the supply and demand structure of partial industrial chains, to identify the main upstream industry which affects the costs of products and the main downstream industry affecting the product demand. What's more, they also can give a full analysis about the correlations between main industries and the degree and trend of their decentralization and concentration.

Needed by the research, the whole network can be divided or extracted subnets with different types of industries. And the correlation network between the third ones (Fig. 1 and 2), with which we can analyze the features of industrial correlations and structures using some specific indicators. The research about the above three kinds of subnets shows that in Shandong province the downstream industries are found hard to promote agriculture quickly. Moreover, the influence of service industries on industries is weaker than the whole correlation between industries. Form the angle of industrial correlation, these weak links should be the focus of Industrial restructuring.

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The authors wish to thank the helpful comments and suggestions from To meet the actual needs, industrial network can do some optimization and analysis of network, such as analysis of industrial chains and enterprise strategies, analysis of the nature of the industry and industrial level, analysis of industrial correlation structure and regional economic competitiveness, analysis of circular economy and industrial clustering, etc.

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