Research on Financial Risk Path Identification of New Energy Enterprises Based on ISM-MICMAC Model

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Abstract. Due to the relatively low input and output of developing countries in the field of new energy at this stage, it is particularly important to accurately identify the main influencing factors of financial risks of new energy enterprises. This paper takes the financial risk of China's new energy enterprises as the research object, identifies 17 factors affecting the financial risk of new energy enterprises after sorting out relevant indicators, and innovatively uses ISM (Interpretative structural model) -MICMAC (Matrix of Cross-Impact Multiplications Applied to Classification) to show the logical level and influence relationship between various factors. The results show that new energy enterprises should first consider the fundamental factor of management myopia; strengthen the control of intermediate factors, such as lack of environmental awareness, and improper investment; monitor the appearance layer factors with strong dependence at any time, such as inappropriate technical talent reserve. This study is helpful to provide practical significance for the identification of the financial risk chain of new energy enterprises.

Keywords: ISM-MICMAC, Corporate financial risk, risk paths identification, new energy enterprises.

1. Introduction

New energy enterprises refer to enterprises that are based on new technologies and new materials, are just beginning to develop and utilize or are actively researching, and are to be promoted other than traditional energy sources such as solar energy and wind energy. In the context of China 's industrial transformation, new energy companies have been given a heavy responsibility. In recent years, governments at all levels have continuously introduced various policies involving ' new energy vehicles ', ' hydrogen energy ' and other fields to promote the development of new energy industries. It can be seen that the new energy industry is highly valued by the state. However, the development of new energy enterprises is not satisfactory. The main reason is that there is a certain deviation in the attitude and cognition of new energy enterprises towards innovation.It is undeniable that under the strong support of the state, the investment intensity of new energy enterprises in innovation is constantly increasing, but compared with the huge investment in innovation, the output efficiency is unbearable. At the same time, due to the uncertainty and high risk of the innovation process, the innovation of many enterprises is not sustainable, which leads to the low utilization rate of resources [1].So far, more and more attention has been paid to the financial risks of new energy enterprises, and there are many researches in this field.

This paper focuses on the relevant content of financial internal and external risk analysis of new energy enterprises. In terms of internal financial risks, through Pei 's [2] research, it is believed that internal financial risk factors are unique factors of enterprises and are factors generated by their own events, including management factors, financial management factors, financial factors and business factors. Yan and Kong [3] also found that managers ' ability is the core factor affecting business decision-making and strategy implementation, which has a direct impact on enterprise value. Zou and

Zhang [4] found that on the whole, venture capital can stimulate the innovation output of new energy enterprises. Kisgen [5] believes that the reduction of corporate credit rating will indirectly affect their own financing capacity.

In terms of external financial risks, Wang and Lv [6] found that green finance can not only significantly improve the quantity and quality of green innovation of new energy enterprises, but also help new energy enterprises get rid of financing difficulties. Sun and Shi [7] through empirical analysis found that new energy vehicle manufacturing industry needs the support of national policies, thereby reducing their own financial risks. Li and Jiang [8] tested in strategic emerging industries, government subsidies can significantly improve the technical efficiency of enterprises, encourage R & D investment, expand the scale of enterprises and enhance profitability are important channels for government subsidies to play a role.At the same time, Ke and Li [9] believe that when the degree of product market monopoly in which the enterprise is located is large (that is, the degree of product market competition in which the enterprise is located is small), the positive impact of the pointing signal and activation signal of R & D subsidies on the enterprise will be further enhanced.

In general, the existing analysis of financial risks of new energy enterprises is relatively one-sided. Some of them classify the internal risks of enterprises, but few of them conduct more refined research on internal risk indicators. Some of them conduct empirical analysis and test on several indicators, but to a certain extent, they ignore the logic and directivity between indicators. At the same time, the number of observed indicators is small and not comprehensive enough. After collecting and sorting out the relevant indicators of internal and external financial risks of new energy enterprises, this paper innovatively uses the ISM (Interpretative Structural Model) -MICMAC (Cross-Influence Matrix Multiplication) coupling method to express the logical level and correlation between various indicators, and makes them coherent and clear, which provides practical significance for the identification of financial risk chain of new energy enterprises.

2. Construction of Financial Risk Index System for New Energy Enterprises

2.1. Inside the enterprise

The management factors are mainly due to the limitations of short-term management decisions in the management process of new energy enterprises in a certain period of time, and the low ability of enterprise managers often increases the fluctuation of enterprise risks. At the same time, due to the particularity of the industry, that is, less impact on the environment, if the lack of environmental awareness often leads to damage to the interests of corporate reputation and other aspects, and its sensitivity is often stronger than other types of enterprises, thereby increasing corporate financial risks. At the same time, the level of credit rating system will also affect the financing ability of enterprises, so the three indicators of low management ability, poor awareness of environmental protection and low corporate credit rating are selected.

Financial management factors are mainly due to problems in investment in fixed assets and other aspects of enterprises, and excessive or too little funds raised often lead to an increase in corporate financial risks. Therefore, two indicators of improper investment and excessive or insufficient financing are selected.

Financial factors are mainly due to raw materials, products and other enterprises due to the long time in the warehouse accumulation and the proportion of accounts receivable is too high to lead to the increase of cost and the deterioration of cash flow often produce financial risks, so the selection of excessive inventory, accounts receivable ratio is too high these two indicators.

The operating factors are mainly due to the higher requirements of new energy enterprises for technological innovation, and innovative technologies often invest a lot of money. If the benefits caused by innovation are low, that is, insufficient effective investment or wrong direction of technological development, low income of main business and poor profitability, it will aggravate the financial risks of enterprises. At the same time, venture capital can significantly improve the innovation ability of new energy enterprises [10].Therefore, select the wrong direction of technology

development, lack of effective investment in technology development, technical personnel reserve is not appropriate, lack of innovation incentive intensity, low main business income of these five indicators.

In summary, 12 indicators are selected, including management myopia (A1), poor awareness of environmental protection (A2), low credit rating of new energy enterprises (A3), investment dislocation (A4), excessive or insufficient financing (A5), excessive inventory (A6), high proportion of accounts receivable (A7), wrong direction of technology development (A8), insufficient effective investment in technology development (A9), inappropriate technical talent reserve (A1), insufficient innovation incentive intensity (A11), and low main business income (A12).

2.2. External enterprise

The lack of government subsidies and the poor effect of fiscal and tax incentives in government policies often hit the enthusiasm of new energy enterprises, reduce the net profit of enterprises, and thus increase the financial risks of enterprises. Therefore, the two indicators of insufficient government subsidies and poor fiscal and tax incentives are selected.

In terms of peer competition, due to the fact that the market scale often does not change much in the short term, the number of new energy enterprises in the market and the small market share will lead to certain restrictions and constraints on the operating ceiling of new energy enterprises, which is not conducive to the operation of enterprises and increases the financial risks of enterprises. Therefore, the two indicators of more total number of industry companies and less market share are selected.

At the same time, the development of green finance in the region where new energy enterprises are located will obviously affect the operation of new energy enterprises and thus affect the financial risks of enterprises. Therefore, the indicator of poor development of green finance in the region is selected.

In summary, five indicators are selected: insufficient government subsidies (A13), poor fiscal and tax incentives (A14), large number of industry companies (A15), small market share (A16), and poor regional green finance development (A17). Therefore, the index system constructed in this paper is shown in Table 1.

Table 1. New energy enterprise financial risk index system table

First grade indexes	Second index	Indicator code	Reference
Financial risk	Management myopia	A1	[2], [3]
	Lack of environmental awareness	A2	[2]
	Low credit rating of new energy enterprises	A3	[5]
	Investment dislocation	A4	[2]
	Excessive or insufficient financing	A5	[2]
	Too much inventory	A6	[2]
	The proportion of accounts receivable is too high	A7	[2]
	Technology development direction error	A8	[2]
	Insufficient effective investment in technology development	A9	[2]
	Improper technical talent reserve	A10	[2]
	Insufficient innovation incentive intensity	A11	[1], [10]
	Low main business income	A12	[11]
Government policy	Insufficient government subsidies	A13	[8]
	Poor fiscal incentive effect	A14	[1]
Competition	Total number of industry companies	A15	[9]
	Less market share	A16	[9]
Miscellaneous	Poor Environment for Green Finance Development	A17	[4]

3. ISM Method

Interpretative Structural Model (ISM) is a kind of method that can express the logical level and relevance among various factors through a multi-level structure model [12]. ISM model can deeply excavate the deep influence factors and surface influence factors of a complex system, and present the specific relationship between different factors and the overall structure of the system in the form of graph theory, which makes the relationship between factors more organized. In addition, the ISM model can overcome the limitations of the human brain in analyzing and processing problems with complex logical structures and a large number of influencing factors, which makes the conclusion more objective. Therefore, ISM provides an efficient way to understand the connections between different complicated system factors and qualitatively analyze the hierarchical relationship between the factors of complex systems. At present, the ISM model is widely used in the fields of enterprise risk, supply chain, and energy. The steps involved in the ISM methodology are given as follows:

STEP 1*: Identify important factors.*

First, the researcher needs to combine the practical experience and expertise of experts to identify the significant influencing factors in a complex systemic problem and to categorize and aggregate these factors.

STEP 2*: Identify the mutual relations of the important factors and establish the structural self-interaction matrix (SSIM).*

Before the establishment of the ISM model, the interrelationship among the factors should be judged first, and the structural self-interaction matrix (SSIM) should be established based on this to systematically reflect the intrinsic link between the various elements. In the ISM modeling method, the interrelationships among the elements are usually represented by V, A, X, and O: V means row variable *i* lead to column variable *j*; A means column variable *j* leads to row variable *i*; X means row variable *i* and column variable *j* are interrelated; O means row variable *i* and column variable *j* are unrelated.

STEP 3*: Establish the adjacency matrix (AM)*

After the structural self-interaction matrix (SSIM) matrix is finished, it has to be converted into the adjacency matrix, a binary matrix, by substituting V, A, X, and O to 1 or 0 according to the relationship previously established. If the (*i*, *j*) entry in the SSIM is V, then the (*i*, *j*) entry in the adjacency matrix becomes 1, and the (*j*, *i*) entry becomes 0; if the (*i*, *j*) entry in the SSIM is A, then the (*i*, *j*) entry in the adjacency matrix becomes 0, and the (*j*, *i*) entry becomes 1; if the (*i*, *j*) entry in the SSIM is X, then the (*i*, *j*) entry in the adjacency matrix becomes 1, and the (*j*, *i*) entry also becomes 1; if the (*i*, *j*) entry in the SSIM is O, then the (*i*, *j*) entry in the adjacency matrix becomes 0, and the (*j*, *i*) entry also becomes 0.According to the above operation rules, the adjacency matrix *A* can be obtained:

$$A = (a_{ij})_{m\times n} \tag{1}$$

STEP 4*: Establish the reachability matrix (RM)*

The reachability matrix describes in matrix form the extent to which factors within a system that are intrinsically linked can be reached through various pathways between them. It calculates the adjacency matrix based on the Boolean algebraic rule, then the reachability matrix can be obtained. The calculation rules are as follows:

$$(A+I) \neq (A+I)^2 \neq \cdots \neq (A+I)^n = (A+I)^{n+1} = RM \tag{2}$$

Where A in the above equation is the adjacency matrix and I is the unit matrix. When the element in the reachability matrix is 1, there is an accessible path between factor *i* and factor *j*; when the element in the reachability matrix is 0, there is no reachable path between factor *i* and factor *j*. The function of generating the reachability matrix is to represent the direct or indirect influence relationship between various factors.

STEP 5*: Divide the factors' level*

In order to classify the different stages of the model, partitions were conducted. To establish the hierarchy structure, variable-level partitions were established based on the reachability set $P(R_i)$, the antecedently set $Q(R_i)$, and the intersection set $T(R_i)$. The mathematical definition of the intersection set is as follows:

$$P(R_i) \cap Q(R_i) = T(R_i) \tag{3}$$

The reachability set consists of the specific risk R_i itself and other factors that the variable can reach. The antecedent set of a variable consists of the variables themselves and other variables that may reach it. The interaction set of a variable consists of the standard variables in both reachability and antecedent set [13]

4. MICMAC Method

Matrix of Cross-Impact Multiplications Applied to Classification (MICMAC) analysis is a method to analyze the interrelationships and interactions between factors in a system and is often used to identify variables in a system that are highly dependent and highly dynamic. The advantage of the MICMAC analysis method is that it can clearly and intuitively describe the influence relationship between various factors and visualize them. The steps involved in the MICMAC methodology are given as follows [14]:

STEP1: *Calculate the driving power and the dependence power of each factor.* The results of the MICMAC analysis are represented graphically by the coordinate axis, also known as the driving power-dependence power matrix, where the horizontal coordinates represent the dependence power and the vertical coordinates represent the driving power. The driving power of each factor is determined by the sum of the corresponding row factors in the reachability matrix, and the dependence power is determined by the sum of the corresponding column factors in the reachability matrix. Generally speaking, the strong dependence power of a factor means that the solution of the factor depends on the solution of other factors, while the strong driving power means that the solution of the factor can help solve other factors.

STEP2*: Plot dependency-driver diagram.* MICMAC analysis is carried out with the help of driving power and dependence power of factors. Using this analysis, we divide all the risk factors into four clusters according to their driving power and dependence power, i.e. autonomous, dependent, linkage, and independent risk factors. These clusters can be easily understood by plotting the dependency-driver diagram which is shown in Figure 1, i.e. the dependence power is shown on the x-axis, and the driving power is shown on the y-axis.

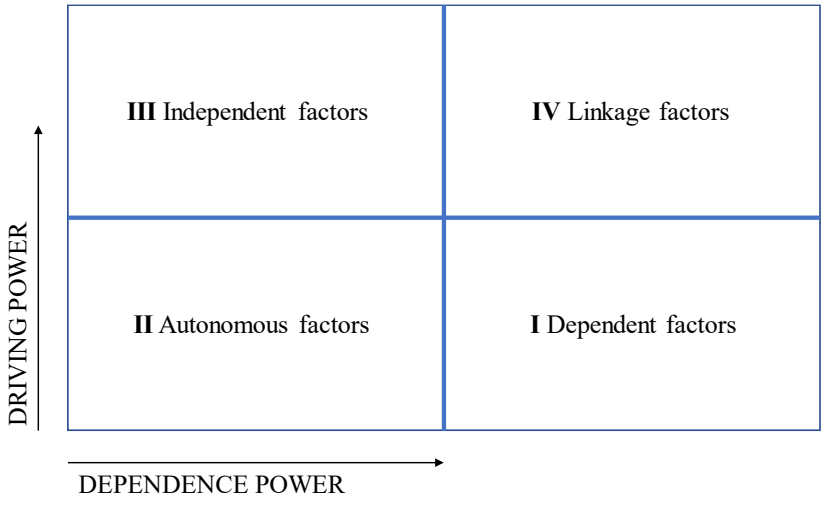

Figure 1. MICMAC diagram

The influencing factors are classified into four categories based on the magnitude of their driving power and dependence power: autonomous cluster, dependent cluster, linkage cluster, and independent cluster. Cluster I (Autonomous) consists of autonomous factors, which have both weak dependence and driving power. Such factors are disconnected from the system. Cluster II (Dependent) consists of dependent factors, which have strong dependence power and weak driving power. Such factors are susceptible to other factors. Cluster III (Linkage) consists of linkage factors, which have both strong dependence and driving power. Variations in such factors will affect other factors and have a feedback effect on themselves. Cluster IV (Independent) consists of independent factors, which have strong driving power and weak dependence power.

5. Case study

5.1. ISM Calculation and Analysis

An explanatory structural model is established to analyze the influence of 17 known factors on the financial risk of new energy enterprises. Firstly, the binary relationship between each influencing factor is judged and the adjacency matrix A is constructed. To avoid the error of the final result caused by the subjectivity of the opinion, the previous 10 experts were invited to score the closeness between the 17 influencing factors vaguely. If more than half of the experts believe that row element Ai has some binary relation with column element Aj, it is marked as 1, otherwise 0. The adjacency matrix A constructed is shown in table 2.

Table 2. Adjacency matrix A of financial risk influencing factors of new energy enterprises

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}
A_1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
A_2	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
A_3	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0
A_4	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0
A_5	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
A_6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
A_7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A_8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
A_9	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
A_{10}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A_{11}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
A_{12}	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
A_{13}	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
A_{14}	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0
A_{15}	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
A_{16}	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
A_{17}	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0

The adjacency matrix A shows the direct relationship between the financial risk factors of new energy enterprises, but it cannot reflect the indirect relationship between the various factors. Therefore, it is necessary to reflect the direct and indirect relationship between the various factors through the reachable matrix M. For the above adjacency matrix A, the reachable matrix R is calculated based on Matlab, see Table 3.

Table 3. The reachable matrix R of financial risk influencing factors of new energy enterprises

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}
A_1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0
A_2	0	1	1	0	1	0	0	1	1	1	1	1	1	1	0	1	0
A_3	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_4	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0
A_5	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_6	0	0	1	0	1	1	0	0	1	1	1	1	1	1	0	1	0
A_7	0	0	1	0	1	0	1	0	1	1	1	1	1	1	0	1	0
A_8	0	0	1	0	1	0	0	1	1	1	1	1	1	1	0	1	0
A_9	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{10}	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
A_{11}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{12}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{13}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{14}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{15}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	1	0
A_{16}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	0
A_{17}	0	0	1	0	1	0	0	0	1	1	1	1	1	1	0	1	1

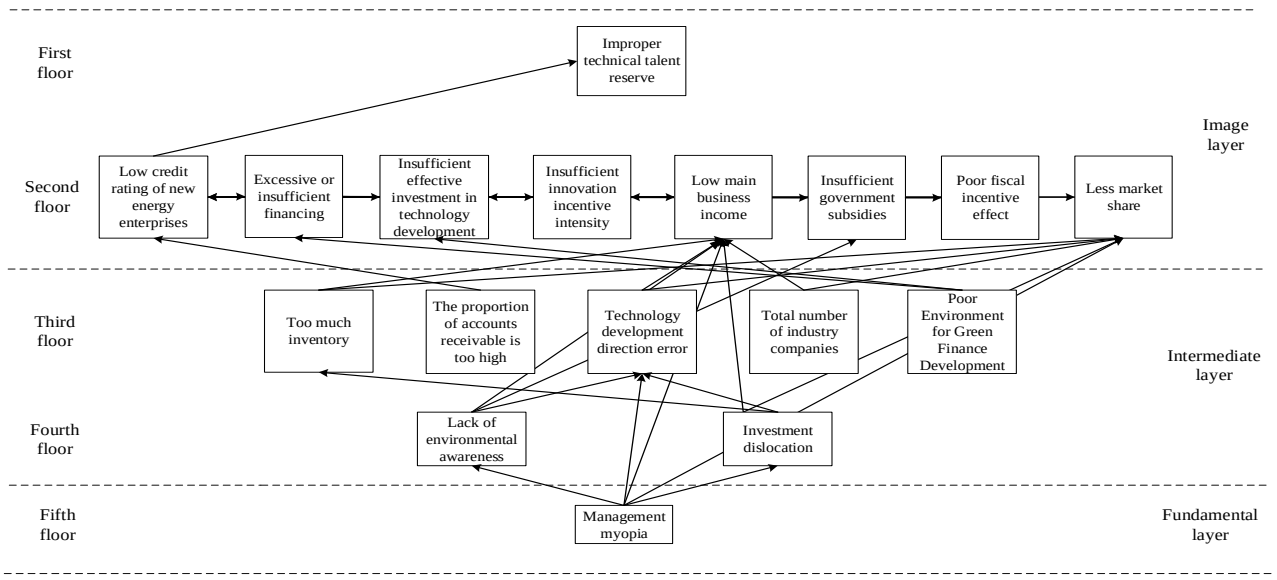

Figure 2. Interpretative Structural Model of Financial Risk Factors of New Energy Enterprises

The influencing factors of green transformation of the manufacturing industry under the goal of carbon neutrality can be divided into five levels. According to the ISM interpretation structure model method, the model can be divided into the fundamental layer, the middle layer, and the representation layer. The fifth layer is the fundamental layer, the third and fourth are the middle layer, and the first and second layers are the representation layer.

The influencing factors at the bottom are the fundamental layer: It can be seen from Figure 1 that the influencing factor of this layer is management myopia A1. Management myopia is the deepest and most fundamental factor affecting the financial risk of new energy enterprises, and it is the primary consideration for the development of new energy enterprises.

The influencing factors in the middle are the middle layer: the influencing factors of this layer are lack of environmental awareness A2 and improper investment A4; the influencing factors of the third layer are too much inventory A6, the too high proportion of accounts receivable A7, wrong direction of technology opening A8, the more total number of industry companies A15, and poor development of green finance A17. Environmental awareness plays an important role in the corporate culture of new energy enterprises. Different from traditional enterprises, the lack of environmental awareness

will lead to the wrong direction of technology development of new energy enterprises and deviate from the development direction of new energy enterprises, which will lead to the reduction of enterprise income and the reduction of government subsidies for enterprises themselves. When new energy companies invest improperly in the strategic direction, it will directly affect the direction of internal technology development and the number of product inventories, further reducing the company's main business income and reducing the company's market share.

The influencing factors at the top level are the representation layer: the interaction between the low credit rating of new energy enterprises and the excessive or insufficient financing of enterprises, the interaction between the lack of effective investment in technological development, the lack of incentive innovation intensity and the low income of the main business, and the lack of government subsidies and the poor effect of fiscal and tax incentives. Policy factors such as poor effects also directly affect the market share of enterprises. The influencing factor of technical talent reserve is less related to other factors.

5.2. MICMAC Calculation and Analysis

The dependence and driving force of each influencing factor are calculated by the reachable matrix R, and the driving force-dependence classification diagram of financial risk influencing factors of new energy enterprises is shown in Figure 3. The 17 factors affecting the financial risk of new energy enterprises include three categories: dependent factors, independent factors, and linkage factors

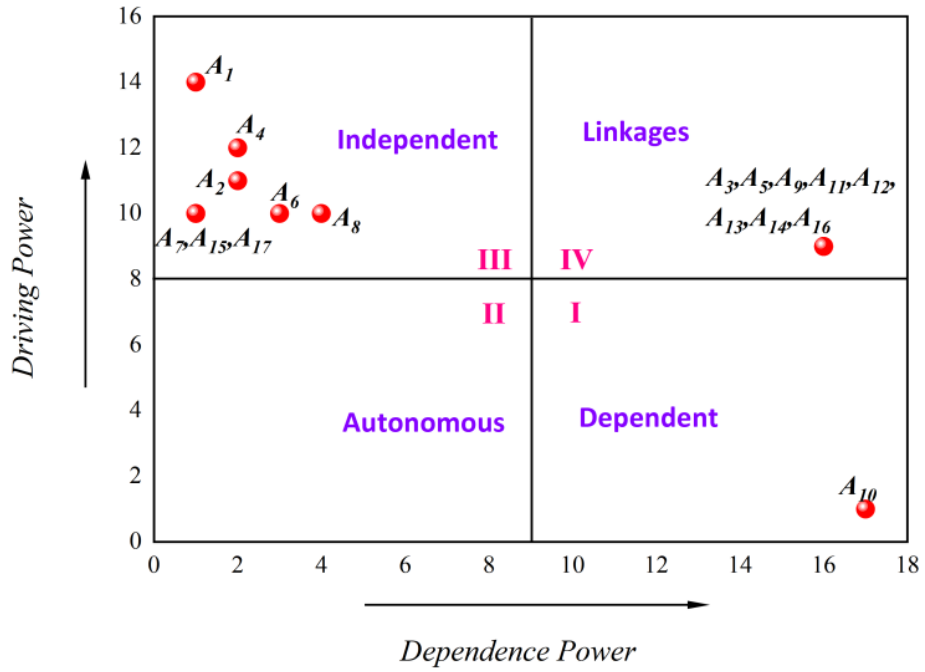

Figure 3. MICMAC Analysis Results of Financial Risk Factors Affecting New Energy Enterprises

The first quadrant is the dependent area. The influencing factors in this quadrant have higher dependence and lower driving force. The inappropriate technical talent reserve is located in this quadrant. This factor depends on the low credit rating of the lower new energy enterprises and is affected by its driving force. Generally speaking, the low credit rating of new energy enterprises will lead to the inappropriate reserve of technical talents.

The second quadrant is the autonomous region, and there is no influencing factor in this quadrant.

The third quadrant is an independent area, and the influencing factors in this quadrant have lower dependence and higher driving force. The factors of the third, fourth and fifth layers in the ISM model are located in this area, which has a strong driving force for the high-level influencing factors. It is not easy to control it indirectly by controlling other influencing factors, and once these factors are destroyed, a series of chain effects will occur, so it should be paid enough attention to.

The fourth quadrant is the linkage area. The influence factors in this quadrant are highly dependent and driven, and often have the effect of transmitting the influence of the lower factors to the upper level in the system. Low credit rating of new energy enterprises, excessive or insufficient financing, insufficient effective investment in technology development, insufficient innovation incentive intensity, low main business income, insufficient government subsidies, poor fiscal and tax incentives, and small market share are located in the linkage area but are very close to the dependent area. From the ISM model diagram, it can be seen that the influence of the underlying factors on the high-level factors is transmitted through these factors, which is consistent with the model results.

6. Conclusions

In this paper, the financial risk of new energy enterprises is taken as the research object, and the internal financial risk and external financial risk of enterprises are analyzed respectively. Through the collection and collation of relevant indicators, 17 factors affecting the financial risk of new energy enterprises are identified, and the ISM-MICMAC model is innovatively used to express the logical level and correlation between various factors. The research conclusions are as follows:

(1) The ISM model is used to divide the 17 influencing factors into different levels, and the multi-level hierarchical structure diagram of financial risk influencing factors of new energy enterprises is obtained. According to the multi-layer hierarchical structure diagram, the model can be divided into fundamental layers, middle layers, and representation layers.

(2) According to the MICMAC analysis method, the driving power-dependence power matrix can be obtained, and then the high driving power factors and high dependence power factors can be identified. The results show that when new energy enterprises prevent financial risks, they should first consider the fundamental factor of management myopia. Strengthen the control of intermediate factors, such as lack of environmental awareness, improper investment, excessive inventory, and accounts receivable ratio is too high at any time to monitor the strong dependence of the presentation layer factors, such as technical personnel reserves inappropriate, poor tax incentives.

This study helps to identify the main influencing factors and hierarchical relationships that affect the financial risks of new energy enterprises, and deeply understand the interaction mechanism of various influencing factors that lead to the occurrence of financial risks of new energy enterprises. Finally, it gives countermeasures and suggestions, which can improve the prevention level of financial risks for new energy enterprises, and further improve the theoretical research on the impact of financial risks of new energy enterprises. In the future research, the financial risk path identification of new energy enterprises can be discussed based on more samples in real scenarios. In addition, the ISM-MICMAC model can also be applied to the financial risk path analysis of other types of enterprises.

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