Research on Financial Risk Path Identification of Small and Medium-sized Energy Enterprises Based on ISM-MICMAC Model

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Abstract. Small and medium-sized energy enterprises face many risks in the process of carrying out financial activities, but the lack of systematic risk path identification countermeasures is easy to make them suffer serious economic losses. Based on the literature analysis method and expert interview method, this paper determines 15 factors that affect the financial risk of small and medium-sized energy enterprises, and uses the ISM to determine the multi-level hierarchical structure of the influencing factors, and then analyzes the hierarchical structure between the factors and the path that affects the financial risk of small and medium-sized energy enterprises. Then, the driving force and dependence of each influencing factor are mined by MICMAC, and the financial risk path of small and medium-sized energy enterprises is identified. This study takes the influencing factors of financial risk of small and medium-sized energy enterprises as the research object. The research results have certain universality, which can provide new solutions for small and medium-sized energy enterprises when facing development problems.

Keywords: ISM; MICMAC; financial risk; energy enterprises;

1. Introduction

Since the outbreak of the novel coronavirus epidemic, the global economy is expected to experience a recession, and energy demand has fallen off a cliff, which has caused a historic price drop in various energy sources in the world energy market. Due to the increase of energy costs and the instability of supply, there are many unstable factors in energy enterprises. In addition, small and medium-sized enterprises are vulnerable to external factors and encounter many financial risks. Therefore, this paper analyzes and discusses the financial risks faced by small and medium-sized energy enterprises in China. At present, there are many researches in this field. MA et al. [1] analyzed the causes and transmission paths of financial risks from the perspective of analysis framework, which provided a reference analysis framework for financial risk monitoring and early warning. Yin Xiaobo [2] discussed the importance of financial and economic benefits and risk prevention and control of energy power enterprises, and analyzed the effective strategies of financial and economic benefits and risk prevention and control of energy power enterprises. Liu Sheng et al. [3] studied the impact of climate change on the financial risks of the renewable energy industry through the construction of mathematical models; taking the development of Shenneng Group 's financial industry as an example, Wu Junhao[4] introduced the practice of energy group in financial risk management. Based on the monthly empirical results of principal component analysis, Zhang Keqin[5] studied the risk assessment and influencing factors of China 's energy financial market; through the analysis of energy finance related issues, Gao Xiaoxin[6] makes a prospect for the research in the field of energy finance; Wang Quanyu[7] constructs a financial risk management system with market volatility risk management, liquidity risk management and counterparty risk management as the core, and analyzes the factors that enhance the group 's ability to withstand market price volatility risk ; Pang Lu[8] through the financial investment risk and its causes are summarized, and put forward the corresponding countermeasures and suggestions to enhance the enterprise ' s ability to resist risks, so as to promote the sustainable and healthy development of enterprises.

Most of the previous articles are qualitative and quantitative research, and the research on risk transmission path needs to be further studied. This paper is characterized by data visualization. Based

on the construction of financial risk index system of small and medium-sized energy enterprises, this paper studies the financial risk path identification of small and medium-sized energy enterprises by collecting data, constructing and calculating and analyzing ISM-MICMAC model. This paper sorts out and visualizes some problems existing in energy financial risk and energy financial development at home and abroad, aiming to provide some references for the development of financial risk prevention and control of small and medium-sized energy enterprises.

2. Construction of Financial Risk Index System for Small and Medium Energy Enterprises

2.1. Internal financial risk

Corporate culture is the spiritual pillar of the survival of enterprises. Poor culture can easily lead to internal financial risks. Business leaders pay most attention to the operating income, easy to ignore other problems in the development of enterprises, resulting in business decision-making errors ; enterprise leaders lack awareness of internal control, daily work is still using the traditional system, prone to defects and loopholes, the lack of sound internal control and supervision mechanism ; there is also a lack of sufficient attention to corporate financial risk management, and the risk management system is not perfect ; enterprise safety management is not perfect, once the enterprise in the operation process of safety accidents, will bring irreparable losses to the enterprise ; the employee welfare system is not perfect, salary is an effective incentive means in human resource management, whether it is economic or non-economic compensation, can play an incentive role for employees ; there is a lack of internal communication mechanism in enterprises. If there are too many enterprise levels, communication distortion may occur, and personnel in various departments may also misunderstand the information transmitted.

2.2. External financial risks

There is a risk of financing enterprises, enterprises to raise funds from outside the enterprise financial uncertainty risk, such as exchange rate risk, financial leverage effect ; in addition, the enterprise ' s capital investment, income uncertainty is relatively strong, and then the investment risk, to bring losses to the enterprise ; there are liquidity risks in the enterprise, and the cash and assets of the enterprise cannot be fully transformed, so the enterprise cannot fulfill the corresponding cash payment responsibility and debt responsibility ;Enterprises may have legal risks, business managers or employees, the use of convenient duties, as well as financial management loopholes, corruption, bribery, or misappropriation of public funds, resulting in corporate financial deficits, inconsistent accounts and so on ; enterprises are prone to debt recovery and repayment risks, enterprises in the course of business due to unreasonable capital structure arrangements, debt recovery and other issues resulting in tight corporate funds, debt pressure risk ; risks from emergencies, the sudden outbreak of the new coronavirus and shutdowns have led to problems in market demand and labor cost control for many small and medium-sized enterprises, resulting in a significant reduction in revenue and profits.

To sum up, the financial risk impact index system of energy enterprises constructed in this paper is shown in Table 1:

Table 1. Financial risk impact index system of energy enterprises

Second grade indexes	Third grade indexes	Index description	Reference
Inner Indexes(II)	Weak corporate culture(II_1)	Enterprise culture is the spiritual pillar of enterprise existence and the inner soul of enterprise	**[9]**

	Business decision errors(II_2)	Enterprise leaders attach great importance to the operating income, easy to ignore other problems in enterprise development	**[10]**
	Lack of perfect internal control supervision mechanism(II_3)	Enterprise leaders lack awareness of their own internal control, daily work is still using the traditional system, prone to defects and loopholes	**[11]**
	Low level of risk management(II_4)	Lack of adequate attention to risk management	**[11]**
	Imperfect Enterprise Safety Management(II_5)	Safety management is very important for any enterprise. Once a safety accident occurs in the operation process, it will bring irreparable losses to the enterprise.	**[12]**
	The employee salary welfare system is not perfect(II_6)	Wage compensation is an effective incentive method in human resource management. Whether it is economic compensation or non-economic compensation, it can motivate employees.	**[13]**
	Lack of internal communication mechanism(II_7)	Communication distortions may occur if there are too many enterprise levels, and department personnel may also misunderstand the information being passed	**[14]**
External Indexes(OI)	Funding Risk(OI_1)	Enterprises to raise funds from outside the enterprise financial uncertainty risk, such as exchange rate risk, financial leverage effect	**[15]**
	Investment Risk(OI_2)	Enterprise funds in the investment, income uncertainty is relatively strong, and then the investment risk, to bring losses to the enterprise	**[15]**
	Liquidity Risk(OI_3)	Enterprise cash and assets can not be fully transformed, enterprises can not fulfill the corresponding cash responsibility and liability	**[15]**
	legal Risk(OI_4)	Enterprise managers or employees, the use of job convenience, as well as financial management loopholes in corruption and bribery, or misappropriation of public funds, resulting in corporate financial deficits, inconsistent accounts and so on.	**[16]**
	Debt Recovery And Repayment Risk(OI_5)	The risk of capital shortage and debt repayment pressure caused by unreasonable capital structure arrangement and debt recovery in the course of operation	**[17]**
	Event Risk(OI_6)	The sudden outbreak of the new coronavirus epidemic and shutdowns have led to problems in market demand and cost control of workers in many small and medium-sized enterprises, resulting in a significant reduction in income and profits	**[17]**

3. ISM Method

Interpretative Structural Modeling (ISM) was proposed by Professor Warfield in 1973 to analyze complex socio-economic activities. The basic idea of this method is to divide the complex system into several subsystem elements, and use computer technology to process the system elements on the basis of people 's knowledge and experience to construct a model with multi-level hierarchical structure. Through the correction and interpretation of the model, the level and structure of the system are clarified, so as to realize the hierarchical, organized and systematic understanding and analysis of multi-factor problems. It has a very wide range of applications, from international issues such as energy issues to regional economic development, enterprises and even personal issues. ISM steps are as follows:

STEP1: Determine the influencing factors.

The 13 grade 3 indexes in the table were taken as the research object, and each index was marked with the symbol.

STEP2: Determine the relationship between the factors.

The logical relationship between the influencing factors is given. ' 1 ' represents that there is a connection between the factors, and ' 0 ' represents that there is no connection between the factors.

STEP3: Create an adjacency matrix.

Adjacency matrix is a matrix arranged according to the logical relationship of adjacent elements. According to the survey results, the adjacency matrix A is established following the principle of minority obeying majority.

STEP4: Generate reachable matrix.

The reachability matrix is a matrix form that reflects the degree that can be reached between the elements through a certain path, which can be realized by Boolean algebraic rules. Based on the Boolean operation formula, the adjacency matrix is imported into MATLAB software and transformed into reachability matrix.

STEP5: Hierarchical division.

According to the reachable matrix, the antecedent set A (Si) and the reachable set R (Si) are determined. The antecedent set A (Si) refers to the set of elements reaching Si, and the reachable set R (Si) refers to the set of elements reaching Si. The common set C (Si) is obtained by R (Si) ∩ A (Si) = C (Si).

4. MICMAC Method

Matrix impacts cross-reference multiplication applied classification (MICMAC) is a variable proposed by DUPERRIN and GODET in 1973 to identify highly dynamic and highly dependent variables in the system.[18] It uses the reaction path and hierarchical cycle of factors in the system to study the diffusion of the relationship between factors. According to the reachability matrix, MICMAC is used to supplement the structural relationship between influencing factors. The sum of the values of the columns of the reachable matrix M is the dependence of the factors, and the sum of the rows is the driving force of the factors. The dependence and the driving force are used as the horizontal and vertical axes to establish a coordinate system, which is equally divided into four regions: autonomous factor region, dependent factor region, associated factor region and independent factor region. Using MICMAC to analyze the driving force and dependence of various influencing factors of financial risks of small and medium-sized energy enterprises is convenient to understand the substantive role of factors in the system, and can provide new solutions for small and medium-sized energy enterprises to deal with different problems in their development. MICMAC analysis steps are as follows:

STEP1: Calculate the driving force DRi and dependence DEj of each factor of the system, and then calculate the average value of driving force and dependence, which is used as the quadrant boundary.

STEP2: Second, calculate the driving force and dependence based on the reachability matrix and divide all factors into four quadrants of the driving force-dependence space.

5. Calculation and analysis

5.1. Data collection

In this paper, three experts are invited to score the influencing factors of the indicators. Among them, 1 represents the mutual influence between the indicators, and 0 indicates that there is no relationship. The initial adjacency matrix is obtained as shown in Table 2 :

Table 2. Adjacency Matrix

	II_1	II_2	II_3	II_4	II_5	II_6	II_7	OI	OI_2	OI_3	OI_4	OI_5	OI_6
II_1	0	0	0	0	0	0	1	0	0	0	0	0	0
II_2	0	0	0	1	0	0	0	0	1	0	0	0	0
II_3	0	0	0	1	0	1	0	0	0	0	0	0	0
II_4	0	0	0	0	0	0	0	0	1	0	0	0	0
II_5	0	0	0	0	0	0	0	1	0	0	0	0	1
II_6	1	0	0	0	0	0	0	0	0	0	0	0	0
II_7	0	1	0	0	0	0	0	0	0	0	0	0	0
OI_1	0	0	0	0	0	0	0	0	0	0	0	1	0
OI_2	0	0	0	0	0	0	0	0	0	0	0	1	0
OI_3	0	0	0	0	0	0	0	0	0	0	1	1	0
OI_4	1	0	0	0	0	0	0	0	0	1	0	0	0
OI_5	0	0	0	0	0	0	0	1	0	0	0	0	0
OI_6	0	1	0	0	0	0	0	0	0	0	0	1	0

5.2. ISM operation and analysis

Based on the expert scoring constructed in section 5.1, this paper calculates the reachable matrix based on SPSSAU software, which is shown in table 3. The hierarchical decomposition is shown in Table 4.

Table 3. Reachability Matrix

	Reachability Matrix												
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
C1	1	1	0	1	0	0	1	1	1	0	0	1	0
C2	0	1	0	1	0	0	0	1	1	0	0	1	0
C3	1	1	1	1	0	1	1	1	1	0	0	1	0
C4	0	0	0	1	0	0	0	1	1	0	0	1	0
C5	0	1	0	1	1	0	0	1	1	0	0	1	1
C6	1	1	0	1	0	1	1	1	1	0	0	1	0
C7	0	1	0	1	0	0	1	1	1	0	0	1	0
C8	0	0	0	0	0	0	0	1	0	0	0	1	0
C9	0	0	0	0	0	0	0	1	1	0	0	1	0
C10	0	0	0	0	0	0	0	1	0	1	1	1	0
C11	0	0	0	0	0	0	0	1	0	1	1	1	0
C12	0	0	0	0	0	0	0	1	0	0	0	1	0
C13	0	1	0	1	0	0	0	1	1	0	0	1	1

Table 4. Hierarchical Decomposition

Hierarchical Decomposition	
Level	Factor
Level 1(top level)	C8,C12
Level 2	C9,C10,C11
Level 3	C4
Level 4	C2
Level 5	C7,C13
Level 6	C1,C5
Level 7	C6
Level 8(bottom level)	C3

Finally, according to the hierarchical classification, the hierarchical directed graph is drawn as shown in Figure 1:

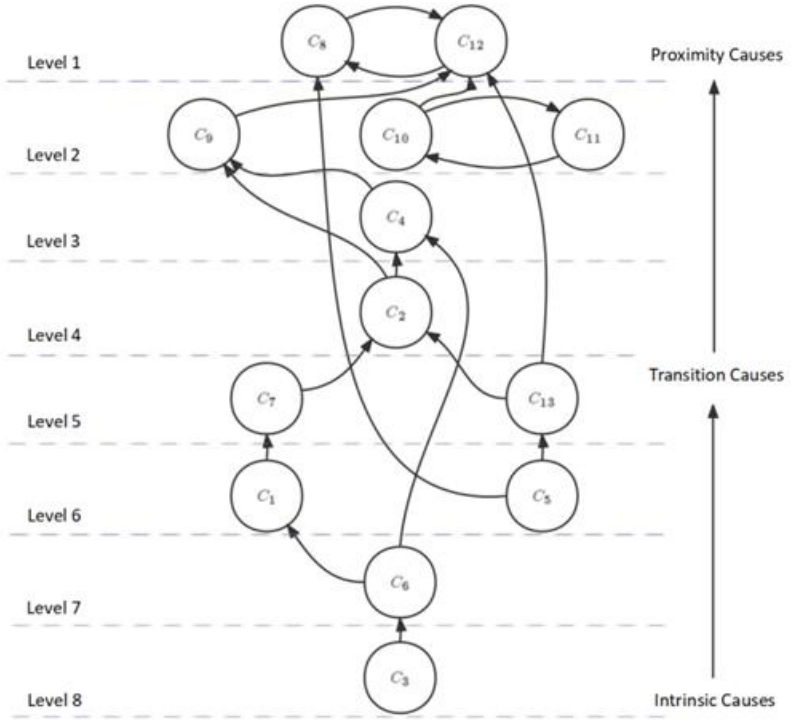

Figure 1. ISM level directed graph

According to Figure 1, the nearest neighbor cause is located in the first layer of the model, including C8 and C12, which are the direct causes of financial risks of small and medium-sized energy enterprises. The transition cause is located in the second to seventh layers of the model, including ten

cause factors of C9 C10 C11 C4 C2 C7 C13 C1 C5 C6. These ten factors play a role in connecting the relationship between essential cause and neighbor cause, and are indirect factors leading to financial risks. The essential cause is located in the eighth layer of the model, including C3, which is the macro manifestation of the cause factor. It can affect the neighboring cause factors by affecting the transitional cause factors.

5.3. MICMAC operation and analysis

Based on the ISM calculation results, based on the MICMAC Method in the fourth chapter, the driving force and dependence of each index are calculated according to the reachable matrix, and the Power Map is shown in Figure 2:

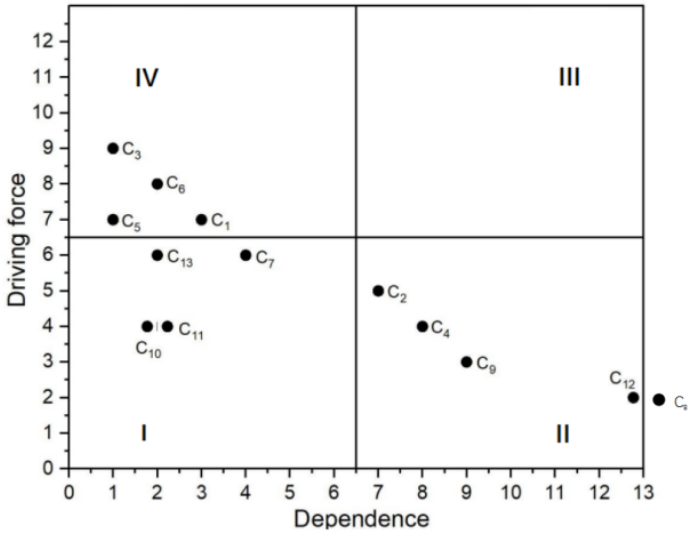

Figure 2. MICMAC result

It can be found from Figure 2 that the causative factors are divided into three categorie**s:** autonomous cluster factors, independent cluster factors and dependent cluster factors.

There are 4 causes of autonomous cluster (quadrant I), namely C10 C11 C13 C7. C7 belongs to internal factors, C10 C11 C13 belongs to external factors. It has lower driving force and lower dependence, but it plays a connecting role in the interaction between internal factors and external factors. Once the internal factors have problems, they will affect the external factors, which will greatly increase the possibility of financial risks. If the financial risk of the company is caused by the employees through illegal ways, it will further lead to the increase of investment risk and financing risk. The occurrence of emergencies will also bring indirect risks to the financing, investment and production of the enterprise. Therefore, the autonomous cluster factor is the cause of the first governance in the financial risk prevention and control of small and medium-sized energy enterprises.

2. There were 5 cause factors of dependent cluster (quadrant II), namely C2 C4 C8 C9 C12. C2 C4 is an internal factor, and C8 C9 C12 is an external factor. It has higher dependence and lower driving force. Among them, C12 and C8 are the two most dependent factors, which are the direct causes of financial risks in small and medium-sized energy enterprises. If there is a problem in the financing of enterprises, it is easy to have a financial crisis, which in turn causes a series of financial risks, and the debt repayment pressure of small and medium-sized energy enterprises is also easy to lead to financial tension.

3. There are 4 causes belonging to independent cluster (quadrant IV), namely C1 C3 C5 C6, which are all internal factors. It has a high driving force and low dependence. Among them, C3 is the most important cause factor of dependence motivation. It is located at the bottom of the ISM model and is a deep cause factor. It will lead to the occurrence of risk by affecting other cause factors. Therefore, the revitalization of corporate culture, improve the internal control and supervision mechanism, improve employee welfare system can curb financial risks from the root causes.

6. Conclusion

Through the establishment of Interpretative Structural Model (ISM) and Cross Influence Matrix Multiplication (MICMAC), this study combs the hierarchical relationship between various influencing factors and the internal mechanism of financial risk of small and medium-sized energy enterprises, and discusses the dependence and driving force of each influencing factor. The results show that The results show that the key driving factors of financial risks of small and medium-sized energy enterprises are weak corporate culture, economic decision-making mistakes, lack of perfect internal control and supervision mechanism, low level of risk management, imperfect enterprise safety management, imperfect employee salary and welfare system, lack of internal communication mechanism, financing risk, investment risk, liquidity risk, debt recovery and repayment risk and emergency risk. Besides, some advice were given below:

(1) Small and medium-sized energy enterprises should establish and improve the financial risk management mechanism.

The investment and financing activities of small and medium-sized enterprises in the process of legal exhibition should reduce the cost of investment to the greatest extent to ensure the smooth realization of the target. Through the establishment of a sound financial management mechanism, clear the future direction of investment, to ensure that enterprises can achieve more long-term development through investment.

(2) Small and medium-sized energy enterprises should improve the management level.

Improving the level of management is an important requirement and challenge for financial risk control of SMEs. In order to effectively reduce the financial experience of small and medium-sized enterprises, it is necessary to continuously improve the internal management mechanism and communication mechanism of enterprises, establish a sound employee welfare system, pay attention to the development of corporate culture, and improve the management level.

The research results are scientific and universal, and have certain application and guiding value for small and medium-sized energy enterprises to solve financial risks.

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