Research on the identification and prevention of supply chain finance risks based on ISM-MICMAC model

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Abstract. Supply chain finance is an important means to address the shortage of funds for small and medium-sized enterprises (SMEs). In recent years, the global outbreak of the Covid-19 epidemic has exacerbated the financing challenges of SMEs, and the importance of supply chain finance to the real economy has become increasingly evident, but at the same time, supply chain finance has also exposed many risks. This paper identifies 21 risk factors in supply chain finance, determines the hierarchical relationship of the risk factors by constructing an explanatory structural model (ISM), and then applies the cross-influence matrix multiplication method (MICMAC) to calculate the dependency and driving force magnitude of the 21 risk factors. The conclusions are as follows: natural environmental risks (S_5), the hidden risk of core enterprise management (S_{12}) are deep-rooted supply chain finance risks and have strong driving forces. Inadequate corporate solvency (S_6), inadequate corporate profitability (S_7) Inadequate corporate operating capacity (S_8) Inadequate growth capability of enterprises (S_9), inadequate credit guarantee capacity of core enterprises (S_{11}), low level of creditworthiness of SMEs (S_{13}) is a direct influence on the risk of supply chain finance, which is more influenced by intermediate factors and has a strong dependency. This result will provide scientific decision-making basis for supply chain financial risk management, saving more time and cost.

Keywords: supply chain finance, risk management, ISM, MICMAC.

1. Introduction

With the globalization of trade, competition has gradually changed from traditional intra-enterprise competition to supply chain competition. Therefore, for enterprises in the middle and upper reaches of the supply chain, especially SMEs, the use of supply chain financing is extremely important for themselves and even the whole supply chain. In recent years, countries have been encouraging the development of supply chain finance to broaden the financing channels for SMEs. However, since the global outbreak of the new crown epidemic in 2020, the integrated trade economy has been severely hit, and SMEs need large amounts of capital to resume production and business activities, which has stimulated the boom of supply chain finance and increased the uncertainty of the supply chain. In other words, the more developed the supply chain economy is, the longer the supply chain is, and the higher the incidence of potential risks. In other words, the more developed the supply chain economy is, the longer the supply chain is, and the higher the incidence of potential risks.

In the area of risk identification and rating in supply chain finance, Chinese scholars have also conducted empirical studies through various research methods in the past decade. Li[3] discarded the traditional risk rating method of "main body rating as the basis and debt rating as a supplement" and introduced the "main body plus bond, with emphasis on bond" rating principle. Li [3] abandoned the traditional risk rating method of "main body rating and bond rating" and introduced the rating principle of "main body plus bond, and focus on bond". For example, Fu[4] used complex system theory and symbiosis theory to construct a topology and symbiosis model of the supply chain finance network led by core enterprises based on the analysis of various supply chain finance models and their risk characteristics, and systematically presented the mechanism of risk occurrence in supply chain finance. In addition, research methods of artificial intelligence have also been introduced into

the study of supply chain finance risk. Qian & Zhang [5] used a dynamic variational particle swarm algorithm (DPSO) and the AdaBoost algorithm to collaboratively optimize and integrate a support vector machine (SVM) based on the collection of supply chain finance credit risk evaluation indicators, the AdaBoost-DPSO- SVM model, which is later applied to supply chain finance in the field of new energy vehicles in China for empirical research and proved to have better classification and identification performance, optimizing the current credit evaluation method.

Despite the breakthroughs in research methods, most of the research on supply chain finance at this stage focuses on risk identification and risk evaluation, and the system of supply chain risk indicators to cope with the development of financial innovation has still not been established and perfected, nor has it been able to conduct systematic and quantitative analysis of the various influencing factors. There is a hierarchical relationship between many risk factors. Only by using effective research methods to analyze the hierarchical structure of them, dig out the most important risk factors and shorten the risk propagation path, can supply chain risk prevention be most effectively achieved.

To this end, based on the analysis of existing literature, this paper systematically analyses the sources of supply chain finance risks, and uses the ISM-MICMAC model to analyze the relationship between the influencing factors of supply chain finance, establishes an objective multi-layer step structure model of supply chain finance, identifies the interrelationship of individual risk factors from the multi-dimensional complex factors, identifies the major and minor risks, and finally decomposes the complex system into This provides a new way of thinking for the study of supply chain finance risk traceability and, to a certain extent, improves the relevance and effectiveness of supply chain finance risk prevention measures.

2. Supply chain finance risk impact factor identification

There are more existing studies on the identification of supply chain risk factors, and the early systematic risk classification can be traced back to Liu [6] who argued that supply chain finance mainly has potential risks such as credit risk, market risk, operational and operational risk, and legal risk. li [3], in his study on the risk assessment of supply chain finance, divided the complex financial risks into systemic and non-systemic risks, with systemic risks including macroeconomic, industry sector, and the risk of the construction of the supply chain itself, while non-systematic risks involve various factors such as corporate credit, finance, and specific operations during the implementation of the business. In this paper, based on summarizing the past research literature and combining the current stage of the development of supply chain finance, the risk factors that meet the research requirements and have representative characteristics are compiled.

2.1 Macro systemic risk

Macro systemic risk, i.e. exogenous risk in supply chain finance. Macro-systemic risk covers a wide range of aspects and has a wide impact, involving many aspects of supply chain finance, and posing a huge challenge to the enterprises in the chain, especially the small and medium-sized enterprises, in terms of risk prevention. The macro-level uncontrollable factors are complex and diverse, such as fluctuations in bank interest rates or market prices due to an unstable economic environment, loopholes in the system due to imperfect laws and regulations, or vicious competition caused by the lack of stable cooperation relationships within the industry due to the lack of development. Also, natural disasters such as earthquakes, floods, and plagues can affect the stability of the entire supply chain and cause huge losses to enterprises, especially those concerning agriculture [7]. With the innovative development of financial technology, some enterprises have imperfect mastery of financial science and technology, resulting in the inability to take timely measures to close technical loopholes and security risks, which objectively also brings technical security risks to supply chain finance

2.2 Financial risks

Each node of the supply chain involves the exchange and operation of financial flows, and changes in the financial position of individual enterprises can pass on financial risk to other enterprises in the supply chain along with the supply chain. The financial risk of an enterprise is mainly measured from the perspective of the traditional analysis of the financial ratios of the enterprise. Financial indicators visually reflect the solvency, profitability, operating capacity, and growth capacity of an enterprise and are better comparable. Solvency is the ability of one enterprise to meet its obligations, and is measured by indicators such as current ratio and leverage ratio; operating capacity is mainly reflected by an enterprise's ability to fund itself and conduct business and is measured by indicators such as ROA and capital turnover ratio. Profitability is the ability of an enterprise to increase earnings for investors over a certain period and is measured by indicators such as sales margin and ROE. Growth capacity is a forecast of the prospects of the business and the industry and is measured by indicators such as sales revenue growth rate and profit growth rate. Performance below industry standard levels is likely to have an impact on the overall stability of supply chain finance and should be of concern to business managers.

2.3 Credit risk

The credit risk of supply chain finance is more complex. Due to factors such as information asymmetry and risk transfer, the level of credit of enterprises directly affects the safety and efficiency of capital operation in the supply chain. The examination of the credit risk of supply chain finance is mainly divided into the examination of core enterprises, and small and medium-sized enterprises. The most basic of these is the credit level of the small and medium-sized enterprises in the chain, i.e. transaction performance, and loan repayment. Zhao & Jiang [8] pointed out the existence of ' moral hazard ' of core enterprises, which means enterprises use information asymmetry to hide business information, resulting in losses to banks and other information disadvantaged parties, or use industry status to spread false information, which has a negative impact on the supply chain. Wang [2] adds an examination of the creditworthiness of SME managers. The operation and development of SMEs are more dependent on the quality and creditworthiness of their managers than core enterprises with well-established management systems.

2.4 Operational risk

Under the background of financial innovation, the supply chain finance business covers all aspects of the supply chain system, with a wide range of participating subjects and a more cumbersome operation process, which can easily lead to a series of risks due to improper operation in all aspects. For example, in the early stage of business, enterprises do not have the proper training for employees, their knowledge reserves and business capabilities are not up to standard, or enterprises adopt inappropriate business models, lack strict regulation of business processes, and unclear supervision rights and responsibilities. Logistics enterprises are the coordinators of the various parties involved in supply chain finance and play the role of supervision of the goods deposit [9]. If logistics enterprises lack advanced equipment or supervision levels to match the industry, they will not be able to respond quickly to changes in the development of the supply chain and will pose a risk to the interface of the various links in the supply chain.

2.5 Information risk

The efficiency of supply chain finance depends to a great extent on the efficiency of information flow. The information risk of supply chain finance is mainly manifested in the obstruction of information sharing among the main actors in the supply chain and the security risks of intellectual property rights. The failure of core enterprises to build a smooth information sharing platform, the lack of transparency in each link of the supply chain, or the deliberate use of the supply chain by enterprises to disseminate false and poor quality information in pursuit of their interests will affect the transmission and communication of information, resulting in a lack of reliability, integrity, and

authenticity of the information. At the same time, the dramatic increase in the amount of information in the supply chain also enhances the risk of data loss and information leakage, which cannot guarantee the security of information and will easily attribute to intellectual property security risks [10].

2.6 Pledge risk

Pledge risk refers mainly to the negative impact of market fluctuations, difficulty in preservation, sales risk, and other factors on the value of inventory. Inventory pledge loans are one of the common models in supply chain finance where a certain period is stipulated for the borrower to close out its position. During this period, the price and liquidity of the inventory will change in line with market prices and liquidity. If market prices are volatile and market liquidity is poor, the value of the inventory can seriously decline [11]. The perishability of inventory varies, and the value of inventory will also be diminished by the inability of the supervising company to match the various commodities with advanced preservation facilities for long-term storage. In addition, the level of sales and realization of pledged goods are subject to uncertainties such as sales channels and customer loyalty market capacity.

In summary, the indicator system of influencing factors constructed in this paper is shown in Table 1.

Table1 Sources and basis of risk factors

Categories of risk	Risk factors	Descriptive definitions	Reference
Macro-systemic risk	Market fluctuations S_1	The unstable economic environment with fluctuating bank rates and market prices	[6]
	Legal loopholes S_2	Inadequacy of laws and regulations	[6]
	Industry risks S_3	Underdeveloped industry, unstable partnerships, and unhealthy competition in the industry	[6]
	Technical safety hazards S_4	Companies have an imperfect grasp of financial science and technology and are unable to take timely measures to close technology gaps and security risks	[10]
	Natural environmental risks S_5	Disruptions to a part of the supply chain caused by natural disasters, war, and other irresistible causes	[7]
Financial risk	Inadequate solvency S_6	The company's current ratio, quick ratio, and leverage ratios are below industry standards	[12]
	Inadequate profitability S_7	Corporate sales margins, ROE below industry standards	[12]
	Inadequate capacity of operating S_8	Lack of capital self-sufficiency, ROA, asset turnover, and business growth rate below industry standards	[12]
	Inadequate capacity for growth S_9	Inadequate new product development capability, with sales revenue growth rate, net profit growth rate, and total asset growth rate below industry standards	[12]
Credit risk	The moral hazard of core enterpriseS_{10}	Core companies use their position in the industry to spread false information	[8]

	Inadequate credit guarantee of core enterprise S_{11}	Low credit rating of core enterprises in the bank, inadequate supply chain credit guarantee capacity, and the tendency to accumulate liabilities beyond their risk tolerance	[10]
	Misgovern of core enterprise S_{12}	Core business managers have a poor history of management performance and low levels of personal creditworthiness	[2]
	Low level of creditworthiness among SMEs S_{13}	High level of default by SMEs in terms of transaction performance, loan repayment, and lack of truthfulness of information	[10]
Operational risk	Poor quality of staff S_{14}	Inadequate pre-training and inspection of enterprises, the inadequate knowledge base of staff, and substandard business skills resulting in operational errors	[10]
	Poorly regulated processes S_{15}	Improper business model and lack of strict regulation of document transfer or notification processes and operations during business completion	[10]
	Malfeasance of logistics enterprise S_{16}	Lack of professional skills, the strength of liquidated damages, and willingness to cooperate by logistics companies	[9]
Information risk	Information sharing obstacles S_{17}	The information transfer platform of core enterprises is lagging, enterprises withhold or misreport information in pursuit of their own interests, information lacks strong penetration and information transfer is inefficient	[10]
	Intellectual property security risks S_{18}	The security of shared information is not guaranteed and there is a risk of loss and leakage of important information	[10]
Pledge risk	Price fluctuations of pledges S_{19}	The longer the inventory is held, the more significant the impact of market price fluctuations it receives	[3]
	Deterioration of the pledge S_{20}	The perishability of inventories varies, and core businesses are sometimes unable to equip themselves with advanced equipment and technology to preserve inventories for long periods	[3]
	Sales fluctuation of pledges S_{21}	Inventory sales are heavily influenced by channel stability, customer loyalty, and market volume	[3]

3. ISM model

3.1 ISM fundamentals

The Interpretative Structural Modeling Method (ISM) is a systems engineering research method created by Professor Warfelt in 1973 to study the structural relationships of systems for the analysis of complex socio-economic system problems. The logical relationships between the elements of a complex system are described by logical operations on the adjacency matrix of the directed graph, and the reachable matrix is obtained by decomposing it so that the complex system problem is reduced

to a well-organized multi-layer recursive form. [13] The conceptual framework of ISM model of supply chain finance risks is shown in Figure1 below.

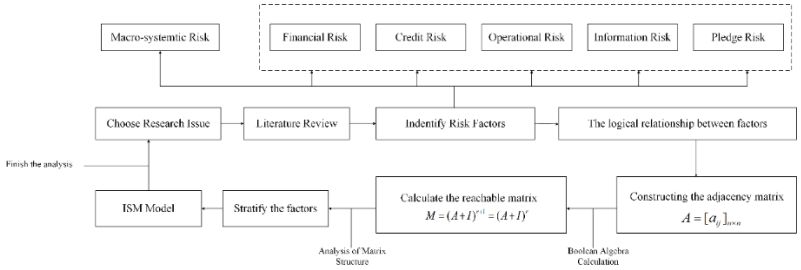

Figure1. Conceptual framework of ISM model

3.2 ISM modeling of influencing factors

Step1:Constructing the adjacency matrix

An adjacency matrix is a matrix that represents the state of the connections between elements of a directed connectivity graph. The values of the elements in the connection matrix can only be 0 and 1. When an element influences an element it is taken as 1 and when it has no influence it is taken as 0. Such a directed binary relationship can be represented by the adjacency matrix. $A=[a_{ij}]_{n\times n}$

$$a_{ij}=\begin{cases}1, & i\ is\ related\ to\ j\\ 0, & i\ is\ related\ to\ j\end{cases} \tag{1}$$

Through the study of each risk factor in supply chain finance practice on the efficiency of supply chain operation, combined with the previous literature on the subject, the logical relationship between the risk factors can be identified and the logical relationship between the elements is organized into a 21st order adjacency matrix as follows.

$$A=\begin{bmatrix}
0&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&1&0\\
0&0&1&0&0&0&0&0&0&0&0&0&1&0&1&0&0&1&0&0&0\\
0&0&0&0&0&0&0&0&0&1&0&0&0&1&0&1&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&1&0&0&0&0&0&1&0&1&1&0&0\\
1&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&1&1\\
0&0&0&0&0&0&0&1&1&1&0&1&0&1&0&0&0&0&0&0&0\\
0&0&0&0&0&0&1&0&0&1&0&1&0&1&0&0&0&0&0&0&0\\
0&0&0&0&0&0&1&1&0&1&0&1&0&1&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0&0&0&0&0\\
0&0&0&0&0&0&0&0&0&1&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&0&0&0&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
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0&0&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&0&0&0
\end{bmatrix} \tag{2}$$

Step2:Constructing the reachable matrix

The reachability matrix describes in matrix form the extent to which factors within a system that are intrinsically linked can be reached by various pathways between them. The adjacency matrix A is subjected to Boolean iterations with the unit matrix I until the following equation holds.

$$(A+I)^{r+1}=(A+I)^r\neq(A+I)^{r-1}\ldots\neq(A+I) \tag{3}$$

Then the matrix is called the reachable matrix, where the number r is determined according to the number of iterative algorithms. This paper uses MATLAB software to calculate the reachable matrix *M*.

$$M=\begin{bmatrix}
1&0&1&0&0&1&1&1&1&0&1&0&1&0&1&0&0&0&1&1&0\\
0&1&1&0&0&1&1&1&1&0&1&0&1&0&1&0&0&1&0&0&0\\
0&0&1&0&0&1&1&1&1&0&1&0&1&0&1&0&0&0&0&0&0\\
0&0&0&1&0&1&1&1&1&0&1&0&1&0&1&0&1&1&0&0&0\\
1&0&1&0&1&1&1&1&1&0&1&0&1&0&1&0&0&0&1&1&1\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&1&0&0&1&1&1&1&1&1&0&1&0&1&0&1&1&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&1&0&0&1&1&1&1&1&1&1&1&0&1&0&1&1&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&0\\
0&0&0&1&0&1&1&1&1&0&1&0&1&1&1&0&1&1&0&0&0\\
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0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&1&0&0&0&1&0\\
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0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&1&0&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&1&0\\
0&0&0&0&0&1&1&1&1&0&1&0&1&0&0&0&0&0&0&0&1
\end{bmatrix} \tag{4}$$

Step3: Partitions of level

Based on the reachable matrix *M*, the reachable set $R(S_i)$, the prior set $Q(S_i)$ and the common set $C(S_i)=R(S_i)\cap Q(S_i)$ are solved for each risk factor, where the reachable set $R(S_i)$ is the set of all the column factors corresponding to matrix element 1 for each row of the reachable matrixSi, and the prior set $Q(S_i)$ is the set of all the row factors corresponding to matrix element 1 for each column of the reachable matrix S_i, consisting of the factor itself and the other factors that may reach it. The result is given in the following table. Table2 shows the factors of reachable sets, prior sets and common sets

When $L_1=C(S_i)=P(S_i)$, S_i is the factor of the first level Then the corresponding rows and columns are crossed out and the operation is repeated until all factors are divided. The hierarchical ranking of the factors is $L_1,L_2,L_3,\ldots,L_t$ (t indicates the highest number of levels), where L_t indicates the highest level. This paper continues with the MATLAB operation based on the reachable matrix *M* calculated by Step2.

Table2 Table of Factor Reachable Sets, Prior Sets and Common Sets

	Accessible set R(Si)	Advance Set Q (Si)	Common set C(Si)
S_1	1,6,7,8,9,11,13,15,19,20	1,5	1
S_2	2,3,6,7,8,9,11,13,15,18	2	2
S_3	3,6,7,8,9,11,13,15	1,2,3,5,10,12	3
S_4	4,6,7,8,9,11,13,15,17,18	4,14	4
S_5	1,3,5,6,7,8,9,11,13,15,19,20,21	5	5
S_6	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_7	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_8	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_9	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_{10}	3,6,7,8,9,10,11,13,15,17,18	10,12	10
S_{11}	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_{12}	3,6,7,8,9,10,11,12,13,15,17,18	12	12
S_{13}	6,7,8,9,11,13	1-16,19,20,21	6,7,8,9,11,13
S_{14}	4,6,7,8,9,11,13,14,15,17,18	14	14

S_{15}	6,7,8,9,11,13,15	1,2,3,4,5,10,12,14,15	15
S_{16}	6,7,8,9,11,13,16,20	16	16
S_{17}	17,18	4.10.12.14.17	17
S_{18}	18	2,4,10,12,14,17,18	18
S_{19}	6,7,8,9,11,13,19	1,5,19	19
S_{20}	6,7,8,9,11,13,20	1,5,16,20	20
S_{21}	6,7,8,9,11,13,21	5,21	21

Step4: Formation of ISM-based model

From the results obtained in Step4, the risk factors are ranked from the top level to the bottom level, and the logical relationships between the factors are visualized with arrow lines, by drawing the ladder structure model and performing model analysis. Figure2 shows the ISM model of supply chain finance risk after steps of calculation.

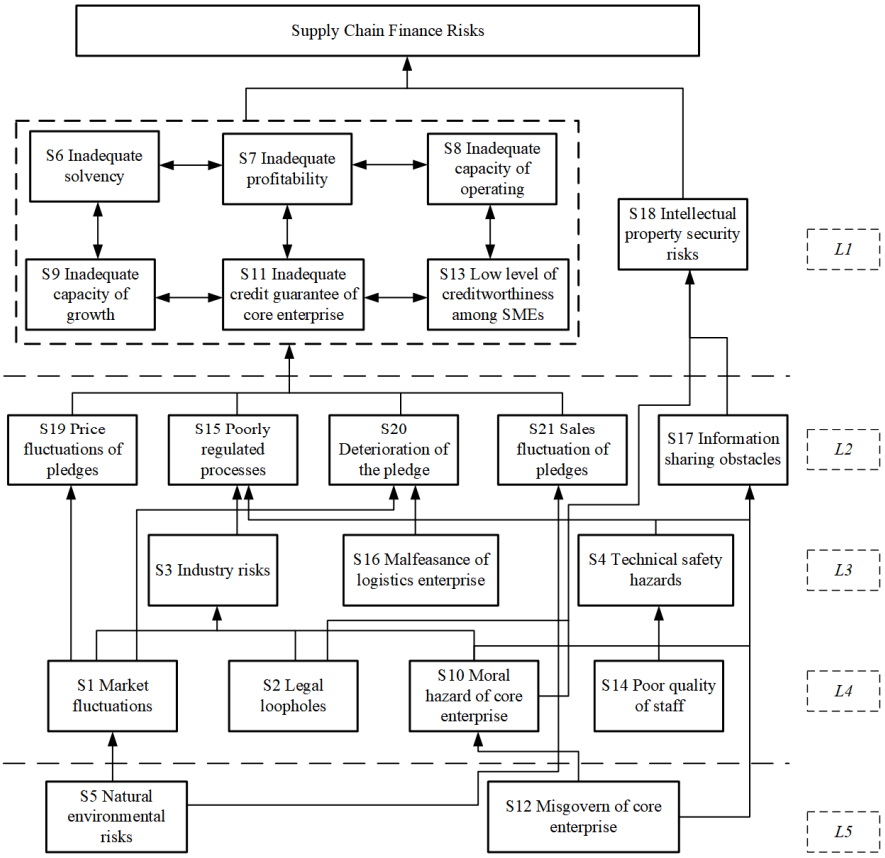

Figure2. ISM l model of supply chain finance risk

3.3 Formation of ISM-based model

By constructing the ISM model, we can more clearly identify the levels of each factor.

(1) Risk factors located at the bottom include natural environmental risks (S_5), misgoverning the core enterprise (S_{12}), which are fundamentally deep for the robustness of supply chain finance, or indirectly affect the rest of the factors. The enterprises often ignore the problems of S_{12} in the operation. The main body of corporate governance is the staff, and the creditworthiness and management ability of managers will be reflected in the various processes of corporate business, indirectly affecting the development direction of the enterprise. Promoting the innovation of managerial assessment methods and effectively improving the level of supervision of management

can solve some of the hidden risks of supply chain finance at the root. In addition, although all parts of the supply chain are involved in natural environmental risks, enterprises can, to a certain extent, mitigate the losses of intermediate links in distress and enhance the risk resistance of the whole supply chain by increasing the investment in hazard prevention based on the summation of industry experience.

(2) There are 12 risk factors in the intermediate level ($L_2 \sim L_4$), including market fluctuations (S_1), legal loopholes (S_2), industry risk (S_3) and technical security risks (S_4) in the macro-systemic risk dimension, the moral hazard of core enterprises (S_{10}) in the credit risk dimension, poor staff quality (S_{14}), poor process standardization (S_{15}) and malfeasance logistics (S_{16}) in the operational risk dimension, information sharing obstacles (S_{17}) in the information risk dimension, price fluctuations of pledged goods (S_{19}), deterioration of pledged goods (S_{20}) and Sales fluctuation of pledged goods (S_{21}) in the pledge risk dimension. These risk factors are indirect influences that cascade the effects of the underlying influences upwards to the top influences. The industry risk factors (S_3) are the more important systemic nodes and are driven by lower-level market fluctuations (S_1), systemic loopholes (S_2) and core corporate moral hazard (S_{10}), which in turn directly influence the top-level factors, while poor employee quality (S_{14}) and logistics corporate malfeasance (S_{16}) are relatively independent influences that are not influenced by the bottom-level factors.

(3) Factors located at the top include inadequate solvency (S_6), inadequate profitability (S_7), inadequate operating capacity (S_8) and inadequate growth capacity (S_9) in the financial risk dimension, and credit risk dimension including the credit guarantee capacity of core enterprises (S_{11}), low creditworthiness of SMEs (S_{13}) and the security risks of intellectual property rights (S_{18}) in the information risk dimension, which are fundamental factors and are directly fundamental factors that directly affect the level of robustness of supply chain finance. Except for IP security risks, which have (S_{18}) a relatively independent path of impact propagation, the remaining fundamental factors interact with each other in a complex manner. Financial risk is often the most direct cause of a shortage of funds in a particular part of the supply chain, resulting in a break in the chain; while credit crises can propagate along the supply chain, leading to a collapse of the whole chain of supply chain finance

4. MICMAC METHOD

4.1 MICMAC fundamentals

Based on the ISM model to determine the hierarchy of each risk factor in supply chain finance, the MICMAC method can be used to analyze the drivers and dependencies of each factor, to clarify the position and role of each factor in the system.MICMAC is a method proposed by Duperrin and Godet to analyze the interrelationships and interactions between factors in a system and is commonly used to identify variables with high dynamics and high dependence. [4]

4.2 MICMAC model constructing

Step1: Dependencies are represented by horizontal coordinates and drivers are represented by vertical coordinates.

Step2: The driver of the factor can be obtained by counting the number of influencing factors with matrix element 1 in the *ith* row of the matrix where the influencing factor S_i *is located, i.*e. the driver.

$$D_i = \sum f_i \tag{5}$$

Step3: The dependence of the factors can be obtained by counting the number of influencing factors with matrix element 1 in the *jth* column of the matrix where the influencing factor S_i is located, i.e. dependence.

$$R_j = \sum f_j \tag{6}$$

Step4: The greater the driving force, the greater the degree of influence of the influence on other factors; the greater the dependency, the greater the dependency of the influence on other influences. Results of driving force and dependency statistics. In general, by addressing risk factors with high drivers, a large number of other risk factors can be addressed together, which are often referred to as critical factors, while addressing risk factors with high dependencies requires a large number of other risk factors to be addressed first.

According to the magnitude of the driving force and dependency of the risk factors they can be divided into four categories: I autonomous elements, II dependent elements, III linked elements, and IV independent elements, which correspond to the four quadrants of the coordinate axis respectively. Based on the magnitude of the driving force and dependency of each risk factor calculated by the reachable matrix *M* and using the average value of the driving force and dependency as the dividing line, the MICMAC analysis of the risk influencing factors of supply chain finance is shown in the Figure3.

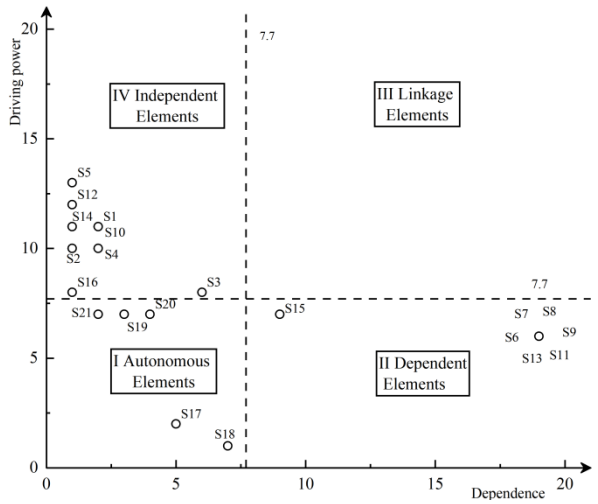

Figure3. MICMAC Analysis of Supply Chain Finance Risk

4.3 MICMAC analysis of risk factors

(1) Autonomy Cluster Influencing Factors. The risk factors in the quadrant I have in common are low drivers and low dependencies. The factors in this quadrant are information-sharing barriers (S_{17}), IP security risks (S_{18}), price volatility of pledged goods (S_{19}), deterioration of pledged goods (S_{20}), and Sales fluctuation of pledged goods (S_{21}). Of these, the security risk of intellectual property (S_{18}) is a direct factor and has no impact on the other factors; all other factors are indirect. It can be seen that the risks in the information and pledge dimensions are independent of the system. In addressing the risks in the supply chain finance system, all parties involved in the supply chain should additionally build a good information-sharing platform to improve the efficiency of information transfer and prevent the loss and leakage of important data, as well as optimize the enterprise treasury system and focus on the construction of supporting facilities to prevent losses caused by fluctuations in the value of pledges.

(2) Dependency Cluster Influencing Factors. The risk factors in quadrant II have in common lower drivers and higher dependencies. Factors that fall into this quadrant include inadequate solvency (S_6), inadequate e profitability (S_7), inadequate operating capacity (S_8), inadequate growth capacity(S_9), inadequate credit guarantee of core corporate (S_{11}), low SME creditworthiness (S_{13}), and poor process discipline (S_{15}). Such factors are often dependent on other issues being addressed. For example, industry-set business process norms and regulatory rules and regulations can restrain companies from breaking the law and improve the standardization of supply chain finance processes. The creditworthiness of both core enterprises and SMEs and the capabilities of enterprises in the financial dimension are interdependent and interrelated. When all the financial capabilities of an enterprise are higher than the industry standard level, the credit guarantee ability of the enterprise will

be enhanced accordingly; while an enterprise with a low credit level will be restricted in many aspects of various business activities such as financing, production and sales, and its debt servicing, profitability, operation, and growth ability will inevitably be reduced.

(3) Linking Cluster Influencing Factors. The risk factors in quadrant III have in common a high degree of drive and a high degree of dependency, but they are unstable, interact with each other, and tend to backfire on themselves. None of the factors selected in this case fall into this category, suggesting that the factors are relatively stable.

(4) Independent Cluster Impact Factors. The common denominator of quadrant IV factors is a higher driving force and lower dependency on market risk (S_1), legal loopholes (S_2), industry risk (S_3), technical safety hazards (S_4), natural environment risk (S_5), core enterprise moral risk (S_{10}), misgovern a core enterprise (S_{12}), poor staff quality (S_{14}) and malfeasance logistics enterprise (S_{16}). These factors are mostly macro-environmental risk factors, which require enterprises to make early risk forecasts and formulate risk management objectives and contingency strategies according to the structure and environment of the supply chain. Another part of the factors is related to the "people" themselves. Companies should invest more in staff training and improve the monitoring and evaluation system for management and employees. If these issues are given high priority, their resolution will mitigate the negative impact of other risk factors on the entire supply chain system.

5. Conclusions and Insights

Based on the literature research, this paper selects 21 risk factors in 6 dimensions that affect the security of supply chain finance, establishes a hierarchical model of risk factors and the driving forces and dependencies of each influencing factor through the ISM model and MICMA method, and explores the association mechanism of supply chain finance risk factors. The results of the study show that.

(1) Natural environmental risks (S_5) and misgoverning core enterprises (S_{12}) are deep-rooted supply chain finance risks and have strong driving forces. However, in reality, these two types of factors are often overlooked in the business process as they are difficult to be quantified. In the author's view, despite the practical difficulties in predicting and avoiding risks in the natural environment, enterprises can largely mitigate losses from environmental risks if they combine their industry experience, identify risks as early as possible according to the structure and environment of the supply chain, anticipate risk outcomes, and set risk management targets and performance measures. Secondly, enterprises, especially core enterprises, can also effectively improve the overall quality of their management by improving their management's assessment methods and supervision system.

(2) Inadequate solvency (S_6), inadequate profitability (S_7), inadequate operational capacity (S_8), inadequate growth capacity (S_9), inadequate credit guarantee of core enterprises (S_{11}), and low creditworthiness of SMEs (S_{13}) are the direct influencing factors of supply chain finance risks, which are influenced by intermediate factors and have a strong dependency on, and the factors are interlinked and affect each other. Although financial capability and creditworthiness are the most direct measures of supply chain finance participants and the most direct factors affecting the safety of supply chain finance, it is important to identify the deeper influencing factors behind these types of factors to address the risk nodes at a lower cost upstream if we want to resolve the major risks facing supply chain finance.

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