Big Data Analysis and Calculation of Capital Chain Break Risk Intelligent Path Identification Based on FISM Model

Junting Dong [1], Canwei Yang [2], Lanqi Yu [3,*]

[1] School of Economics and Management, China University of Petroleum, Beijing, 102249, Beijing, China

[2] College of Mathematical Sciences, South China Normal University, 510631, Guangdong, China

[3] Law School, Jiangxi University of Science and Technology, 341000, Jiangxi, China

* Corresponding Author Email: yulanqi1113@163.com

Abstract. TIn the fierce market competition, small and medium-sized enterprises are frequently caught in financial difficulties or even bankruptcy due to capital chain rupture. Identifying and analysing the risk path of capital chain rupture and improving the operation and management of enterprise capital chains has become an urgent theoretical and practical problem. Based on the theoretical analysis of the causes of capital chain fracture, this paper puts forward 17 indicators to identify the possibility of capital chain fracture and scores the correlation degree to establish the fuzzy adjacency matrix of each indicator, and construct the FISM model to analyse it and finally draw a multi-level hierarchical directed graph. A complex system with a six-level hierarchical structure is obtained, and the relationship between the influencing factors of capital chain fracture in the financing, investment, capital management, operation management and capital recovery is obtained. Based on this, the risk path of enterprise capital chain fracture is identified and analysed. Finally, through the research and analysis of the capital chain rupture, the potential influencing factors are explored to achieve a virtuous cycle of the capital chain so that enterprises can survive and develop in an increasingly competitive market.

Keywords: FISM model, capital chain rupture, risk path, business operation.

1. Introduction

The capital chain is the basic circulation chain needed to maintain the normal production and operation of enterprises. To a certain extent, the rupture of the capital chain reflects the partial fission of enterprise management, which negatively impacts enterprise management activities. Therefore, to prevent enterprise capital chain rupture, identifying and studying the risk path of capital chain rupture, improving the management of enterprise capital chain operation process has important significance.

At present, the domestic and foreign academic circles on the enterprise capital chain fracture theory and related research are few, for its risk path view is also very profound. Yi [1] studied and analysed how internal and external indicators affect the capital chain rupture of enterprises by using the system dynamics method; Gao [2] analysed the capital chain rupture and its causes, main manifestations and serious harm to SMEs; Kuang [3] proposed that cash is the basic component of the capital chain, and analysed the data with the help of relevant financial data and indicators to obtain the internal and external causes of the capital chain risk; Zhao Hongwei [4] analyses the financial data of enterprises and makes a theoretical analysis of the rupture of enterprise capital chain from the social influence and main characteristic factors, and finds that the rupture of enterprise capital chain is related to financial accounting risks.

Most scholars have done this research before. The research focuses on the financial risk and management of capital chain rupture, and the research is in-depth. Based on previous research experience, this paper chooses to analyse the risk path of capital chain rupture systematically. Based on the FISM model, this paper studies and analyses enterprise capital chain fracture risk path. By analysing much literature and data, some indicators affecting the capital chain fracture are selected according to different processes. Experts are invited to score the correlation degree of the indicators to establish the fuzzy adjacency matrix of each indicator, construct the FISM model to analyse it and

finally draw a multi-level hierarchical directed graph to obtain the important relationship and degree between the influencing factors of capital chain fracture, and accordingly identify and analyse the risk path of enterprise capital chain fracture.

The capital chain is related to the healthy survival and sustainable development of enterprises and economic and social development stability. However, there are many reasons for breaking the enterprise capital chain, and risk identification are

systematic and dynamic. Therefore, we need to analyse the potential risks of the capital chain in a timely and objective manner and systematically sort out and identify the risk path of the capital chain break. On this basis, enterprises can better establish a capital chain management model compatible with the enterprise. Through the research and analysis of capital chain rupture, we can explore its potential influencing factors and realise the sustainable virtuous cycle and turnover of funds to survive and develop in the increasingly competitive market.

2. Analysis of factors affecting financial capital chain rupture

2.1. Financial capital chain rupture (S0)

Enterprise capital chain rupture is inevitable. To maintain a virtuous cycle of the entire business process, the source and use of funds must match the amount and duration. When the use of resources in a certain link exceeds its source, that is, the demand for funds exceeds the supply, resulting in a fund gap. At this point, it is likely to cause the risk of fracture of the whole capital chain.

2.2. Risk analysis of capital chain in the financing process

2.2.1 Single financing channel (S_1)

Most enterprises, mainly through commercial banks or other non-bank financial institutions, are indirect financing. Once the country implements a tight monetary policy, obtaining funds for enterprises increases, financing difficulties easily lead to capital chain rupture [5].

2.2.2 Unreasonable financing structure (S_2)

Unreasonable source of funds, easy to cause the enterprise capital cost burden and capital repayment time limit conflict, increase the enterprise capital chain rupture risk, which is more prominent is short loan long investment

2.2.3 Imperfect financing policy (S_3)

Under the influence of imperfect financing policies, many small and medium-sized enterprises cannot enjoy policy benefits. The credit funds of financial institutions are mainly concentrated on major customers, which to some extent stimulates the investment impulse and excessive debt of enterprises. However, once there is a risk, the disorderly withdrawal behavior of financial institutions will undoubtedly aggravate the fracture of the corporate capital chain [6].

2.2.4 Blind guarantees (S_4)

When the total amount of guarantee exceeds the guarantee capacity of the sponsoring enterprise, the sponsoring enterprise cannot perform its debt responsibility, which easily breaks the capital chain of the sponsoring company. Especially when the capital guarantee chain constitutes a complex guarantee network [7], once the capital turnover of an enterprise is difficult, it is easy to cause a chain reaction, triggering the rupture of the capital chain of other enterprises.

2.3. Capital chain risk analysis in the investment process

2.3.1 Investment target market positioning error (S_5)

Investment target positioning should meet market demand. If the market grasps and the enterprise own ability judgment insufficiency, will be unable to locate the enterprise investment goal accurately, affects the investment income, even will cause the capital chain rupture seriously.

2.3.2 Unreasonable distribution of funds (S_6)

Due to the close relationship between corporate benefits and capital operation under speculative projects, enterprises often pay attention to short-term goals, resulting in the imbalance between the proportion of industrial investment and the proportion of investment in speculative projects and aggravating the risk of capital chain rupture.

2.3.3 Lack of rigorous and scientific nature of investment budgets (S_7)

Enterprises' unsound investment budget mechanism often leads to low-cost management and capital utilisation, reduced liquidity, increased financial burden, and increased risk of capital chain rupture.

2.4. Fund Chain Risk Analysis in Fund Management Process

2.4.1 Mismanagement of operating funds (S_8)

Improper management of working capital mainly affects the virtuous cycle of enterprise capital chain through three ways: return, operation and investment of funds: if there is too much inventory, slow turnover will affect the return of enterprise funds and increase the risk of capital chain rupture; enterprises occupy working capital for long-term investment, enterprises can not generate income in the short term and cash inflows exist long-term lag effect [8]; insufficient liquidity of working capital leads to a decline in the short-term solvency of enterprises and ultimately leads to the break of the capital chain.

2.4.2 Poor monitoring of capital flow (S_9)

Most enterprises have poor supervision in the operation of funds. Enterprise capital chain interlocking, once the circulation of funds problems, easy to form a chain reaction, to a certain extent, affect the continued development of the project, increase the enterprise and even associated enterprise capital chain fracture risk.

2.4.3 Fund risk prevention and control is not perfect (S_{10})

Enterprise capital risk prevention and control will inevitably have some defects. Capital risk is often reduced by free capital. Maturity debt can not be repaid, and capital turnover is not smooth, liquidity risk expansion of these four forms appear in reality, it leads to the lack of working capital, enterprise shutdown. Moreover, it causes enterprises to fall into a financial crisis because they cannot repay their due debt, and finally, it greatly impacts the security of the enterprise capital chain.

2.5. Risk analysis of capital chain in the management process

2.5.1 Blind expansion and diversification (S_{11})

In order to expand production, many enterprises do not carefully consider the returnability of new investment projects and the financing ability of the enterprise itself, blindly implement the diversification strategy, consume a large number of the original project working capital, increase the financial pressure of enterprises. In addition, the horizontal possession of funds between projects requires a considerable level of management ability to control, which brings serious risks to the enterprise capital chain [9].

2.5.2 Lack of enterprise innovation capability (S_{12})

Enterprises lack of innovation accumulation can not effectively identify the risks of enterprise development, nor can they use innovative resources to improve the conversion rate of results. When the external environment changes, the risk of capital chain rupture is often greater.

2.5.3 Lack of financial capital management talents (S_{13})

Enterprises do not pay enough attention to the training of financial fund management talents. Fund management personnel lack risk control expertise, can not be well based on the actual situation of the

enterprise capital chain operation of accurate management and increases the risk of rupture of enterprise capital chain [10].

2.5.4 High debt repayment pressure (S_{14})

Debt management mainly through three aspects to restrain the beginning operation of enterprise capital chain: one is financial leverage, its two sides will lead to the decline of enterprise capital yield; second, excessive debt, resulting in a tight capital chain; third, it affects corporate reputation and increases the risk of corporate capital chain rupture.

2.6. Risk analysis of capital chain in the process of capital recovery

2.6.1 Inadequate management of accounts receivable (S_{15})

The excessive receivables of enterprises make it difficult to recover the cash, which will affect the normal capital turnover and solvency of enterprises in the current period. In the long run, the company s production and operation are prone to difficulties, increasing the risk of capital chain rupture.

2.6.2 The slow return rate of funds (S_{16})

The problems of hoarding in business activities may lead to the slow operation of the inventory cycle and affect the speed of capital return. The lack of capital backflow means that enterprises can not timely raise funds to make up for the gap, which easily leads to the crisis of capital chain rupture.

2.6.3 Industry development prospects constraints (S_{17})

Industry development prospect is the ' climate ' of enterprise management, has a huge impact on enterprises. The key for enterprises to forecast the development prospect of the industry lies in the grasp of the market, the scientific forecast of the market economy, the prospect of the investment industry and the understanding of the enterprise capital chain [11]. Thus, enterprises can obtain high returns, enhance the liquidity of the capital chain, and reduce the risk of capital chain rupture.

Based on the literature review at home and abroad, this paper selects 17 risk factors that affect the financial capital chain rupture process from five aspects of enterprise financing, investment, capital management, operation and management, and capital recovery. On the basis of these factors, factor S_0 is added, which is defined as financial capital chain rupture. Finally, the factor set system that affects the financial capital chain rupture is shown in TABLE1.

Table 1. Factors affecting financial capital chain rupture

Financial capital chain rupture	Risk analysis of capital chain in the financing process	Capital chain risk analysis in the investment process	Fund Chain Risk Analysis in Fund Management Process	Risk analysis of capital chain in the management process	Risk analysis of capital chain in the process of capital recovery
Financial capital chain rupture S_0	Single financing channel S_1	Investment target market positioning error S_5	Mismanagement of operating funds S_8	Blind expansion and diversification S_{11}	Inadequate management is of accounts receivable S_{15}
	Unreasonable financing structure S_2	Unreasonable distribution of funds S_6	Poor monitoring of capital flow S_9	Lack of enterprise innovation capability S_{12}	The slow return rate of funds S_{16}
	Imperfect financing policy S_3	Lack of rigorous and scientific nature of investment budgets S_7	Fund risk prevention and control is not perfect S_{10}	Lack of financial capital management talents S_{13}	Industry development prospects constraints S_{17}
	Blind guarantees S_4			High debt repayment pressure S_{14}	

3. Research on Risk Path Identification of Financial Fund Chain Break Based on FISM Model

This paper mainly uses the FISM (Fuzzy Interpretative Structural Model) model, which is based on the ISM model proposed by Professor Warfield in the United States to study the relationship between complex economic systems. The fuzzy mathematical relationship is introduced into the model and improved. The advantage of this model is to avoid the subjectivity of operation judgment. In this paper, through the study of the degree of correlation between the target factors, the fuzzy correlation matrix is established, and the threshold is introduced to analyse the strength of the correlation strength to determine the adjacency matrix. The reachable matrix is obtained by Boolean algebra logic operation. The reduction matrix is solved through the hierarchy of the reachable matrix and the plate division of the strong correlation. Finally, the multi-level hierarchical directed graph of the system is drawn, and the FISM model is established. The specific steps are as follows:

3.1. Interrelation of influencing factors

In the FISM model, experts determine the correlation between factors based on personal experience rather than absolutely determine whether there is a correlation. In the interval [0, 1], any decimal number is regarded as the score of correlation between factors [12], forming the 0 – 1 binary relationship between system elements, and finally converting it into the binary fuzzy relationship. The fuzzy adjacency matrix between various factors is obtained as shown in Equation (1).

$$A=\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \tag{1}$$

In this paper, by combing the literature from a series of processes such as corporate financing and capital return, we select 17 factors that affect the financial capital chain break and add the factor S0 (financial capital chain break), and finally get 18 factors that affect the financial capital chain break. These influencing factors are described and analysed, and their correlation degrees are scored. Combined with the opinions of experts, the arithmetic average is selected as the influence degree between the two factors, and the fuzzy adjacency matrix of each factor is obtained :

$$A=\begin{array}{c} \\ S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \\ S_7 \\ S_8 \\ S_9 \\ S_{10} \\ S_{11} \\ S_{12} \\ S_{13} \\ S_{14} \\ S_{15} \\ S_{16} \\ S_{17} \end{array} \begin{array}{c} \begin{array}{cccccccccccccccccc} S_0 & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & S_7 & S_8 & S_9 & S_{10} & S_{11} & S_{12} & S_{13} & S_{14} & S_{15} & S_{16} & S_{17} \end{array} \\ \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.9 & 0.0 & 0.8 & 0.0 & 0.4 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.7 & 0.5 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.7 & 0.0 \\ 0.8 & 0.8 & 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 & 0.7 \\ 0.8 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.9 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.5 & 0.0 & 0.7 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.9 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.7 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.0 \\ 0.9 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.6 & 0.7 & 0.0 & 0.0 & 0.0 & 0.6 & 0.0 & 0.5 & 0.0 \\ 0.8 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.7 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.7 & 0.0 & 0.0 & 0.0 \\ 0.9 & 0.0 & 0.4 & 0.0 & 0.4 & 0.0 & 0.6 & 0.5 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.8 & 0.0 & 0.0 & 0.0 \\ 0.9 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 \\ 0.9 & 0.0 & 0.0 & 0.0 & 0.0 & 0.4 & 0.4 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.7 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.7 & 0.0 \\ 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.8 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.5 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.7 & 0.5 & 0.0 & 0.0 \\ 0.7 & 0.0 & 0.4 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.6 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \end{array}$$

3.2. λ horizontal intercept matrix division

Based on the fuzzy adjacency matrix A, the threshold $\lambda = 0.5$ is selected by experiments. The value of threshold λ affects system hierarchy. The greater the λ, the more hierarchical the system is divided and the finer the system is divided. The smaller the λ, the less hierarchical the system is divided. The rougher the system is divided, the better the system is not divided [12, 13]. According to the research case of this paper, when $\lambda = 0.5$, it can better represent the hierarchical relationship of the model. Decree:

$$a_{ij}=\begin{cases} 1 & (b_{ij} \geq 0.5=\lambda) \\ 0 & (b_{ij} < 0.5=\lambda) \end{cases} \tag{2}$$

The matrix $A_{\lambda=0.5}$ with $\lambda = 0.5$ is obtained.

3.3. Solution of reachable matrix

Fuzzy adjacency matrix $A_{\lambda=0.5}$ plus unit matrix E, using Boolean algebra rules, through MATLAB programming matrix power operation, until $(A+E)^k = (A+E)^{k+1} = M$, can calculate the reachable matrix M (see Fig.1).

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

Figure 1. Reachable matrix M

3.4. λ Reduction matrix solution

The reachable set of the element S_i is defined as the reachable set of the element S_i, which is represented by $R(S_i)$. Then $R(S_i)$ is the set of elements corresponding to all rows whose matrix elements are 1 in the S_i column of the reachable matrix M. The set of relations obtained is shown in (3). The set of elements that reach the Sj is defined as the antecedent set of the element Sj, represented by $Q(S_j)$. Then the set of relations obtained by the set of elements corresponding to all the rows whose matrix elements are 1 in the S_j column of the $Q(S_j)$ reachable matrix is shown in (3):

$$R(S_i)=\left\{S_j \middle| S_j \in S, S_{ij}=1\right\} \tag{3}$$

$$Q(S_j)=\left\{S_i \middle| S_i \in S, S_{ij}=1\right\} \tag{4}$$

$R(S_i)$, $Q(S_j)$, and $R(S_i) \cap Q(S_j)$ of each element can be obtained from the reachable matrix M, and the results are listed in the matrix decomposition table (see TABLE1).

Table 1. Reachable set and antecedent set

$R(S_i)$	$Q(S_j)$	$R(S_i) \cap Q(S_j)$	Hierarchy
S_0	1~17		1
S_1 0~2,4,8~10,14~16	1~3,5,11~13,17	1,2	4
S_2 0~2,4,8~10,14~16	1~3,5,11~13,17	1,2	4
S_3 0~2,4~11,14~17			6
S_4 0,15	1~3,5,11~13,17		2
S_5 0~2,4,6~11,14~16	3,12,13,17		5
S_6 0,6~10,14~16	3,5~7,11~13,17	7	4
S_7 0,6~10,14~16	3,5~7,11~13,17	6,7	4
S_8 0,8~10,14~16	1~3,5~14,16,17	8,9,10,14,16	3
S_9 0,8~10,14~16	1~3,5~14,16,17	8,9,10,14,16	3
S_{10} 0,8~10,14~16	1~3,5~14,16,17	8,9,10,14,16	3
S_{11} 0~2,4,6~10,14~16	3,5,12,13,17		5
S_{12} 0~2,4~11,14~17	13		6
S_{13} 0~2,4~12,14~17			6
S_{14} 0,8~10,14~16	1~3,5~14,16,17	8,9,10,14,16	3
S_{15} 0	1~14,16,17		2
S_{16} 0,8~10,14~16	1~3,5~14,16,17	8,9,10,14,16	3
S_{17} 0~2,4~11,14~16	3,12,13	3	5

According to the idea of element partition, the reduced matrix is obtained in the existing reachable matrix M.

3.5. Drawing multi-level hierarchical directed graphs and establishing FISM

Based on the reduced reachability matrix M, the factors are decomposed step by step to complete the level division, and the hierarchical model of the influencing factors of capital chain rupture is constructed (see Fig.2):

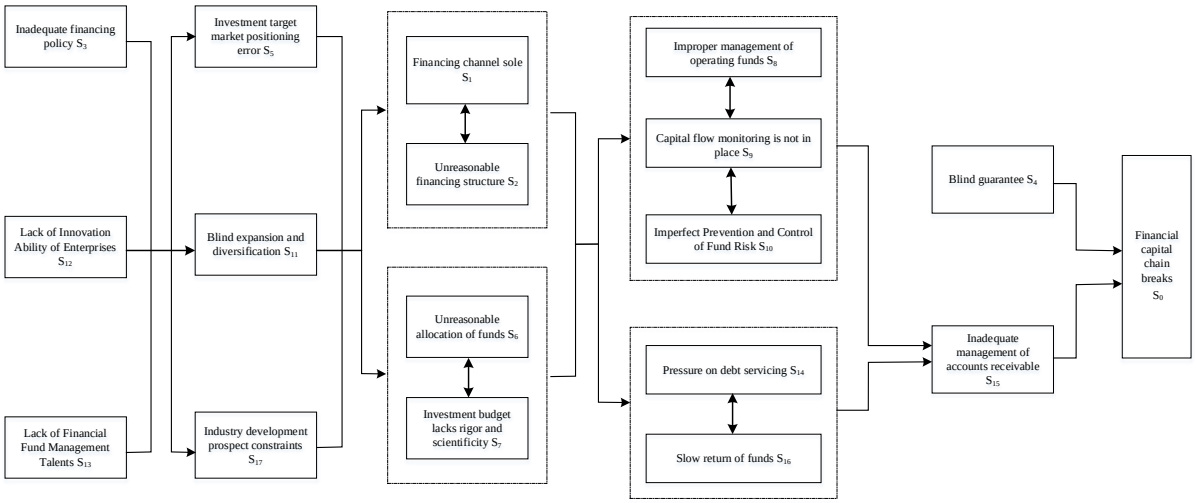

Figure 2. Multi-level Hierarchical Directed Graph of Influencing Factors of Financial Fund Chain Break

4. Research and analysis of financial fund chain break risk path identification based on fism model

4.1. Risk path identification

This paper selects 18 factors that affect the break of the capital chain through the historical literature method from the five processes of enterprise financing, investment, capital management, operation management, and capital recovery. The expert team scores the influence degree between them and obtains each factor's fuzzy adjacency matrix A. In this paper, $\lambda = 0.5$ is selected to filter the fuzzy adjacency matrix A to better represent the hierarchical relationship. Fuzzy adjacency matrix $A_{\lambda=0.5}$ plus unit matrix E, using Boolean algebra rules, through MATLAB programming operation, until $(A+E)^k=(A+E)^{k+1}=M$, get reachable matrix M. The reachable set $R(S_i)$, antecedent set $Q(S_j)$ and intersection set $R(S_i)\cap Q(S_j)$ of each element are obtained from reachable matrix M, and the results are listed in matrix decomposition table. Then, the reachability matrix M is reduced and decomposed step by step to complete the rank division of system elements, and finally, the multi-level hierarchical directed graph of influencing factors of financial capital chain rupture is drawn.

4.2. Hierarchical model analysis of influencing factors of financial capital chain rupture

From the analysis results of the FISM model, the second level of 'blind guarantee (S_4)' and 'accounts receivable management is not in place (S_{15})' are the direct influencing factors of financial capital chain rupture. The first layer of influencing factors includes accounts receivable management and guarantee behaviour, which is also a key link directly affecting the enterprise capital chain rupture.

In the third level, 'improper management of operating funds (S_8)', 'inadequate monitoring of capital flow (S_9)', 'imperfect prevention and control of capital risk (S_{10})', 'high debt repayment pressure (S_{14})' and 'slow return of funds (S_{16})' are five intermediate factors affecting the fracture of capital chain, which jointly affect the second level of 'inadequate accounts receivable (S_{15})'. The first three factors influence each other and directly affect the fund back; the latter two factors are a group of risk factors with correlation and affect the speed of capital return. These five factors are the direct causes of 'accounts receivable is not in place'.

The influencing factors at the fourth level are 'single financing channel (S_1)', 'unreasonable financing structure (S_2)', 'unreasonable allocation of funds (S_6)' and 'lack of rigorous and scientific investment budget (S_7)'. The first two and the latter The factors of the fourth layer include the financing and investment processes of enterprises, which jointly affect the risk factors of the third layer in the process of capital management, operation management and capital recovery.

The influencing factors of the fifth layer are 'investment target market positioning error (S_5)', 'blind expansion and diversification (S_{11})' and 'industry development prospects constraints (S_{17})'. These factors affect the choice of financing methods and financing channels, affect business strategy and investment budget formulation and restrict the financing structure and allocation of funds.

These risk factors in the fourth and fifth layers constitute the intermediate layer that affects the rupture of the capital chain. During this period, these seven factors include the financing, investment, operation, and capital recovery process of enterprises normal business activities. Simultaneously, it also links and affects each other with the upper factors through chain conduction.

The sixth level of influencing factors is the farthest from the 'financial capital chain rupture (S_0)', but it is also the deepest influencing factor — 'imperfect financing policy (S_3)', 'lack of enterprise innovation ability (S_{12})' and 'lack of financial capital management talents (S_{13})'. The sixth layer summarises the policy environment, corporate, business operators of the three fundamental factors. These factors affect the enterprise investment target market positioning, business strategy choice, industry development prospects.

5. Hierarchically structured implementation recommendations to prevent the risk of financial chain rupture

By systematically and scientifically studying the risk path of financial capital chain rupture, we know that to prevent financial capital chain rupture, we need to understand the principle of each influencing factor clearly, fully consider the different characteristics of risk factors at different levels, and take different attention to different levels of factors. According to the hierarchical force, this section will suggest prevention and control suggestions from the fundamental driving layer, the intermediate foundation layer, and the surface dependence layer.

Firstly, the fundamental drivers should be viewed reflectingly and planned reasonably from both internal and external aspects. From the external policy environment of enterprise operation, the current epidemic prevention and control and economic downturn, the government must take various measures to maintain reasonable liquidity of the financial system [14]. Secondly, open all kinds of financial services 'green channel' to provide preferential financial policies for enterprises in special areas and industries; third, the functional departments of the government should form a joint force to enhance the effect of a number of financial policies; finally, it is necessary to continue to deepen financial reform and continue to promote the fight against major financial risks. From the internal point of view, for the lack of innovation ability of enterprises and the lack of financial capital management talents, enterprises should pay attention to the cultivation of talents, create an efficient training platform and improve the incentive mechanism of employees, further stimulating the enthusiasm of high-skilled talents to participate in innovation and innovation actively, and also collect professional talents in various fields, increase the attention to financial management talents.

Secondly, for the intermediate foundation factors in the third, fourth and fifth layers of the hierarchy, the risk of capital chain rupture can be reduced by strengthening scientific investment decisions and capital risk control. To improve the scientificity of decision-making, enterprises should make a full investigation, analyse and evaluate projects, judge whether the project is worth investment according to the current operation situation, and reduce investment risk through decentralised investment. For improving capital risk control, enterprises should improve capital management mechanisms and strengthen the capital operation constraint mechanism of capital monitoring departments.

Finally, the surface dependent layer factor should be concentrated on in this study. According to the multi-level hierarchical directed graph, we know that accounts receivable is not in place is caused by the superposition of other levels of risk factors is dependent on other levels of factors to improve. The following suggestions and measures are mainly aimed at blind guarantee: First, strictly check the credit status of the guaranteed enterprise. Secondly, strengthen the guarantee management; third, establish risk awareness and guarantee insurance system. The surface dependence layer factor can directly impact the risk of financial capital chain rupture, and enterprises should focus on it.

6. Conclusion

This study identifies 18 factors that affect the fracture of capital chain from five perspectives of financing, investment, capital management and operation management and conducts a quantitative and qualitative analysis of these factors with the help of the FISM model. The multi-level hierarchical directed graph is drawn, and the conclusions are as follows:

(1) FISM model reasonably solves the risk path identification problem of capital chain rupture. Fuzzy mathematics is introduced based on the traditional ISM, and the FISM model is used to analyse the influencing factors qualitatively. The visual directed graph is used to reflect the internal relationship between various factors, and then the model's effectiveness is verified.

(2) FISM results showed that 18 risk factors were divided into six levels, significant differences. Blind guarantee, accounts receivable management is not in place is the direct surface factor; improper capital management, capital flow monitoring is not in place, capital risk prevention and control are not perfect, debt repayment pressure, slow return of funds is the middle key factors. The lack of enterprise innovation ability and lack of financial fund management personnel are the deep root factors.

(3) Enterprises should focus on the impact of innovation ability and financial capital management personnel on financial capital chain rupture and reduce the risk of guarantee and accounts receivable management.

Acknowledgements

The author's name is in alphabetical order, and the workload of each author is equivalent.

References

[1] Yi Song, Bin Hu and Zhihan Lv, “A computational analysis of capital chain rupture in e-commerce enterprise,” Electronic Commerce Research, vol.18, no.2, pp.257–276, 2018.

[2] Gaojincheng, “Risk analysis of capital chain rupture of SMEs under the background of supply-side reform,” China market, vol.34, pp.157-158, 2017.

[3] Kuang Zhaoxuan, “Research on the Risk Measurement and Risk Control Path of Hengsheng Real Estate Capital Chain,” Hunan University of Science and Technology, 2018.

[4] Zhao Hongwei, “Analysis on the Causes of Enterprise Capital Chain Break,” The Economist, no.2, pp.287-288, 2021.

[5] Zhang Lifang, Lily, “Comparative study on early warning of capital chain fracture risk of listed companies — based on the analysis of principal components and Logistic model,” Financial and accounting communication, vol.36, pp.106–110, 2015.

[6] Yang Yu, “Cause Analysis and Countermeasures of Enterprise Capital Chain Break,” Hebei Finance, no.1 pp.18-21, 2009.

[7] Du Quan, “Zheng Bingwei. Reflections on the current guarantee chain of enterprises in Zhejiang,” Zhejiang Finance, no.6, pp.20–21, 2010.

[8] Du Xiuzhen, “Research on capital chain management of coal enterprises under the background of supply-side reform,” Coal economy research, vol.37, no.2, pp.67-70, 2017.

[9] He Yong, “The capital chain is broken, and enterprises are hard to survive,” Business culture (first half of the month), no.5, p.21, 2012.

[10] Li Juzheng, “On enterprise capital management and risk control,” Tax, vol.14, no.4, p.289, 2020.

[11] Zeng Ming, “Reflections on corporate investment decisions,” Foreign investment in China, no.22, p.112, 2012.

[12] Zhang Xiqiao, Yuan Yalong and Sun Zhichao, “Research on the improved interpretative structural model of influencing factors of residents ' travel cost,” Journal of Chongqing Jiaotong University (Natural Science Edition), vol.36, no.7, pp.101-105, 2017.

[13] Guo Liyang, “Research on subway fire risk factors based on improved ISM and MICMAC model,” Journal of Wuhan University of Technology, vol.39, no.4, pp:36-92, 2017.

[14] Yi Gang, “Good use of financial support policies to promote epidemic prevention and control and economic and social development,” Chinese financiers, no.5, pp.11-14, 2020.