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Study on identification model of three-dimensional financial risks of chemical enterprise

Feng Ziqin

School of Management and Economics, North China University of Water Resources and Electric Power, Zhengzhou, China

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ABSTRACT

Financial risks are the critical variables in forming enterprise's financial crisis, the cyclical showing of which undecided by the will of people is an objective law. This paper divides financial risks into three types what are Financial Environment-adaptation Risk (FEAR), Financial Resource-allocation Risk (FRAR) and Financial Stakeholder-cooperation Risk (FSCR), which constitutes the three-dimensional financial risk system of chemical enterprise. Based on the literature review, this paper analyses the formation and conduction mechanism of three-dimensional financial risks. Next, it explores the identification principle of three-dimensional financial risks so as to give an efficient method. Then, it builds some matrix identification models for identifying three-dimensional financial risks of chemical enterprise. Furthermore, a case study is also given..

Key words: Chemical enterprise, financial risk, risk identification, matrix model, three dimensions

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INTRODUCTION

In modern risk management theory framework, chemical enterprise is always taken as "organism" which is constituted by multi-dimensional risks and values, what are the premise and foundation for chemical enterprise to take part in market competition. So, risk, value and competitiveness are the basic survival characteristics of chemical enterprise. However, for the reason of increasingly fierce and dynamic competitiveness, chemical enterprise always has financial risks in converting values and creating competitive advantages to enhance its competitiveness and to realize its sustainable development under the guidance of strategies [1]. Michael Porter's diamond model theory (1990) [2] put forward four factors including factor conditions, demand conditions, related and supporting industries, firm strategy, structure and rivalry which can determine the intensity of competitiveness. Argenti (1976) thought that enterprise's survival factors can be divided into three types what are the characteristic of enterprise itself, the characteristic of industry and the characteristic of environment [3]. Therefore, uncertainty is an important characteristic of chemical enterprise and risk management is its essential content.

Financial risks are the critical variables in forming enterprise's financial crisis [4] and the periodic display of financial crisis is an objective law undecided by people's will, the influence of which can be reflected in three dimensions what are financial environment-adaptation risk, financial resource-allocation risk and financial stakeholder-cooperation risk dimensions [5]. As the prosperity fluctuation of macro-economy home and abroad, chemical enterprise's competition has become the basic source of financial risks. The operating resource obtaining, ability forming and value realizing are not only the results of three-dimensional financial risks but also the comprehensive reflection of industry competition. The incompetence or weakness in competition is largely caused by lagging and failure of financial risk identification. Therefore, effectively identifying financial risks has become the key and core of chemical enterprise's competitiveness. Present researches on risk identification mainly adopt the method of Point Estimation and it is difficult in comprehensively grasping risks in time and space. After analyzing the formation and conduction mechanism of three-dimensional financial risks, this paper gives a study on how to

identify three-dimensional financial risks by using the tool of risk identification matrix.

LITERATURE REVIEW

Academic knowledge about financial risks is originated from the knowledge of general risks which can be concluded into three types what are Risk Loss View, Result Difference View and Uncertainty View [6]. Risk Loss View takes financial risks as the possible danger and loss caused by some uncertain factors. Result Difference View points that financial risks are the difference between future practical result and expected result coming from the impact of financial activities' efficiency and effectiveness. And Uncertainty View refers that financial risks are the uncertainty of future gains and losses resulted from financial activities or the uncertainty prescribed by specific probability. In 1895, American scholar John Haynes put forward the concept of risk in "Risk as an Economic Factor Economic Sense". In 1985, Williams J. and Richard M. H. defined risk as differences between the results that might occur in the given circumstances and the specific period of time [7]. In 1986, Robert I. M. defined risk as the uncertainty of loss under certain conditions [8]. Kulp C.A. and John W.H. (1968) defined risk as uncertainty of financial loss under certain conditions [9]. Peng and Xing (2005) defined financial risks as the uncertainty in the transforming process from form-value to connotation-value in capital value operation [10]. Chen (2006) referred financial risks as the probability of loss with the deviation between enterprise's financial benefits and expected benefits caused by some uncertain factors [11]. Jiang and Li (2007) pointed out that financial risk contain three attributes including risks from fund movement, monetization form of risks and potential loss with the deviation between financial benefits and expected benefits caused by uncertain factors [12]. Analyzing from space level, Zhang and Feng (2008) held that factors leading to financial risks came from enterprise's external environment, internal operation and stakeholders, therefore generating Financial Environment-adaptation Risk, Financial Resource-allocation Risk and Financial Stakeholder-cooperation Risk [13].

Financial risk identification which is the key aspect of financial risk management is refers to prediction, identification, inference and induction to financial risks of not yet occurred, potential and practical existed by using certain technology and methods before financial crisis occurring, and it is a process of analyzing reasons and understanding risks. Traditional financial risks identification technologies mainly includes Failure Tree Analysis, Failure Mode, Effects and Criticality Analysis, Hazard and Operability Analysis, Markov Interval Analysis, Brainstorming Method, Financial Statement Method, Flow Chart Method, Site Observation Method, Sensitivity Analysis and Environment Analysis Method. Zhou and Jiang (2003) provided a risk identification technology by given a characteristics-factor model which is applied in project risk management of aerial products development based on check list and improved fish bone diagram risk identification technology [14]. After analyzing the traditional risk identification technology, Chen and Xiao (2005) put forward risk symptom identification technology, which includes risk symptom identification matrix, factor model and risk evolution model steps. They held that risk symptom identification technology is a new risk identification technology. It can identify symptoms and features before risk occurring. And it can also explore and identify the impact situation of innovative events to organization operating performance and identify its types, occurring mechanism and results through studying system performance output orbit [15].

MECHANSIM

TYPES OF THREE-DIMENSIONAL FINANCIAL RISKS

From the current literatures, we can see that financial risks are often classified as investment risk (INR), financing risk (FIR) and other major categories. And these classification methods are always emphasis on the capital operational status. So many hypothesizes must be used to judge the validity of capital market, such as no-arbitrage equilibrium hypothesis, assumption of diminishing marginal utility of capital, risk aversion hypothesis, asymmetric information hypothesis and so on. Peng and Xing (2005), according to the cycle of capital movements, divided financial risks into capital allocation risk (CAR), capital consumption risk (CCR), capital output risk (COR), capital recovery risk (CRR), capital payment risk (CPR) and capital market risk (CMR) [10].

Understanding and grasping formation and conduction mechanism of financial risks from three dimensions are the premise and basis of financial risks identification. As an independently operating "organism", chemical enterprise must get conditions to ensure its sustainable operation, including sustainable value-flow inputting, effective value transformation and sustainable value-flow outputting. And this is a cycling and amplifying process. Sustainable value-flow inputting reflects interactive adaptation between enterprise and external environment, and value transformation manifests chemical enterprise's ability for resource allocation, and sustainable value-flow outputting is the expected result of stakeholders to benefits. Limited by the subjective and objective conditions, chemical enterprise's value-chain isn't unchangeable, and uncertainty, difference and danger construct the main features of enterprise's value activities. So, Financial Environment-adaptation Risk, Financial Resource-allocation Risk and Financial Stakeholder-cooperation Risk make up the three dimensions of enterprise's financial risks, and their formation and conduction mechanism decide enterprises' value characteristics.

Including financial environmental risk (FER), market competition risk (MCR) and element fluctuation risk (EFR), Financial Environment-adaptation Risk is the uncertainty and loss possibility for financial activity to adapt the environment. FER is the uncertainty of financial operation for the reason of macro-economic prosperity fluctuation, etc. MCR is the uncertainty of financial operation for the reason of market competition. EFR is the uncertainty of financial operation for the reason of element fluctuation. Financial Resource-allocation Risk is the uncertainty and loss possibility for financial activity to allocate its financial resources and it can be divided into operational risk (OPR), investment risk (INR), financing risk (FIR) and funding chain risk (FCR). OPR generally refers to uncertainty of profit amount or profit rate for the reason of operation. INR is the danger to gain uncertain expected profit, generally means uncertainty of return in enterprise's investment. FIR is the possibility of losing debt paying ability or changeability of profit. FCR is the possibility of enterprise out of control its cash-flow and leading to fund chain fracture. Likewise, Financial Stakeholder-cooperation Risk is the uncertainty and loss possibility for finance to meet the value expectations of stakeholders. It can be classified as consumer cooperation risk (CCR), other stakeholder cooperation risk (OCR) and long-term profit cooperation risk (LPR). CCR is the possibility of enterprise's financial loss for the reason of consumer relation failure. OCR is the possibility of enterprise's financial loss for the reason of other stakeholder relation failure. LPR is the possibility of enterprise's losing endurable profit and cooperation ability. Types of chemical enterprise's three-dimensional financial risks are shown in Table 1.

Table 1: Types of three-dimensional financial risks of chemical enterprise

Risk Category	*Risk Type*	*In Short*
Financial Environment-adaptation Risk	Financial environmental risk	FER
	Market competition risk	MCR
	Element fluctuation risk	EFR
Financial Resource-allocation Risk	Operational risk	OPR
	Investment risk	INR
	Financing risk	FIR
	Funding chain risk	FCR
Financial Stakeholder-cooperation Risk	Consumer cooperation risk	CCR
	Other stakeholder cooperation risk	OCR
	Long-term profit cooperation risk	LPR

FORMATION OF THREE-DIMENSIONAL FINANCIAL RISKS

Fluctuation of macro-economy and market competition is the main source of Financial Environment-adaptation Risk. Macroeconomic environment fluctuation, which is an exogenous variable of chemical enterprise, is the inevitable performance of economic cycle. It can lead to periodical financial risks to various economic organizations. With respect to FER, it's the inevitable result of macroeconomic fluctuation. When macro-economy is in the recession phase, economic growth will be stagnation which always accompanied by inflation. The producer price index (PPI) goes high and consumer price index (CPI) largely increases. In order to stop the increase of unemployment rate and inhibit inflation, the country will certainly adjust interest rate and exchange rate policies. With respect to EFR, the increasing price of industrial products which caused by cost increasing will be conducted to consumer eventually. And if the conduction is blocked, chemical enterprise must digest the added cost itself by compressing its profits, and this can result in profit decreasing or financial crisis and even bankruptcy. With respect to MCR, it can be explained by Michael Porter's five forces model (1980) [16], which includes five competitiveness factors that is supplier's bargaining ability, buyer's bargaining ability, threats of new comers, threats of substitute and horizontal competition. Facing with the five forces, chemical enterprise must enhance its financial operation to influence the competitive rules of industry from self benefits. After occupying beneficial market, it can do offensively competitive action to strengthen its market position and competitiveness, otherwise it will be in competitive disadvantage status and face financial crisis. Therefore, chemical enterprise is not only survived in the industry and market competition environment, but also influenced by the risk factors coming from industry and market. Financial Environment-adaptation Risk is its basic growth character.

The resource allocation is reflected in three aspects which is effectiveness, efficiency and scale, and it ultimately decided by four levels which is operation, investment, financing and fund chain. Financial Resource-allocation Risk is rooted in the specific business activities and financial activities of chemical enterprise. Because of the scarcity of resource, the limitation of ability, the uncertainty of future and the discrepancy of management, resource allocation failure often become a source of enterprise risk. The economic cycle fluctuation and the low efficiency of internal control can arouse business fluctuation, investment fluctuation, financing fluctuation and fund chain fluctuation, and thus bring about OPR, INR, FIR and FCR. Financial Resource-allocation Risk is the overall performance of these four factors, which requires chemical enterprise having a powerful resource-allocation and innovation ability. With respect to OPR, the competition for production factors (especially high-level factors) coming from industry constitutes its external environment. Meanwhile, the stage feature of chemical enterprise's growth could lead to value-creation inefficient and capital mobility failure. So, the resource allocation efficiency is the premise of OPR.

With regard to INR, the blind expansion of capital could bring about technical risk, market risk and credit risk and so on, which can affect the cash flow of chemical enterprise. FIR can lead to the loss of debt-paying ability and the change of enterprise profit, including external financing risk and internal financing risk. Financing will certainly increase the cost to pay for principal and interest because the profit rate of capital and the interest rate of loan are uncertain. Changeable market and fierce competition both may lead to wrong decision making and therefore bring about large uncertainty to use financing funds effectively. Financing can increase chemical enterprise's cost to get capital. The blindness and failure of capital operation can deteriorate financial relationship and even bring about financial crisis. Fund chain is the basic resource cycle chain to maintain chemical enterprise's normal production and operation. The cycle of "cash to capital and then to cash increment" is the process of operation. It is necessary to keep this benign cycle operating continuously. Lacking of ability to manage financial risks and cash flow, chemical enterprise will probably lead to fund-chain fracture. Therefore, chemical enterprise constantly gains resources from management of business, financing, investment and fund chain, and resolves risks in the allocation of resources. Financial Resource-allocation Risk constitutes its basic capability character.

Chemical enterprise is a diversified stakeholders' contract aggregation, and its development can't go without stakeholders' investment and participation, and it should not only serve for shareholders, but also protect their benefits. Mitchell, Agle and Wood (1997), from the power, legitimacy and urgency dimensions, distinguished the relationship of stakeholders. They divided stakeholders into "dormant", "discretionary", "demanding", "dominant", "dangerous", "dependent" and "definitive" [17]. Carroll (1996) thought that stakeholders can be divided into direct and indirect types from the relationship analysis. And from the position analysis, stakeholders can be divided into "core-stakeholders", "strategic-stakeholders" and "environmental-stakeholders" [18]. The relationship between stakeholders and enterprise is reflected in two aspects. On the one hand, stakeholders invest specific assets to enterprise and demand to gain corresponding profit from enterprise's residue. On the other hand, the specific assets invested by stakeholders may be in risks and stakeholders need to remain necessary control over enterprise. Supply chain refers to the network structure linked by upstream and downstream members related to raw materials in the process of products production and circulation, and the members include raw material suppliers, producers, distributors, retailers, eventual consumers and so on. This value-chain represents the corresponding relationship between enterprise and consumer's values and risks. Only when enterprise enjoys consistent and cooperative profits with consumer can it gain consumer's trust. Otherwise, enterprise will lose consumer and market to bring about Financial Stakeholder-cooperation Risk. Government, shareholders and other stakeholders are also important influential powers of enterprise's value creation. First, enterprise should obey laws to continuously create social wealth. Then, enterprise should focus on value of shareholders and employees to constantly generate energy to create value. Any despise and weakness in the link may lead to OCR. At the same time, enterprise's profit cooperation should reflect the features of long-term and sustainable value which embodies enterprise's endurable profit and cooperation ability. The lack of cooperation ability is the main source of LPR. Therefore, chemical enterprise is supported by the cooperation of stakeholders and takes risks in the game with stakeholders. Financial Stakeholder-cooperation Risk poses its basic relation character.

CONDUCTION OF THREE-DIMENSIONAL FINANCIAL RISKS

Enterprises' risk conduction refers that interference and influence of some external and internal uncertain factors makes the tiny deviation or uncertainty in a certain point in initial time, then attached on various conducting vector, the tiny deviation or uncertainty is conducted and spread to a serial point and surface in enterprises' producing and operating process, later it will lead to the deviation and failure of enterprises' producing and operating aims [19]. Financial risk is key variable not only lead to business failure but also bring about associated enterprise's financial crisis. To explore the conduction law of financial risk is an important part for chemical enterprise to improve its risk management ability. The conduction of financial risk has a cyclical direction, strength and coupling features. The constituent elements of financial risk conduction includes source of financial risk, financial risk motivation, financial risk vehicle, financial risk pathway and financial risk conduction threshold. From the outside of chemical enterprise, the conduction of financial risk mainly includes chain conduction and network conduction modes. From the internal of chemical enterprise, financial risk conduction is mainly follow the space-time theory with some direction and intensity.

Enterprise's three-dimensional financial risks reflect macro, medium and micro levels, and with conduction in time and succession in space. Analyzed from time level, chemical enterprise's three-dimensional financial risks are conducted and spread following the path of "'Non-risk period' to 'Latent period' to 'Development Period' and to 'Realization Period'". Non-risk period means that the risk is very small and can be neglected. Latent Period gestates chemical enterprise's antecedent financial risks, mainly reflected in the fierce degree of macro-economic prosperity situation and market competition. Development Period condenses chemical enterprise's synchronized financial risks, reflecting enterprise's adaptation to risks conducted by macro-economic prosperity situation and market competition, and is the integration of operation, investment, financing and capital management. And Realization Period includes

chemical enterprise's lagging financial risks, mainly reflected through profit cooperation with stakeholders. Analyzed from space level, chemical enterprise's three-dimensional financial risks are conducted and spread through the path of Financial Environment-adaptation Risk to Financial Resource-allocation Risk and to Financial Stakeholder-cooperation Risk, what is a cycle and fluctuating process. Macro-economic fluctuation and market competition are the source of Financial Environment-adaptation Risk which directly or indirectly limits the resource allocation ability of enterprises to bring about Financial Resource-allocation Risk. Meanwhile, the decrease of chemical enterprises' ability to resource allocation can lead to decrease of enterprise's value which can make stakeholders' profit not compensated, what brings about Financial Stakeholder-cooperation Risk.

MODELING & SOLUTION

IDENTIFICATION PRINCIPLE

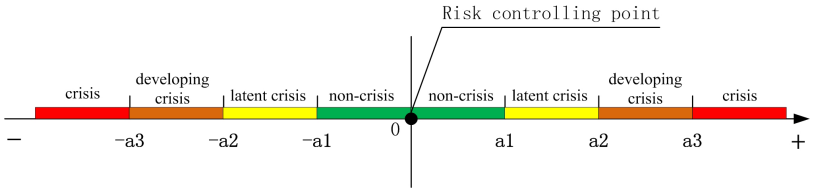

Fig. 1: Three-dimensional financial risk identification principle

To identify three-dimensional financial risks of enterprise, this paper defines risk controlling point as the benchmark and each risk index calculated value t_i can be compared with it. If the risk controlling point value is η, then the compared value can be expressed as △t/η, △t=η-t_i. So, we can judge the risk levels by the value of △t/t. This paper classifies the financial risk level into four types from the development path along with time, which is "none-crisis", "latent crisis", "developing crisis" and "crisis". "none-crisis", which can be shown as green warning light, means that the financial risk is very small and cannot bring about any crisis. "latent-crisis", which can be shown as yellow warning light, means that the financial crisis is in the latent status and can be controlled stably. "developing-crisis", which can be shown as orange warning light, means that the financial risk is in the development period and the financial crisis is rapidly brewing. "crisis", which can be shown as red warning light, means that the financial risk is very large and the financial crisis is appeared.

If the judgment threshold vector set is defined as A=[a1,a2,a3], the value of risk controlling point is η, the index value is t_i, we can construct identifying models to identify three-dimensional financial risks. This paper uses R-values to judge the risk levels. It defines:

- If the calculated value $0 \le |(\eta - t_i)/\eta| < a_1$, then $R \in [0,1)$. It means financial risk is very small and the financial crisis can not occur, so the risk level is "none-crisis".
- If the calculated value $a_1 \le |(\eta - t_i)/\eta| < a_2$, then $R \in [1,2)$. It means financial risk can be controlled stably and financial crisis is in the latent status, so the risk level is "latent crisis".
- If the calculated value $a_2 \le |(\eta - t_i)/\eta| < a_3$, then $R \in [2,3)$. It means financial risk is high and financial crisis is developing, so the risk level is "developing crisis".
- If the calculated value $a_3 \le |(\eta - t_i)/\eta|$, then $R = 3$. It means financial risk is very high and financial crisis is appeared, so the risk level is "crisis".

The calculation formula of R-value can be expressed as: (The impacting judgment of three-dimensional financial risks is listed in Table 2.)

$$R = \begin{cases} \dfrac{|(\eta - t_i)/\eta|}{a_1} & if \quad 0 \le |(\eta - t_i)/\eta| < a_1 \\ \dfrac{|(\eta - t_i)/\eta| - a_1}{a_2 - a_1} + 1 & if \quad a_1 \le |(\eta - t_i)/\eta| < a_2 \\ \dfrac{|(\eta - t_i)/\eta| - a_2}{a_3 - a_2} + 2 & if \quad a_2 \le |(\eta - t_i)/\eta| < a_3 \\ 3 & if \quad |(\eta - t_i)/\eta| \ge a_3 \end{cases} \tag{1}$$

Table 2: Impacting judgment of three-dimensional financial risks

R-value	*Risk Level*	*Means*
[0,1)	none-crisis	Financial risk is very small and financial crisis can not occur.
[1,2)	latent crisis	Financial risk can be controlled stably and financial crisis is in the latent status.
[2,3)	developing crisis	Financial risk is high and financial crisis is developing.
3	crisis	Financial risk is very high and financial crisis is appeared.

We can treat a chemical enterprise as a financial risk space system U including some financial risks subsystems Ui, suppose each risks subsystem can satisfy the conditions of boundary and differentiable, therefore the risk controlling point of every subsystem exists. Because the calculation of chemical enterprise's risk controlling point is complicated and difficult, this paper classifies it by industries and adopts the industry's three years' data of feature samples, and the calculation result is approximately treated as the industry risk controlling point. If ηi is the risk controlling point's value of i-th index, t^k_{ij} is i-th index value of j-th sample in k-th year. Then, the risk controlling points' calculating function can be expressed as:

$$\eta_i = \frac{1}{3n}\sum_{k=1}^{3}\sum_{j=1}^{n} t^k_{ij} \tag{2}$$

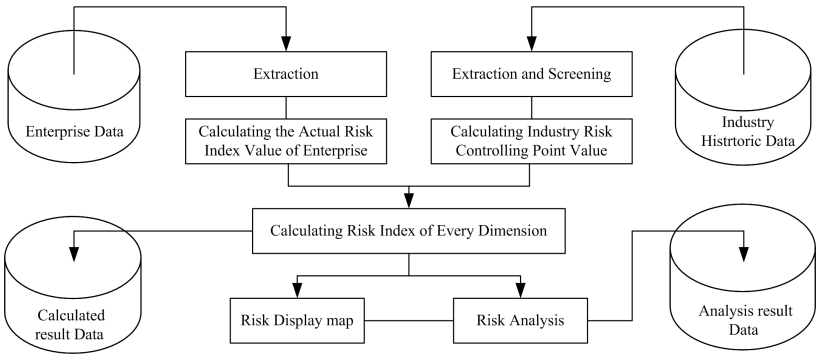

Fig. 2: Data dealing with process of three-dimensional financial risk identification

In order to identify financial risks of enterprise from three dimensions, this paper designs data dealing with program and database. The process can be divided into 9 steps (see Fig. 2).

- Step 1. Industry sample database building.
- Step 2. Enterprise monitoring database building.
- Step 3. Data extraction and screening.
- Step 4. Risk controlling point value calculation.
- Step 5. Actual risk index value calculation.
- Step 6. Dimensional risk index value calculation.
- Step 7. Risk display map.
- Step 8. Risk analysis.
- Step 9. Data saving.

MATRIX MODEL BUILDING

To build a basic matrix model for three-dimensional financial risk identification, this paper divides two-dimensional plane into 16 regions, and uses A~P to represent the risk identification type of each region (see Figure 3), so a financial risk identification types set can be expressed as T={A,B,C,D,E,F,G,H,J,K,L,M,N,O,P}. Given the threshold value set of X is {x1, x2, x3} and the threshold value set of Y is {y1, y2, y3}, we can judge the financial risk level by R-value of x-axis and R-value of y-axis. For example, if the calculated R-value scope is Rx∈(x1,x2] and Ry∈(y1,y2], then the financial risk identification type is "F", which means the financial risk of x-axis is at the second level and the financial risk of y-axis is also at the second level.

For the reason of the accumulation and expansion characteristic of financial risk, we use R-value to measure the risk level, and a different R-value corresponds to a different risk areas. The general interpretation of matrix region is in table 3.

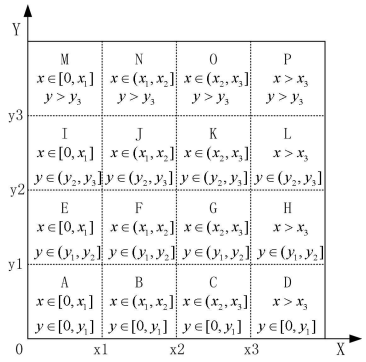

Fig.3: Basic matrix model for financial risk identification

Table 3. The general interpretation of matrix region in the model

Matrix Regions	*X*			*Y*		
	Economic Meanings	*Index Value Scope*	*R-value*	*Economic Meanings*	*Index Value Scope*	*R-value*
A	non-crisis	[0,x1)	[0,1)	non-crisis	[0,y1)	[0,1)
B	latent crisis	[x1,x2)	[1,2)	non-crisis	[0,y1)	[0,1)
C	developing crisis	[x2,x3)	[2,3)	non-crisis	[0,y1)	[0,1)
D	crisis	≥x3	3	non-crisis	[0,y1)	[0,1)
E	non-crisis	[0,x1)	[0,1)	latent crisis	[y1,y2)	[1,2)
F	latent crisis	[x1,x2)	[1,2)	latent crisis	[y1,y2)	[1,2)
G	developing crisis	[x2,x3)	[2,3)	latent crisis	[y1,y2)	[1,2)
H	crisis	≥x3	3	latent crisis	[y1,y2)	[1,2)
I	non-crisis	[0,x1)	[0,1)	developing crisis	[y2,y3)	[2,3)
J	latent crisis	[x1,x2)	[1,2)	developing crisis	[y2,y3)	[2,3)
K	developing crisis	[x2,x3)	[2,3)	developing crisis	[y2,y3)	[2,3)
L	crisis	≥x3	3	developing crisis	[y2,y3)	[2,3)
M	non-crisis	[0,x1)	[0,1)	crisis	≥y3	3
N	latent crisis	[x1,x2)	[1,2)	crisis	≥y3	3
O	developing crisis	[x2,x3)	[2,3)	crisis	≥y3	3
P	crisis	≥x3	3	crisis	≥y3	3

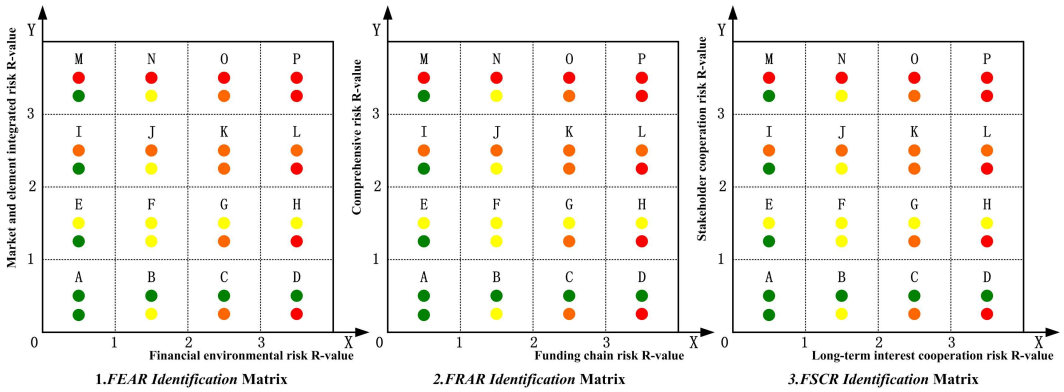

Fig. 4: Matrix identification model of three-dimensional financial risks

Chemical enterprise's financial risks can be identified through matrixes, including Financial Environment-adaptation Risk identification matrix, Financial Resource-allocation Risk identification matrix and Financial Stakeholder-cooperation Risk identification matrix. Financial Environment-adaptation Risk identification matrix uses FER R-value (x_{i1}) as lateral axis, and market and element integrated risk R-value (y_{i1}) as longitudinal axis. And in constructing Financial Resource-allocation Risk identification matrix, FCR R-value (x_{i2}) is lateral axis, and comprehensive risk R-value of operation, investment & financing (y_{i2}) is longitudinal axis. And in Financial Stakeholder-cooperation Risk identification matrix, this paper adopts LPR R-value (x_{i3}) as lateral axis, and stakeholder cooperation risk R-value (y_{i3}) as longitudinal axis (the formulas are 7,8,9). The judgments of three-dimensional financial risks identification matrix are mainly based on the value scope. The three-dimensional financial risk identification models can be shown as Figure 4.

ALGORITHM

Suppose the sample number of chemical enterprise is η what means the domain is $U=\{u_1,u_2,\ldots,u_n\}$. And if the financial risks index vector set is $T=[t_{i1},t_{i2}, \ldots,t_{im}]$, risk controlling point vector set is $\eta=[\eta_1, \eta_2, \ldots, \eta_m]$, then the calculated risk index can be get from the following formula:

$$z_{ij} = \left|1 - t_{ij} / \eta_j\right| \tag{3}$$

Where z_{ij} is the calculated j-th value of i-th enterprise, η_j and t_{ij} separately represent risk controlling point index value and actual risk index value (i=1,2,…,n; j=1,2,…,m) .

Risk controlling point value η_j can be calculated by formula 2, actual value t_{ij} can be calculated from the formulas in table 4, R-values can be calculated by formula 1. So the calculated risk level vector set can be expressed as $R_i=[R_{i1},R_{i2},\ldots,R_{i10}]$.

Then, the Financial Environment-adaptation Risk R-value, the Financial Resource-allocation Risk R-value and the Financial Stakeholder-cooperation Risk R-value can be calculated through the following formulas:

$$R\_FEAR_i = \sum_{j=1}^{3} \omega_j^1 \cdot R_{ij} \tag{4}$$

$$R\_FRAR_i = \sum_{j=4}^{7} \omega_j^2 \cdot R_{ij} \tag{5}$$

$$R\_FSCR_i = \sum_{j=8}^{10} \omega_j^3 \cdot R_{ij} \tag{6}$$

Where $\omega_j^1 = R_j \Big/ \sum_{j=1}^{3} R_j, \sum_{j=1}^{3} \omega_j^1 = 1;\quad \omega_j^2 = R_j \Big/ \sum_{j=4}^{7} R_j, \sum_{j=4}^{7} \omega_j^2 = 1;\quad \omega_j^3 = R_j \Big/ \sum_{j=8}^{10} R_j, \sum_{j=8}^{10} \omega_j^3 = 1.$

Calculation of Financial Environment-adaptation Risk identification matrix adopts following formula:

$$\begin{cases} x_{i1} = R_{i3} \\ y_{i1} = \sqrt{R_{i1} \cdot R_{i2}} \end{cases} \tag{7}$$

Calculation of Financial Resource-allocation Risk identification matrix adopts following formula:

$$\begin{cases} x_{i2} = R_{i7} \\ y_{i2} = \sqrt[3]{R_{i4} \cdot R_{i5} \cdot R_{i6}} \end{cases} \tag{8}$$

And calculation of Financial Stakeholder-cooperation Risk identification matrix adopts following formula:

$$\begin{cases} x_{i3} = R_{i10} \\ y_{i3} = \sqrt{R_{i8} \cdot R_{i9}} \end{cases} \tag{9}$$

Table 4. Index system for three-dimensional financial risk identification

Target Layer Index	*Criterion Layer Index*	*Calculation Formula*	*Notes*
Financial Environment-adaptation Risk index	FER index t_{i1}	$t_{i1} = FE / CIO$	FE: Finance expense CIO: Cash inflows from operating activities
	MCR index t_{i2}	$t_{i2} = VTF / SGP$	VTF:Various taxes and fees SGP:Sales gross profit
	EFR index t_{i3}	$t_{i3} = MMPI$	MMPI:The main raw materials price index
Financial Resource-allocation Risk index	OPR index t_{i4}	$t_{i4} = 1 - COO / CIO$	COO: Cash outflows from operating activities
	INR index t_{i5}	$t_{i5} = 1 - NCA / NCL$	NCA:Non-current assets NCL:Non-current liability
	FIR index t_{i6}	$t_{i6} = STLL / STL$	STLL:Long-term investment of short-term loans STL:Short-term loans
	FCR index t_{i7}	$t_{i7} = BC / COO$	BC:Bank and cash
Financial Stakeholder-cooperation Risk index	CCR index t_{i8}	$t_{i8} = AR / FCA$	FCA:Financial current assets AR:Account receivable
	OCR index t_{i9}	$t_{i9} = RFCFE / RFCF$	RFCFE:Rectified free cash flow equity RCFF:Rectified free cash flow
	LPR index t_{i10}	$t_{i10} = RCAV / RCEV$	RCAV: Rectified cash added value RCEV: Rectified cash earning value

CASE STUDY

INDEX SYSTEM

Based on the above analysis, this paper constructs financial risk identification index system from three dimensions. There are three indexes to reflect Financial Environment-adaptation Risk what are FER index t_{i1}, MCR index t_{i2} and EFR index t_{i3}. There are four indexes to reflect Financial Resource-allocation Risk what are OPR index t_{i4}, INR index t_{i5}, FIR index t_{i6} and FCR index t_{i7}. There are three indexes to reflect Financial Stakeholder-cooperation Risk what are CCR index t_{i8}, OCR index t_{i9} and LPR index t_{i10}. The calculation formulas of indexes are shown in Table 4.

SAMPLE SELECTION & CALCULATION RESULTS

This paper selects some samples of chemical enterprises of China to do the case study. Consideration of the data availability, research samples are limited to A-share companies listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange. Some of the samples are excluded for the reason of the data incomplete. The data of samples is from the year of 2010 to 2012. After data sampling, filtering, calculation and other processes, we can get the calculation results (some is shown in Table 5 and Table 6). From these results, we can see that each of the chemical enterprises has a different type of risk identification matrix in each dimension. For example, No. 1 chemical enterprise has a "F" type of matrix of Financial Environment-adaptation Risk, this means its financial environmental risk and market & elements integrated risk are all in the latent crisis period, and the indicators can be shown as "yellow warning light and yellow warning light".

Table 5: R-values of some of the calculation results

No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
R_{i1}	2.2868	1.0214	0.5451	0.6893	1.3495	2.4606	0.1783	2.3657	1.3644	0.3802
R_{i2}	2.8325	2.5199	2.6564	0.9955	1.8702	0.4420	1.8731	1.8560	1.6784	0.4794
R_{i3}	1.4884	2.0587	0.6783	2.9422	0.2714	2.3244	1.2414	2.1297	2.9063	1.8410
R_{i4}	2.7550	2.7938	0.5863	1.3016	2.0722	0.4287	0.3806	2.3600	0.2048	0.4181
R_{i5}	1.1333	2.9028	2.3359	1.0299	0.7555	0.0328	0.7883	1.5965	1.1817	2.3866
R_{i6}	0.6209	1.4016	1.7577	0.2631	1.8163	1.5408	0.1240	0.5373	0.8467	1.4446
R_{i7}	1.9688	2.0289	1.8500	0.5927	0.4042	1.0827	1.6072	1.2934	1.2503	2.3662
R_{i8}	1.4401	0.8788	2.3991	0.6706	0.8101	0.7789	1.4776	0.4509	2.4603	1.2647
R_{i9}	1.5268	1.4495	0.2394	0.3505	2.8205	0.0823	2.7255	2.1572	0.8503	1.3520
Ri_{10}	1.5310	2.6652	0.7803	2.6705	2.3299	1.8794	2.0072	2.7148	1.2242	1.9002
R_FEAR_i	2.0145	2.3482	1.3929	2.0250	1.5402	1.9354	1.8657	2.349	2.3944	1.3200
R_FRAR_i	1.9079	1.3283	0.7090	1.8247	1.7695	1.7951	1.7731	2.2141	1.5701	1.4449
R_FSCR_i	2.1520	1.7585	2.2534	1.8084	1.5918	2.0639	2.0550	1.6988	1.7361	1.9032

Table 6: Matrix types of some of the calculation results

No.	*Matrix of Financial Environment-adaptation Risk*			*Matrix of Financial Resource-allocation Risk*			*Matrix of Financial Stakeholder-cooperation Risk*		
	X	*Y*	*Type*	*X*	*Y*	*Type*	*X*	*Y*	*Type*
1	1.4884	1.9042	F	1.9688	1.0017	F	1.5310	0.2942	B
2	2.0587	2.5701	K	2.0289	0.6634	C	2.6652	1.3515	G
3	0.6783	1.4886	E	1.8500	0.6861	B	0.7803	0.3379	A
4	2.9422	1.4517	G	0.5927	1.6109	E	2.6705	1.2629	G
5	0.2714	1.6185	E	0.4042	1.2509	E	2.3299	0.5868	C
6	2.3244	1.5725	G	1.0827	1.6206	F	1.8794	1.4300	F
7	1.2414	1.8647	F	1.6072	1.8346	F	2.0072	2.1010	K
8	2.1297	2.1502	K	1.2934	1.9112	F	2.7148	1.5054	G
9	2.9063	2.0568	K	1.2503	0.5444	B	1.2242	1.7783	F
10	1.8410	1.4374	F	2.3662	1.3051	G	1.9002	0.1787	B

CONCLUSION

This paper gives some theoretical analysis and builds some models for the research of three-dimensional financial risks, and an empirical analysis is also made. The main contributions of this paper can be summarized as follows:

(i)Connotation of financial risks has broken through traditional risk view, and has obvious features of dimension. three-dimensional financial risks is a kind of risk view based on the understanding of enterprise's external environment, internal resources and stakeholders, and is an integration of time and space to financial risks. In this paper, three-dimensional financial risks are refers to Financial Environment-adaptation Risk, Financial Resource-allocation Risk and Financial Stakeholder-cooperation Risk.

(ii)Three-dimensional financial risks are formed through the process of environmental adaptation, resource allocation and profits cooperation, and conduct by time and space paths. From time level, three-dimensional financial risks are conducted and spread following the path of "'non-risk period' to 'latent period' to 'development

period' and to 'realization period'". Analyzed from space level, three-dimensional financial risks are conducted and spread with the cycling path of "Financial Environment-adaptation Risk o Financial Resource-allocation Risk and to Financial Stakeholder-cooperation Risk".

(iii)It explores the identifying principle of three-dimensional financial risks, builds financial risk identification matrixes including Financial Environment-adaptation Risk identification matrix, Financial Resource-allocation Risk identification matrix and Financial Stakeholder-cooperation Risk identification matrix. Meanwhile, a case study shows that three-dimensional financial risk identification matrixes can be used to identify financial risks.

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