

Article

# Research on Enterprise Financial Risk Conduction Mechanism Based on System Dynamics

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**Abstract:** Affected by the COVID-19 pandemic and the economic situation, many enterprises have fallen into financial crisis. In order to explore the causes of enterprise financial risk and the conduction path of risk sources, this paper starts from the theory, characteristics, and path of financial risk conduction, combines Hall three-dimensional structure and system dynamics models, establishes the path of enterprise financial risk conduction (causality graph), and combines the value-at-risk VaR model to measure the risk. Based on this methodology, a three-dimensional multiple risk interaction and dynamic–static combination of an enterprise financial risk conduction model is established, aiming at identifying the sources of financial risk in different periods and providing timely risk control countermeasures to avoid financial crises. This paper does not refine some of the indicators and takes into account the probability of different scenarios and/or the number of trigger strategies to avoid or reduce risk. In the future, refining the indicators to include considerations such as production technology will enable a more robust model of corporate financial risk conduction.

**Keywords:** financial risk; financial risk conduction path; system dynamics



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## 1. Introduction

Under the influence of both COVID-19 and the economic situation, many enterprises are in financial crisis (Zheng, Fengjiao et al., 2021) [1]. The financial crisis of enterprises is caused by the coupling effect resulting from the conduction of financial risk sources in the enterprise risk path (Jin Yingying, 2018) [2]. Risk conduction refers to the transmission and influence of risk among the relevant interest groups within the system. Enterprise risk conduction has an objective existence. Due to the constraints of the external environment as well as internal factors, enterprises are subject to a great deal of uncertainty in a fiercely changing competitive market environment. As long as uncertainty exists, enterprises are exposed to many risks. The existence of direct or indirect correlations in the economic system leads to the prevalence of risk conduction (Ye Jianmu, 2005) [3].

Enterprise financial risk conduction exists through information transfer (DeMarzo et al., 1998) [4]. Enterprise financial risk has dynamic conduction, where the financial risk of one enterprise is transmitted to related others in the financial relationship network. The types of paths of enterprise financial risk conduction and subjects of analyses are the butterfly effect, domino effect, coupling effect, and broken windows theory of financial risk conduction (Ye Jianmu, 2009) [5]. Financial risk as a specific research object starts from key elements of conduction, such as the risk source, risk carrier, risk flow, risk representation, conduction path, and risk threshold, and financial risk has general rules and mechanisms in the conduction of enterprises (Xia Che, 2009) [6]. There are three elements of financial risk conduction in enterprises: risk initiation and the fuse and conduction carriers (Chen Aizhao, 2009) [7]. Enterprises are in a state of uncertainty at all times when organising financial activities and handling financial relationships and are extremely vulnerable to financial risks. The frequent occurrence of enterprise financial crises in the past 20 years fully illustrates the dynamic conduction of enterprise financial risks. Within an enterprise's financial system, the financial risk of one financial department is easily transferred to another either directly

or indirectly related financial department. Within a network of interest-based financial relationships, the financial risks of financial relationships are transmitted to the enterprise through the interest chain. Therefore, it is of theoretical value and practical significance to study the mechanism of financial risk conduction in enterprises and propose financial risk conduction control strategies to improve the theory of financial risk management and enhance the level of financial risk management in enterprises (Shen Jun, 2011) [8]. Supply chain risk conduction consists of four main components: risk source, conduction medium, conduction node, and risk receiver (Li Gang, 2011) [9]. The risk sources are the source of supply chain risk conduction, with internal risk sources consisting of risk factors such as systemic risk, management risk, and financial risk and external risk sources, which are determined by market and environmental uncertainty (Guan, Z., 2011) [10]. In order to study the transmission of financial risk elements in enterprise projects chain, Li et al. 2013 [11] constructed a risk network model of the enterprise projects chain based on complex networks and reported that financial risk conduction has the characteristics of a complex network. The enterprise risk conduction medium is a tangible material or intangible effect that transmits risk sources, mainly materials, capital, and personnel (Liu Chunxia, 2015) [12]. Studies have attempted to identify risk management variables and find a causal relationship between enterprise financial risk and the quality of internal governance and management opportunism (Kamaludin et al., 2016) [13]. Strategies have also been presented on how to control the financial risk conduction related to real cases (Li Bin, 2017) [14]. Enterprise financial risk conduction from the perspective of vulnerability, i.e., when the failure of one enterprise would lead to the failure of other enterprises, is when ordinary financial vulnerability occurs (Davis et al., 2019) [15]. Yang et al. 2021 [16] introduced a temporal dimension to characterise the evolution of enterprise risk events, such as dynamism, suddenness, and timeliness.

Scholars have been studying financial risk for a long time, but little research has been conducted on the dynamics of financial risk, that is, on the conduction of financial risk and its control. Studies on financial risk conduction commonly use static models to study the probability and consequences of their events; however, risks are not always static. Due to the dynamic changes in the constant flow of funds, the conduction of financial risks is characterised by readiness and multiplicity (Chen Yuntao, 2017) [17]. The positive and negative feedback in the conduction process of financial risk has a certain degree of correlation with the direction of the flow of corporate capital and is influenced by very many external and internal factors. The assessment of financial risk needs to take into account stock and flow (Wang Zhuquan, 2020) [18], when the risk accumulates to a certain amount beyond the risk threshold, or when the risk threshold level decreases due to the influence of internal and external factors; the risk factors within the enterprise start to shift from static to dynamic attachment to the risk vector and along the conduction path, diffusing and spreading the risk within and outside the enterprise in the form of old risk representations or new forms of coupled mutations (Xia Che and Deng Mingran, 2006) [19]. The enterprise is often not a single risk in action; it is multiple risks interacting with each other. Failure to develop an enterprise financial risk conduction model that combines multiple risk interactions of dynamics and statics can easily result in:

- (1) The flow of cash being dynamic and being unable to effectively model the flow trend of cash without realistic meaning;
- (2) There may be more than one source of risk to the enterprise, and if one focuses on only one source of risk and loses sight of the other, the control programme cannot cover it effectively;
- (3) Risk sources can affect each other if there is a strong coupling effect risk interaction and conduction that can cause more harm to the enterprise.

To this end, this paper attempts to establish a three-dimensional model of enterprise financial risk conduction based on the system dynamics theory with multiple risk interactions and a combination of dynamics and statics. The study explored the mechanism of enterprise financial risk conduction in the new era and discovered that enterprise financial

risk conduction has complexity, dynamics, feedback and time lag in line with the characteristics of the system dynamics model (Wang Min, 2016) [20]. As a major theory of systematic thinking, system dynamics is good at dealing with long-term, dynamic, and non-linear problems. System dynamics is derived from “structuralism”, which focuses more on the linkages and structure of system elements rather than on the numerical values of system elements (Bianchi, 2010; Cosenz and Noto, 2016) [21,22]. As an intersection and branch of the fields of systems science and management science, system dynamics is an analytical study of the cause and effect and feedback of systems to identify and propose solutions to system problems (Darabi and Hosseinichimeh, 2020) [23]. System dynamics can simulate variables and use mathematics and logic to randomly test and delay functions.

## 2. Definition of Concept and Theoretical Foundation

### 2.1. Financial Risk

According to the Merriam-Webster dictionary, risk is a presence that can cause loss or damage. Risk factors are defined as various factors that have an impact (positive or negative) on risk. Risk is defined as an event, situation, or activity that could lead to a potential loss. A loss is defined as a negative outcome from a risk. Note that risk factors are not risks per se, or that risks do not necessarily cause losses (Qin L, 2012) [24].

Financial risk is the possibility of a deterioration in financial position, which is an important factor in the rise and fall of a business. Although enterprises want to maintain a good financial position, financial risk is very difficult to avoid in the course of business. Financial risk is usually divided into narrow and broad concepts. Narrow financial risk focuses on the ability of an enterprise to use monetary funds to repay debts as they fall due, and this can only reflect the financial problems of the enterprise within a certain period of time; broad financial risk focuses more on the overall business process of the enterprise, and the uncertain internal and external factors in the business process that may affect the expected financial returns of the enterprise are collectively referred to as the financial risk. Therefore, the source of financial risk is induced by risk factors which have a positive or negative effect on finance (Chen Xiangqing, 2018) [25]. In this paper, financial risk is qualitatively measured as the potential for financial loss and negative outcomes.

### 2.2. Enterprise Financial Risk Conduction

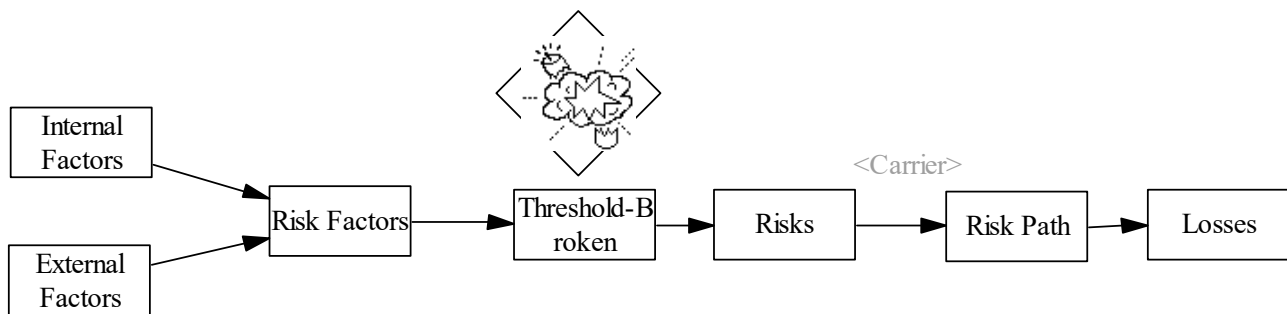
#### 2.2.1. The Concept of Enterprise Financial Risk Conduction

Most scholars have studied financial risk conduction, but little research has been conducted on enterprise financial risk conduction. In China, led by scholars from Wuhan University of Technology, the study of enterprise financial risk conduction combines the swinging system, thermodynamics, and other non-financial domain knowledge and views enterprise finance as a system of interconnectedness and mutual influence formed by its financial relationships. From a systems theory perspective, the bursting and conduction of enterprise financial risk and the series of interactions between the subject and the mediator can be viewed as a complete system, which can be called the financial risk conduction system. Based on the aforementioned broad definition of financial risk, the conduction of financial risk refers to the economic loss caused by the uncertainty of financial activities or financial relationships at another node or a series of nodes in the system path, which is caused by the risk factors induced by the information or financial activities in a link or node in the business and in the development process environment of the enterprise.

#### 2.2.2. Characteristics of Enterprise Financial Risk Conduction

The conduction of financial risk can only occur when a number of conditions are met. In the process of operation and development, enterprises are affected by external and internal factors, causing the real financial activities to deviate from the established financial objectives and accumulate into static financial risk factors. When the accumulation of risk

factors exceeds the threshold value that the enterprise can control, a dynamic risk flow is formed, and the risk flow passes through the carriers of capital, information, personnel, and technology and proceeds along the capital supply chain and business process chain paths of financial activities (Hu Cuiping, 2008) [26]. The elements of enterprise financial risk conduction are shown in Figure 1.



**Figure 1.** Diagram of the elements of enterprise financial risk conduction.

Therefore, financial risk conduction has the following characteristics:

(1) Dynamicity

When risk factors accumulate to a certain amount beyond the risk threshold or when the risk threshold level decreases due to internal and external factors, the risk factors within the enterprise start to shift from static to dynamic, forming risk sources attached to risk carriers and spreading within and outside the enterprise along the conduction path with the original risk representations or new risk forms after coupling mutations. The transmission of financial risk refers to not only the conduction of a node or link within the enterprise, but also refers to the conduction of financial risk to other stakeholders through the carrier. The dynamic nature of risk is also reflected in the transfer of risk from one place to another place where it occurs; for example, when an investment loses money and the enterprise raises funds to cover the loss, the risk is transferred from investment to financing.

(2) Latent Property and Concealment

Macro financial risk is essentially a mirror image of the financial risk of micro entities (Wang Zhuquan, 2020) [18]. As systemic financial risks have a long-term latent property and concealment nature before they erupt, only when quantitative changes accumulate to a certain extent will they suddenly undergo qualitative changes (Wang Zhaoxing, 2020) [27]. Therefore, financial risks also have a long-term latent property and concealment nature before they erupt, and they will erupt in the conduction path when the volume of risk factors accumulates to a certain level beyond a controllable threshold.

(3) Interactivity

In the process of enterprise financial risk conduction, the direction of financial risk conduction is interactively transmitted in many ways. For the nodes with a high correlation of economic interests, the financial risk conduction is stronger; the risk of a certain node will be transmitted in multiple directions, with the carrier or the risk of multiple directions being transmitted to a certain node with the carrier. Moreover, the financial risk of the enterprise is not only internally influenced but is also influenced by the complex and changing external environment. The internal environment of the enterprise is adjusted based on the requirements of the industry environment (Hong W.C., 2021) [28], and the consideration of financial risk requires a combination of internal and external factors. Therefore, financial risk conduction has interactivity.

#### (4) Feedback nature

There are multiple feedback loops in the day-to-day conduction of an enterprise's financial risk. The main attributes of the enterprise include total assets, liabilities, taxes, market share, etc. The decision variables are closely related to enterprise financing, investment, production and operation, and profit distribution, and when one fulcrum sends out a response, the associated fulcrums will provide feedback. When an enterprise's raw material costs rise, it will have an impact on the pricing and sales of goods, thus making reductions in other parts of the costs and forming a feedback loop.

### 2.3. Theoretical Foundation

#### 2.3.1. Cash Flow Theory

Cash flow theory is the theory of cash, cash flow, and free cash flow and is the most fundamental theory of financial management. Cash flow is usually a general term for the inflow and outflow of cash and cash equivalents generated through certain economic activities and their total amount in a certain accounting period in accordance with the cash receipts and payment systems. It objectively exists throughout the business activities of an enterprise and not only dynamically reflects the economic activities of the enterprise and protects and controls them, but also indicates the ability of the enterprise to obtain cash and cash equivalents. Financial risk and cash flow show a very complex relationship in the whole process of the enterprise's capital movement; the two are mutually constrained and, at the same time, not separate from each other. As a result, there is no certainty that financial risk is hidden in the entire process of daily capital movements of an enterprise. As the blood that sustains a business, cash flow not only provides an important basis for continued operations but also provides an indispensable resource for the expansion and reproduction of the business. If the cash flow is poor, the business is at risk of insolvency. The common denominator of both is to enable the enterprise to survive in a competitive market, to achieve long-term stable development, to create maximum market value for the enterprise, and to ultimately achieve the strategic objectives of the enterprise (Yang Zhiyu and Yang Jinghai, 2014) [29].

Comparing an enterprise to a "reservoir" (Cao Yuwei, 2017) [30], the inflow of cash is compared with the inflow of water, which will increase the stock of the reservoir, whereas the outflow of cash will reduce its stock; the reservoir plays an accumulative and buffering role for the inflow and outflow, and the net cash flow represents the stock of the reservoir. The size of the stock largely determines the ability of the enterprise to withstand financial risks, but this does not mean that the larger the size of the "reservoir" the better, although this will reduce the possibility of a break in the enterprise's cash chain. The accumulation of cash in the enterprise without reasonable use, to a certain extent, will limit the enterprise's production and operation activities. This is not conducive to the survival and expansion of the enterprise.

#### 2.3.2. Stakeholder Theory

An enterprise cannot survive without such an interest group, without whose support the enterprise cannot survive. Such an interest group is called a stakeholder (Freeman R.E., 1984) [31]. They are the ones who have invested physical capital, human capital, financial capital, or something of value in the enterprise and have thereby assumed some risk; rather, they have taken risks as a result of the enterprise's activities (Clarkson, M.B.E., 1994) [32].

As a contract complex that brings together the needs of multiple interests, the enterprise on the one hand relies on the profits of the enterprise in order to realise the needs of each party's interests so that the goals of the various stakeholders in the enterprise have a certain degree of overlap; in turn, the interests of the enterprise are interrelated and interlocked to achieve the goals of each party's independent interests. Therefore, stakeholder theory is the basis for locating and analysing the interrelationship between an enterprise and its stakeholders, and it is because of the conflicting and contradictory needs of their

interests that clarifying the interests of each party is the basis and key to studying the conduction of financial risk in an enterprise.

### 2.3.3. System Theory

A system is a collection of interconnected and interacting elements or organisations that form the whole body. A system can be thought of as a collection of various elements that come together (Qian Xuesen, 1988; Klir, G.J., 2001) [33,34]. These elements are diverse, complex, irregular, non-linear, and unpredictable. At the same time, these elements are interconnected and interact with each other (Tang Zhicheng, 2020; Ramos Guilherme and Aguiar A, 2022) [35,36]. These elements work together as an aggregate. By considering the entire business operation as an aggregate consisting of various elements, the entire financial operation process of the business is a complete system.

#### (1) Hall Three-dimensional Structure

Using Hall three-dimensional structure, also known as Hall's system engineering, system engineering work or activities can be decomposed into different stages and steps; to complete the corresponding tasks of each stage and step, different professional knowledge and skills are required to guide process and are represented with the time, logical, and knowledge dimensions as the coordinates, respectively. The seven stages in the time dimension represent the whole life cycle of the project. The seven processes in the logical dimensions represent the whole process of the project, and the various disciplines necessary to complete each phase and the corresponding tasks are found in the knowledge dimension; a three-dimensional spatial structure is constructed to represent the overall structure of the system using the combination of different dimensions to describe the overall structure and spatial composition of the system (Hall, A.D., 2007) [37]. A Hall three-dimensional structure decomposes the enterprise financial risk conduction system from different dimensions, providing an effective way of thinking for the study of the mechanism of enterprise financial risk conduction. This paper uses the time dimension as the basis to analyse the impact of the financial activities (knowledge dimension) of different core stakeholders (logical dimension) on the conduction of financial risk in the whole life cycle of the enterprise.

In the time dimension, the conduction of financial risk occurs throughout the life cycle of an enterprise, including the start-up, growth, maturity, and decline periods (Cao Yu et al., 2009; Chen Shen et al., 2016) [38,39]. Financial risk occurs at different stages of an enterprise's life cycle and needs to be analysed according to the process and characteristics of capital movements at each stage. From the logic dimension, the core stakeholders involved in different stages of the enterprise are different, and they pay different risks and have different benefit needs and thus may cause or face different financial risks. In terms of the knowledge dimension, the content of financial activities carried out by different core stakeholders at different stages of the enterprise's entire life cycle also varies, and the impact of financial risks arising from their financial activities also varies.

#### (2) System Dynamics

Professor Jay W. Forrester's publication *Industrial Dynamics: A Major Breakthrough for Decision Makers*, which applied systems thinking to industrial business management (Forrester, J.W., 1958) [40], opened a new era of systems thinking; his publication *Industrial Dynamics*, which clarified the principles of dynamic behaviour in systems, completely established systems dynamics in its theoretical integrity (Lyneis, J.M., 1980) [41]. System dynamics is a discipline based on systems theory using the help of computer simulations to study the causal feedback structure and dynamic behaviour of systems, and it is considered as an effective tool for studying the influence of the internal structure and feedback mechanisms on the dynamic behaviour of systems (Ghaffarzadegan, N., Lyneis et al., 2011) [42].

As shown in Figure 2, the use of a Hall three-dimensional structure can be used to systematically decompose and qualitatively study the enterprise financial risk transmission system; combining this with system dynamics can further quantitatively simulate the whole process and results of enterprise financial risk conduction and can further comprehensively analyse the mechanism of enterprise financial risk conduction from both qualitative and quantitative aspects.

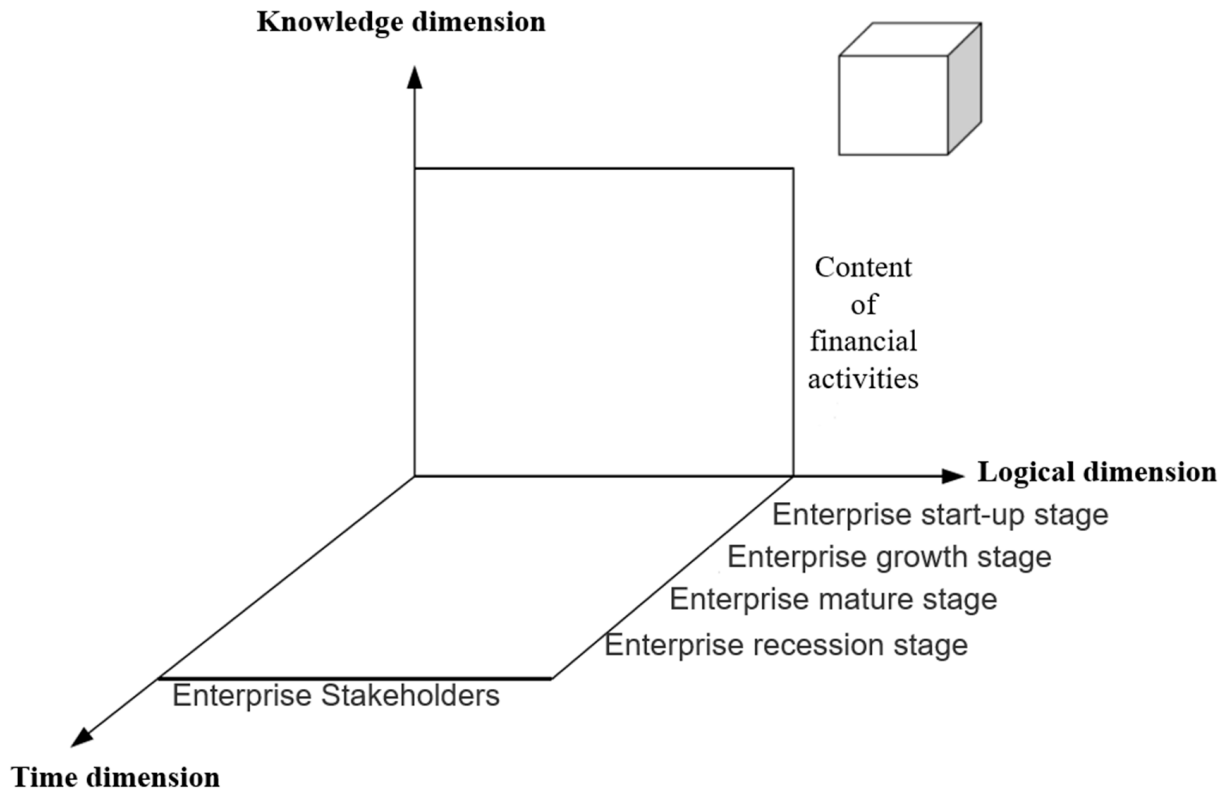


Figure 2. Hall three-dimensional structure diagram.

2.4. Value-at-Risk Measurement Model

When measuring the financial risk of an enterprise, the level of strategic decision-making is a non-financial metric that needs to be measured in terms of the reflection of the external market, i.e., the stock market. The VaR model in this study is based on Li Ying, 2013 [43].

$$r = (P_t - P_{t-1}) / P_t \tag{1}$$

where:

- $r$  is the rate of return;
- $P_t$  is the closing price of the stock;
- $P_{t-1}$  is the opening price of the stock.

$$P = P_0(1 + r) \tag{2}$$

where:

- $P_0$  is the opening value of the selected company's shares;
- $P$  is the closing value of the selected company's shares.

$$P^* = P_0(1 + r^*) \tag{3}$$

where:

$P^*$  is the minimum value of the selected company's shares at the end of the period;  
 $r^*$  is the minimum rate of return.

$$\text{Prob}(P \leq P^*) = \int_{p^*}^{+\infty} f(w)dw = a \quad (4)$$

where the confidence level is  $a$ ; set the probability distribution as  $f(w)$ .

The mean and standard deviation of the return  $r$  over the holding period  $\Delta t$  are  $\mu$  and  $\sigma$ , respectively. The quantile of the confidence level  $a$  is  $\xi^*$ , which can be obtained by looking up the table, and the expected value at the end of the period is  $E(p)$ , The relative loss =  $E(p) - P^* = P_0 (u - r^*)$ .

$$\int_{p^*}^{+\infty} f(w)dw = \int_{-\infty}^{\xi^*} f(r)dr = a \quad (5)$$

If  $r^* = \mu - \sigma_p \xi^*$ , then relative loss =  $P_0 \sigma_p \xi^*$ .

Obtain value-at-risk:

$$\text{VaR} = \sigma_p \xi^* \quad (6)$$

### 3. Enterprise Financial Risk Transmission Modelling

#### 3.1. Factors Affecting the Index System

The Hall three-dimensional structure was used to decompose the financial conduction path in the enterprise system. From the production source, it mainly included cash flow generated from operating, investment, and financing activities. These production and operation activities are not only influenced by factors external to the enterprise, including national macroeconomic policies, politics and laws, science and technology, social culture, decision-makers and investor human factors, and competition in the same industry, but also by the internal development of the enterprise, such as the life cycle of the enterprise, business strategy, investment decisions, financial policies, and accounting policies of the enterprise (Fan Qiaoli, Wang Jianzhong, 2016) [44].

#### 3.2. Methods of Indicator Selection

There are usually many methods of indicator selection. As the financial risk conduction system was constructed based on the perspective of system dynamics, the key issue was to determine the boundary of the system, that is, to determine the boundary of the enterprise's financial risk conduction path. The root of this is to select indicators based on the principle of full coverage of all influencing factors as far as possible. There were three main methods used in the study. The first was frequency analysis, which is a statistical analysis of the frequency of indicators used in reports, authoritative publications, or media materials on the content of the study, from which the more frequent indicators are selected. The second was theoretical analysis, which is mainly based on the analysis and research of key issues based on the existing theories of relevant books, monographs, academic papers and reports, etc., from which factors with research value or potential research value are selected; finally, the index system is set according to these factors. Thirdly, the factors in the financial risk conduction path were analysed and decomposed based on the Hall three-dimensional structure for the determination of indicators.

#### 3.3. Causal Analysis

##### 3.3.1. Causality

Causality is universal and exists in a wide range of systems. Causal analysis is an effective way of thinking and dissecting the connections of something as a whole or in parts. Causality forms the basis for modelling system dynamics. By determining the causality of a system of enterprise financial conduction indicators, it is not only possible to reflect the



qualitative relationships between the variables within the system of the enterprise financial risk conduction path but to also see the structural framework of the system's feedback, predict the trend of the indicators, and thus grasp the micro-structure of the system of corporate financial risk conduction indicators as a whole.

### 3.3.2. Feedback Loops

After determining the purpose of the study and the problem to be solved, the system should be analysed as a whole, factors selected should be analysed, unnecessary factors should be discarded, key factors of each sub-system should be retained, and links within and between the sub-systems should be reflected in the links of the indicator parameters through causality, which constitutes a feedback loop of causality. There are two types of causal feedback loops: one is the positive feedback loop; that is, when the previous variable increases or decreases, the dependent variable will also increase or decrease, reflecting the same orientation; the other loop is the negative feedback loop, which is the opposite of the positive feedback loop.

### 3.4. Construction of Enterprise Financial Risk Conduction Path

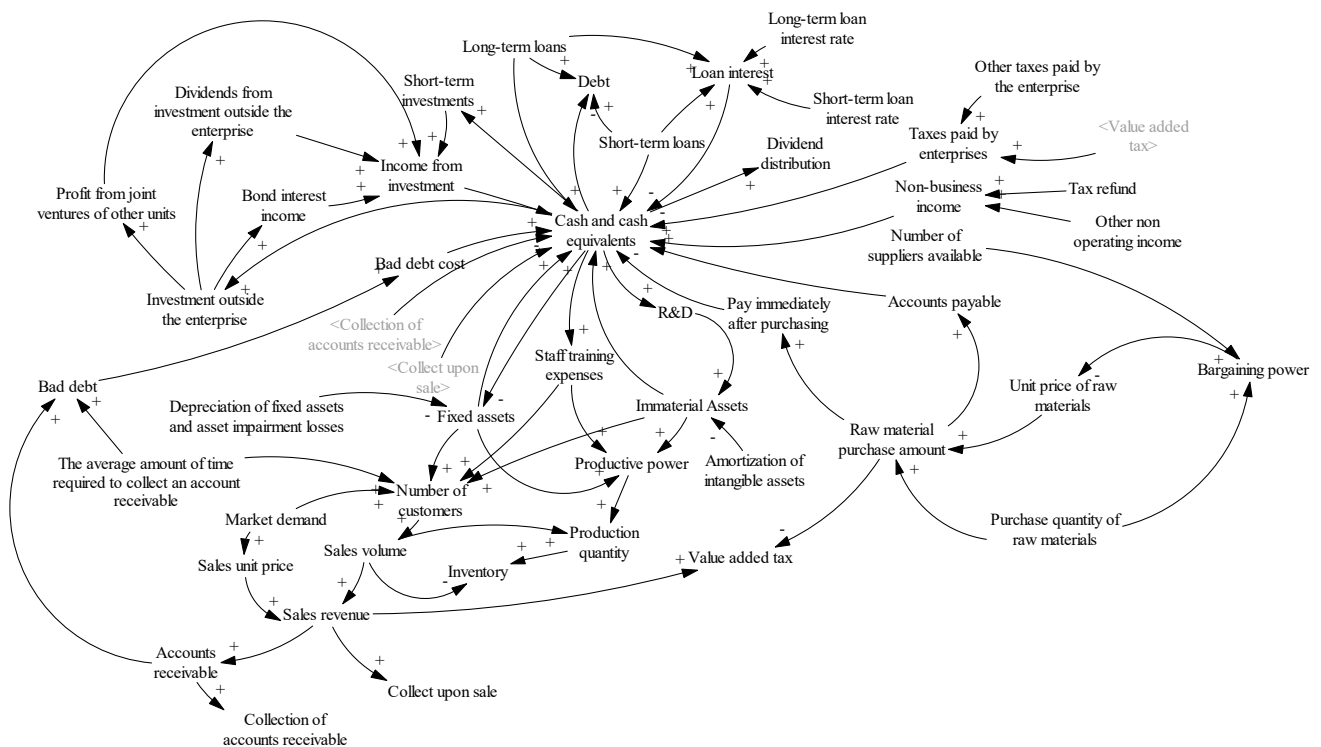
The enterprise financial risk conduction path includes cash flow and personnel information transmission in operating, investment, and financing activities. The financial risk transmission indicator system is divided into three major categories, which are the operating activities financial risk conduction indicator system, investment activities financial risk conduction indicator system, and financing activities financial risk conduction indicator system. The following ideas were used to construct the cash flow financial risk conduction system for enterprises.

(1) Risk conduction path for investment activities: A. high staff training costs → staff training quality not effectively improved → production efficiency/sales efficiency not improved → lower sales → lower profits → lower cash; B. investment failure → investment funds not recovered → lower cash; C. poor R&D output → production capacity/competitiveness not improved → lower profits → lower cash.

(2) Risk conduction path for financing activities: A. high cost of financing → insufficient operating cash to cover financing costs → increased borrowing → increased interest → enterprises fail to repay principal and interest on time; B. increased borrowing rates in financial markets → increased interest rates on short-term borrowing → increased interest costs → decreased profit.

(3) Risk conduction path for operating activities: A. increased product competitiveness/longer collection cycles/stronger sales capacity of employees/increased market demand → increased number of customers → increased sales volume → increased sales revenue → increased accounts receivable → increased bad debt losses → lower profits and cash; B. excessive production of products → higher number of goods in stock → increased storage and transportation costs → lower cash; C. weak bargaining power → increased raw material purchase costs → lower profits → lower cash; D. increased unit price of raw materials → increased raw material purchase costs → lower profits → lower cash.

According to the above establishment of each indicator system, the analysis of the interconnection between each indicator and each indicator system will form an organic whole within the system, thus determining the causal relationship between each indicator system (subsystem), respectively. A diagram of the conduction path of corporate financial risk is established as shown in Figure 3.



**Figure 3.** Enterprise financial risk conduction path diagram.

(1) Accounts receivable as a source of risk—According to the statistical analysis of the National Data Centre of the China Economic Information Network, the total amount of overdue accounts receivable of enterprises in China is as high as 60%, which is much higher than the standard. where the total amount of overdue accounts receivable should not be higher than 10% (Hu Cuiping, 2012) [26]. Therefore, the number of accounts receivable has become one of the biggest sources of financial risk for enterprises in China. A large number of accounts receivable not only weakens the short-term solvency of enterprises but also affects the payment, debt servicing, and turnover capacity of enterprises with the reduction in cash flow, which is an important factor leading to financial crisis. During the start-up period of an enterprise, in order to capture the market and expand sales, more sales on credit are taken to attract customers and expand market share. At this time, the enterprise generates a higher paper profit and if the receivables are not collected in a timely manner, it will result in a lower cash inflow to the business and hence a lower net cash flow from operating activities.

(2) Number of customers as a source of risk—In the start-up period, the number of customers is small, with the external factors of brand influence, the weakening of competition in the same industry, and internal factors of staff quality to improve the number of customers of the enterprise will then increase (BARTH, M.E. et al., 1998) [45]. In the growth phase, when the enterprise is “market-oriented” and the strategic goal is to increase its market share, customer capital will play a greater role. Under certain external policies, the adoption of a lenient credit policy will lead to an increase in the number of customers, which will lead to an increase in sales volume and unit price, which in turn will lead to an increase in sales revenue and ultimately to an increase in cash inflows; at the same time, with the increase in sales revenue, the enterprise’s accounts receivable will also increase, and under a lenient credit policy, the enterprise’s bad debt losses will increase, which in turn will lead to an increase in cash outflows, resulting in an increase in the enterprise’s cash flow risk. This will lead to an increase in cash outflow, resulting in an increase in the cash flow risk of the enterprise, which in turn will lead to an unfavourable financial risk for the enterprise. Cash outflows will increase with the increase in employee salaries, staff training costs, and various taxes. In the recession period, the number of

customers decreases, but value creation heavily relies on customer and human capital (Li Dongwei and Li Jianliang, 2012) [46]; the likelihood of customers maintaining business relationships with the enterprise is critical to mitigating financial risk.

(3) Decline in sales as a source of risk—After the enterprise enters the recession period due to poor sales of the enterprise's products, resulting in a backlog of products and an increase in inventory, the increase in inventory will lead to a slowdown in the enterprise's cash flow and the demand for working capital will increase; if the enterprise's capital reserves are insufficient to meet the normal production and operation activities of the enterprise, the enterprise will incur new debts in order to maintain normal survival, such as incurring bank loans and financial institution loans. The enterprise may generate new stakeholders, or group enterprise and other stakeholders to provide financial support (Song Haitao et al., 2013) [47].

(4) Rising raw material prices as a source of risk—For example, the price of a chemical enterprise's products is highly correlated with the price of oil, and when the cost of raw materials rises, the cost of the product increases and the purchasing power of consumers decreases, and thus profits are reduced. In the start-up phase, enterprises will be able to capture the market with reduced profits and face financial crisis at any time; in the recession phase, enterprises will face reduced profits and accelerate bankruptcy.

(5) Investment mistakes as a source of risk—The main purpose of investment by enterprises is to obtain investment income. Enterprise investment can be divided into internal investment and external investment. Internal investment is mainly to buy production equipment and expand plant and other fixed assets investment; external investment is mainly short-term investment, long-term investment, and other investments. Enterprises dispose of fixed assets, intangible assets, and long-term assets. When the cash outflow from an enterprise's investment activities is not returned, the source of funds needed to repay debts is lost, thus increasing the risk of debt servicing. With increased asset liquidity, enterprises invest more in investing in innovative activities during the start-up, growth, and decline phases; in contrast, fewer investments are made during the maturity phase.

(6) Financial market volatility as a source of risk—Enterprises raise funds not only to expand themselves and repay debts but also to adjust their capital structure and reduce their capital costs and risks. Financing activities are the starting point of enterprise financial management, and the raising of funds in the fierce market competition will be related to the continued operation and survival of enterprise production. When an enterprise's cash flow is insufficient, it needs to carry out financing activities. Enterprises mainly raise funds by increasing cash inflows through paid-in capital and borrowed liabilities (short-term and long-term liabilities), and transaction costs in the financing process are influenced by the financial markets. For example, interest rates depend on the capital and demand in the financial markets after a loan is obtained, while changes in the financial system, such as changes in the exchange rate obtained, may increase the risk of financial transactions. Enterprises often use it to finance short-term loans, and when short-term loans increase, hard financing can lead to increasingly higher interest rates. In addition, some enterprises lose their business and trade because they are unable to pay the interest on their loans (S. Mathu sudhanan et al., 2021) [48]. The way a business operates, the plans it sets, and the financing risks it takes can vary at different times (HABIB, A. 2017) [49]. In the growth phase, when sales are gradually increasing and the enterprise needs a lot of capital to meet its own development and has less retained earnings, its own capital cannot meet the enterprise's production, and the enterprise must borrow externally for funding. In the growth phase, the enterprise's risk-taking capacity is low (Ma Ning, 2018) [50]. The amount of external funding raised by enterprises over the life cycle satisfies the pecking order theory, which states that enterprises lend more to banks in the growth phase than in the maturity and decline phases. During the growth phase, enterprises have more investment opportunities and internal funds that cannot meet their needs, so they increase their external financing needs in order to maintain an internal financial flexibility supply (Zhang Xindong and Chen Yiping, 2015) [51]. The capital investment used when enterprises

are in the growth phase comes more from external financing. Therefore, the financial risk significantly increases when enterprises are in the growth phase. When an enterprise enters the maturity period, all aspects are in a stable state; the production and demand of products reach a stable state, the market share tends to be saturated, the free cash flow and retained earnings in the enterprise are more abundant (DeAngelo, 2007) [52], internal funds can meet the needs of its activities, external financing is greatly reduced, and the financial risk is also reduced. When an enterprise enters a recession, its market share is reduced, its technological innovation capacity decreases, the emergence of a large number of new products can cause them to become impaired or even pile up in warehouses unable to be sold to the market, the enterprise's capital turnover becomes obstructed, sales revenue and free cash flow are greatly reduced, and even losses are incurred (Chen Yan, 2017) [53]. All of these phenomena can lead to a deterioration in the enterprise's financial position (Ye Jianfang, 2010) [54]. During a recession period, the enterprise's external reputation ability is greatly reduced, creditors will be over-supervised, the possibility of bankruptcy will increase, and the financial risk of the enterprise is greatly increased.

### 3.5. Financial Risk Conduction Modeling

The financial risk conduction model can start from the listed disclosure data and end at a variable time. The known part of the input values is obtained from the annual report, and the unknown part of the input values is obtained from the empirical combined regression or time series model if a forecasting model is created. This model is a continuity model. As the accounting assumption is that the enterprise is an ongoing concern, there is no end event marked. The long-term loan, short-term loan, retained earnings, fixed assets, intangible assets, investment outside the enterprise, accounts receivable, accounts payable, cash, and cash equivalents in the financial risk conduction model are stocks, and the equation is represented by the integral INTEG (). A financial risk conduction model (stock and flow diagram) based on the aforementioned causality diagram was developed as shown in Figure 4. The equation of the enterprise financial risk conduction model as shown in Table 1.

**Table 1.** The equation of the enterprise financial risk conduction model.

Cash and cash equivalents = Integ (cash inflow – cash outflow, initial value of cash and cash equivalents)
Cash inflow = Financing capital inflow + investment cash inflow + operating cash inflow + reserve funds of enterprises
Cash outflow = Outflow of financing funds + investment cash outflow + operating cash outflow
Current ratio = (cash and cash equivalents + accounts receivable + new foreign investment × proportion of short-term investment)/(accounts payable + short-term loan repayment + long-term loan repayment)
Equity to liability ratio = (long-term loan + short-term loan + accounts payable)/(retained earnings + reserve funds of enterprises + capital stock)
Ratio of shareholders' equity to fixed assets = (Retained earnings + capital stock)/fixed assets
Long-term loan ratio = Long-term loans/(fixed assets + intangible assets + increasing investment outside the enterprise)

Table 1. Cont.

$p = \text{EXP} (6.289 \times \text{Current ratio} - 3.735 \times \text{Equity to liability ratio} - 1.11 \times \text{Ratio of shareholders' equity to fixed assets} - 8.5 \times \text{Long-term loan ratio} + 0.028 \times \text{average accounts receivable turnover ratio} + 0.631 \times \text{inventory turnover} - 6.823 \times \text{turnover rate of total assets} - 4.85 \times \text{value increasing rate of the value retention} + 75.23 \times \text{VaR}) / (1 + \text{EXP} (6.289 \times \text{current ratio} - 3.735 \times \text{equity to liability ratio} - 1.11 \times \text{ratio of shareholders' equity to fixed assets} - 8.5 \times \text{long-term loan ratio} + 0.028 \times \text{average accounts receivable turnover ratio} + 0.631 \times \text{inventory turnover} - 6.823 \times \text{turnover rate of total assets} - 4.85 \times \text{value increasing rate of the value retention} + 75.23 \times \text{VaR}))^1$
Net cash flow from investment activities = Investment cash inflow – investment cash outflow
Net cash flow of financing activities = Financing cash inflow – financing cash outflow
Net cash flow from operating activities = Operating cash inflow – operating cash outflow
Financing fund inflow = Long-term loan financing + investment absorption + short-term loan financing + other cash received related to financing activities
Outflow from financing activities = Long-term loan repayment + short-term loan repayment + short-term loan interest + long-term loan interest + dividend payment + other cash paid related to financing activities
Investment cash inflow = Disposal of fixed assets + disposal of intangible assets + bond interest income + dividends from foreign investment + profits from joint ventures of other units
Investment cash outflow = Internal investment + new external investment
Operating cash inflow = Cash received from credit sales + cash received + tax refund
Operating cash outflow = Payroll payment + amount payable on demand + cash payment + VAT + other taxes paid by the enterprise
VAT = (Sales volume – unit price of raw materials × sales volume) × tax rate
Accounts receivable = INTEG (Cash received from credit sales – credit sales, initial value of accounts receivable)
Bad debt = Accounts receivable × bad debt rate
Cash received from credit sales = Accounts receivable/Collection cycle
Long-term loan = INTEG (Long-term loan financing – long-term loan repayment, initial value of long-term loan)
Long-term loan interest = Long-term loan × long-term loan interest rate
Short-term loan = INTEG (Short-term loan financing – short-term loan repayment, initial value of short-term loan)
Short-term loan interest = Short-term loan × short-term loan interest rate
Credit sales = Sales × (1 – cash receipt rate)
Cash receipts = Sales × Cash receipt rate
Sales amount = Sales unit price × sales volume
Sales volume = a × number of customers (coefficient a is obtained from the regression equation between the number of customers over the years and the sales volume)
Number of customers = a × fixed assets + b × intangible assets + c × market demand + d × staff quality (a, b, c, d coefficients are obtained from the multiple regression equation of fixed assets, intangible assets, market demand, staff quality to customer quantity over the years)
Staff quality of Chinese state-owned enterprises = IF THEN ELSE (staff training cost ≤ 800, 0, (IF THEN ELSE (staff training cost < 3250, 0.43, (IF THEN ELSE (staff training cost = 3250, 0.86, (IF THEN ELSE (staff training cost ≤ 4600, 0.4, 0))))))
Staff quality of Chinese private enterprises = IF THEN ELSE (staff training cost ≤ 1050, 0, (IF THEN ELSE (staff training cost < 3400, 0.36, (IF THEN ELSE (staff training cost = 3400, 0.73, (IF THEN ELSE (staff training cost ≤ 4800, 0.36, 0))))))

**Table 1.** *Cont.*

Staff quality of foreign-funded enterprises in China = IF THEN ELSE (staff training cost < 3950, 0.35, (IF THEN ELSE (staff training cost = 3950, 0.69, 0.35))) <sup>2</sup> (Tang Xueliang, 2016) [55]
Fixed assets = INTEG (Fixed assets increase – depreciation – fixed assets disposal, initial value of fixed assets)
Intangible assets = INTEG (Conversion to intangible assets – amortization of intangible assets – disposal of intangible assets, initial value of fixed assets)
Investment outside the enterprise = INTEG (Increasing investment outside the enterprise – withdrawal of investment outside the enterprise, initial value of investment outside the enterprise)
Pay immediately after purchase = Purchase amount of raw materials × pay immediately after purchase rate
Credit purchase amount = Raw material purchase amount × (1 – pay immediately after purchase rate)
Accounts payable = INTEG (Purchase amount on credit – cash payment, initial value of accounts payable)
Net profit = Total profit – total profit × income tax rate
Retained earnings = INTEG (Net profit – dividend payment, initial retained earnings)
Dividend payment = Net profit × dividend payment rate
Total profit = Sales – sales volume × unit price of raw materials – taxes and surcharges – selling expenses – administrative expenses – research and development – financial expenses + disposal of fixed assets + disposal of intangible assets – other expenses

### 3.6. Computer Simulation

In this study, the simulation of the corporate financial risk transmission model was carried out by introducing the relevant data of China Dive Company Limited (300526) from 2017 to 2021, which can be obtained from the corporate annual reports and the Wind website.

The positive net investment flows, positive net operating flows, and negative net financing flows in 2020 in Figure 5 are generally good signals for the business, as most companies at this stage have mature products and stable investments. However, the enterprise's net flows from financing in 2020 are less than a quarter year-on-year which, combined with the sharp increase in the negative financial risk of the company in Figure 6, depict that the main source of net cash flows is into investing activities and net flows from financing activities are declining from 2019 onwards. The risk factors are identified through the cause analysis in Vensim software.

In Figure 7, the year-on-year sales in 2020 show a precipitous decline; when combined with Figure 8, the surge in sales volume, the source of financial risk, comes from weak margins. Production is started in 2021 in the hope of getting the business healthy funding with thin margins, but a second source of risk is created in 2021 with falling sales, and the source of risk is transmitted along two financial paths. The first by 2020 product sales rise → excessive production in 2021 → higher product inventories → higher storage and transportation costs → lower cash; the second sales are falling → higher inventories → higher storage and transportation costs → lower cash. At this point, enterprises need to consider adjusting the production and sales structure and clearing inventory in a timely manner.

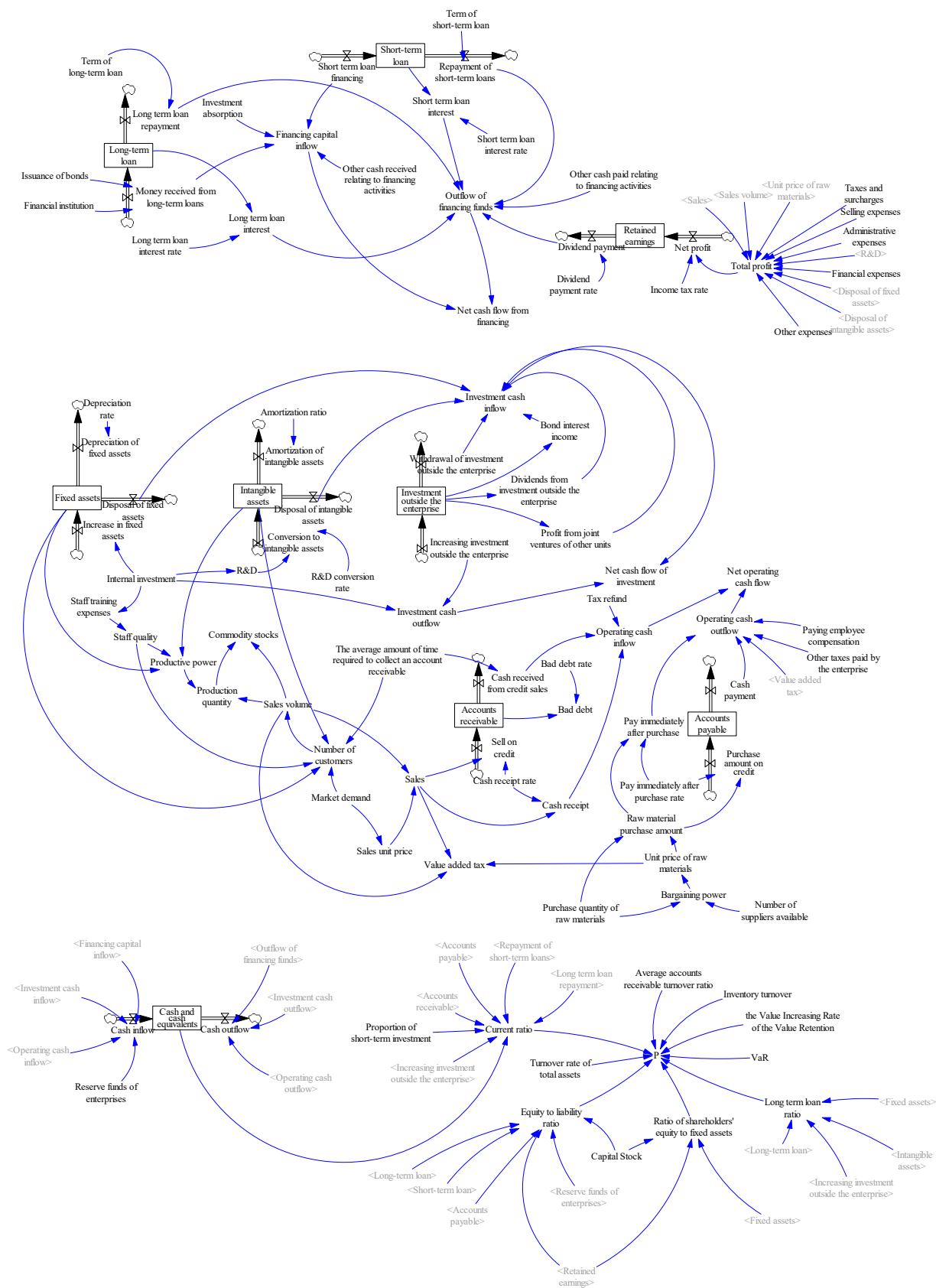


Figure 4. Financial risk conduction model diagram.

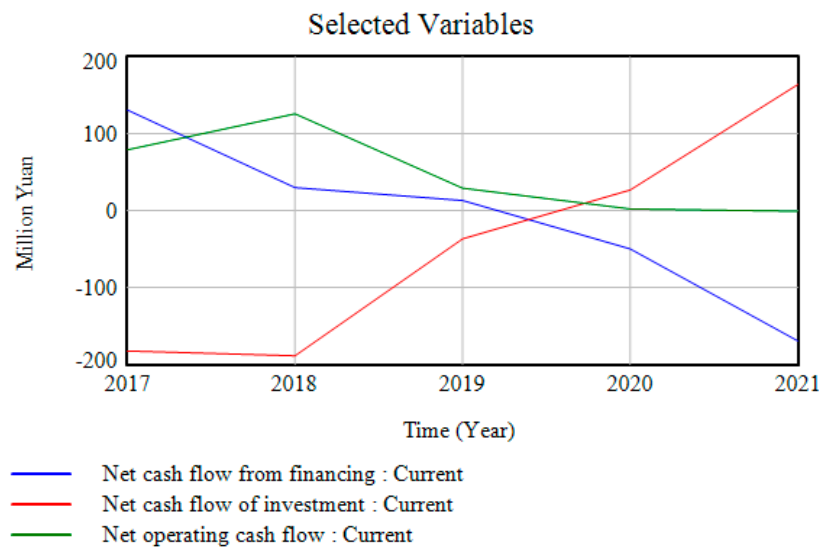


Figure 5. Net cash flow from investing, financing, and operating activities of China Dive Company Limited from 2017 to 2021.

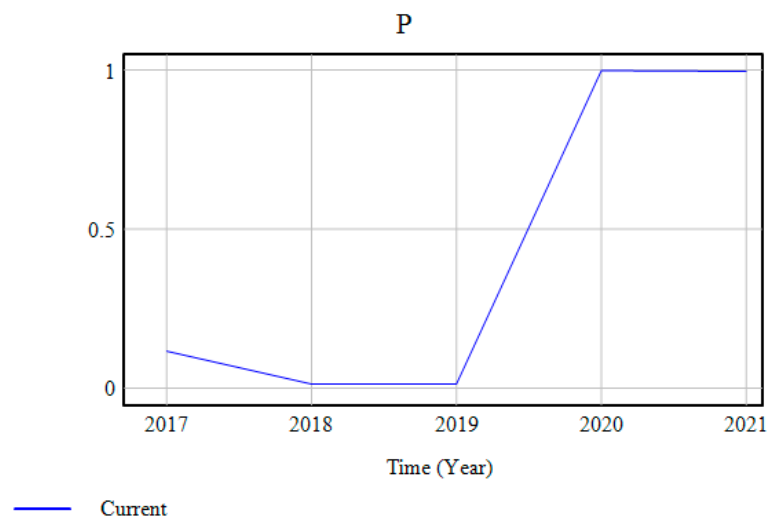


Figure 6. Corporate financial risk values for 2017–2021 for China Dive Company Limited.

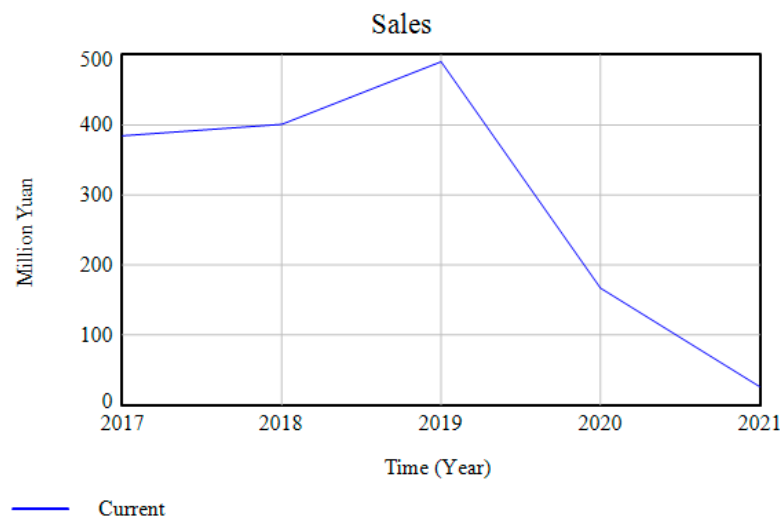
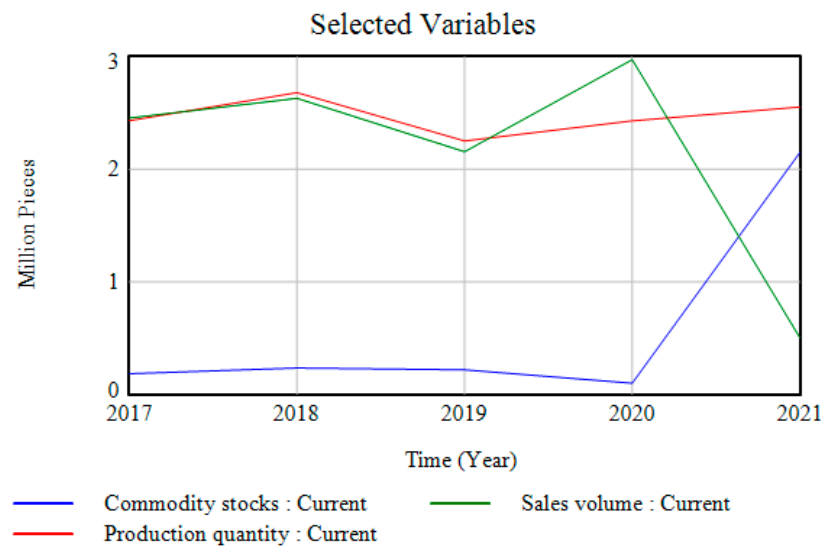


Figure 7. China Dive Company Limited’s product sales 2017–2021.





**Figure 8.** Product sales, yield, and inventory of China Dive Company Limited, 2017–2021.

#### 4. Control Measures

The financial risk conduction model represents the path flow of the cash flows between the operating, investing, and financing activities. The model further analyses the operation of an enterprise's capital chain at a more micro level through the financial risk conduction model. When cash and cash equivalents are performing poorly, managers analyse the causes of the cash flow risk faced by the target enterprise at each period according to Vensim's own causality tree and formulate relevant strategies. This paper provides countermeasures based on the cash flow of the operating, investment, and financing activities. The specific situation also requires specific analysis of:

(1) Net cash flow from operating activities is positive, net cash flow from investing activities is negative, and net cash flow from financing activities is negative—In such cases, the working capital of the enterprise is relatively healthy, and the net cash inflow from operating activities of the target enterprise can provide positive cash flow, which can not only meet the daily production and operation expenses of the enterprise, but also use the excess cash to expand production, repay debts, or make external investments. Negative investment cash indicates that the expenditure on foreign investment in the period is greater than the investment income, indicating that the enterprise is in a period of business expansion. Meanwhile, negative financing indicates that the enterprise is cash-rich with decreased debt, and the dividend repayment is greater than the borrowing of equity financing, etc. At this stage, managers need to keep an eye on the market and business dynamics to rationalise their expansion.

(2) Net cash flow from operating activities is positive, net cash flow from investing activities is positive, and net cash flow from financing activities is negative—In this case, the target enterprise is in the product maturity stage when financial risk may arise from interest rate fluctuations in financial markets. Maturing enterprises need to have a strong competitive advantage and maintain a stable market share. However, due to the financing activities built during the start-up and growth phases, the enterprise still needs to repay external funds in order to maintain its good financial standing. At a given decision point, the amount of investment opportunities and scale of operations faced by an enterprise is objective, so the amount of capital required is constant. As a rational economic person, its financing will inevitably be traded off between availability and cost, and only when low-cost channels cannot meet financing needs will it seek higher-cost financing. If a maturing enterprise has a need for financing, it should firstly use sufficient retained earnings and secondly obtain funds through listing and issuing shares and medium- to long-term bank loans.

(3) Net cash flow from operating activities is negative, net cash flow from investing activities is negative, and net cash flow from financing activities is positive—In this case, the target enterprise is at the stage of product start-up. The enterprise's current assets are mainly accounts receivable and inventories, so the cash flow from operating activities is negative. At the same time, a large amount of investment is required to build and improve production capacity, and there is no asset liquidation business, so there is no cash inflow from the sale of assets. Therefore, the enterprise can only rely on external financing to make up for the cash outflow generated by operating activities and investment activities, so only financing activities have net cash inflow. At this stage, enterprises need to invest a lot of capital to build production capacity, develop markets, research new products, etc. Their only source of funding is through debt, financing, and other financing activities.

(4) Net cash flow from operating activities is negative, net cash flow from investing activities is positive, and net cash flow from financing activities is positive, when the financial risk factor profile is high and the financial risk factor in operating activities is most likely to be the cost of inventories—During this period, the enterprise's sales revenue increases, but it still needs to produce or purchase in large quantities to obtain enough goods for sale, and thus the cash flow from operating activities is negative. The supply chain can be appropriately adjusted to improve its bargaining power, control inventory costs, and increase profits. Even for profitable businesses, the faster they grow, the more cash they need and the more they still need to raise large amounts of capital for production and investment needs. The target enterprise is facing irregular production and needs to liquidate its investments through investment activities such as the sale of fixed assets or raising of large amounts of capital to cover the shortfall caused by operational difficulties and to avoid damage to shareholders' interests and the enterprise's reputation. If this results in a decline in equity, it will lead to a contraction in fundraising inflows, which in turn will lead to a series of vicious circles. Managers need to be vigilant in the flow and management of capital flows at this stage.

(5) Net cash flow from operating activities is negative, net cash flow from investing activities is positive, and net cash flow from financing activities is negative—In this case, the target enterprise is in a period of decline. The sign of a recession is declining profitability, but the collection of accounts receivable and the sale of inventories will result in the most positive cash flows from operating activities. In addition, unused fixed assets can be sold and disposed of, resulting in positive cash flows from investing activities. As the market shrinks and the product sales and market share decline, cash outflows from operating activities begin to exceed cash inflows and net cash flows gradually become negative, which is accompanied by debts incurred in the previous period, so that the enterprise has to make up for the lack of available funds through the recovery of investments. At this stage, managers need to take care to ensure timely recovery of investment amounts, collection of receivables, timely realisation of related assets, and healthy cash flow.

(6) Net cash flow from operating activities is negative, net cash flow from investing activities is negative, and net cash flow from financing activities is negative—When all three main categories of net cash flow are negative, it indicates that the target enterprise may be on the verge of financial difficulties. The enterprise has incurred a large amount of receivables, has payment difficulties, and has to rely on debt or equity expansion to maintain payments. Alternatively, the enterprise has only cash to invest and no funds to return, and it can only rely on its existing resources to barely maintain its current production and operations; the cash income from operations cannot cover the relevant expenses, and the enterprise faces sources of risk such as poor business credit. Once the cash and cash equivalents held by the enterprise are depleted, the enterprise's capital chain will break, and it will be declared bankrupt.

(7) Net cash flow from operating activities is positive, net cash flow from investing activities is negative, and net cash flow from financing activities is positive—In this case, the higher the quality of cash flow and the more robust the investment activity, the more the target enterprise is in a period of high growth. During this period, the enterprise's

technology and products are largely recognised by the market, the size of the enterprise's workforce and sales performance exponentially grow, and internal management difficulties dramatically increase; the enterprise's bargaining power with the environment increases and product sales rapidly rise, resulting in the return of a large amount of monetary capital from operating activities. In order to consolidate and continue to expand its market share during this period, the enterprise needs to make significant additional investments, which may not be met by net cash flow from operating activities alone and therefore must be supplemented by raising the necessary external funds; thus, cash flow from investments remains negative and cash flow from financing is positive. The demands on the management skills of business leaders, production and technology, human resources, marketing, planning and decision-making in the internal management of business organisations are the highest in this period. The demands on the relationship skills and execution skills of business leaders, organisational structure, safety and environmental protection, finance, and control in the internal management of business organisations are also relatively high.

(8) Net cash flow from operating activities is positive, net cash flow from investing activities is positive, and net cash flow from financing activities is positive—When all three main categories of net cash flows are positive, it indicates that the target enterprise has sufficient funds, whether in operating, investing, or financing. The enterprise has disposed assets during this period, where the generated net proceeds and cash inflows from operating activities exceeded the outflows. The amount absorbed (including equity, loans, etc.) in the current year (or period) is greater than the amount of debt repayment, dividend distribution, etc., i.e., the inflow is greater than the outflow. Positive net cash flow from investments can come from investment income or through the sale of investments. A business is funded with positive net cash flow from operations and investments. If the investment cash flow becomes negative in the later stages, then it is an indication that funds are being hoarded for expansion. If funds are not being hoarded for expansion, it may be suspected that there is a diverting of funds to related companies or persons through the shell of a listed company, thereby leading to a misappropriation of corporate funds; therefore, stakeholders should be particularly aware of this. At this stage, managers need to restructure the cash flow of the business to create a more efficient and effective business. (Ding Xinyi, 2022; Liao Ke, 2015; Luo Zhaohua, 2000) [56–58].

## 5. Conclusions

In this study, the system dynamics theory was developed to refine the cash flow activities of an enterprise in terms of operating, financing, and investment activities. The analysis and feedback of the enterprise's financial system was used to identify and propose solutions to systemic problems and to explore the possible existence of multiple risk factors along the path of financial activities. When the accumulation of risk factors exceeds a certain threshold, a risk source is formed, and the risk source will transmit the risk along the risk conduction path. By predicting the cash flow situation through the enterprise financial risk conduction model, the financial risk source can be predicted in time and alert the management to take corresponding measures to avoid the coupling phenomenon caused by the conduction of risk in the enterprise system, which brings financial crisis to the enterprise. The following limitations exist in this study:

- (1) In this paper, the indicators are not refined in the system part; if the indicators can be fully subdivided, the source of financial risk can be more accurately detected.
- (2) The author does not consider production technology (such as the Cobb–Douglas function) to demonstrate finance risk and confidence interval as a measure of a risk.
- (3) The author does not indicate the internal or external nature of risk appearance.
- (4) The author does not consider the probability of a different scenario and/or a number of trigger strategies to avoid or decrease a risk. These are questions that the author plans to address in future research.

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## Notes

- <sup>1</sup> The formula is based on Li Ying (2013) [44];  $P$  is the financial risk measure obtained by building a logistic regression model. VaR takes a 95% confidence interval; if  $p > 0.5$ , the enterprise is at financial risk; if  $p < 0.5$ , the enterprise is healthy.
- <sup>2</sup> For different enterprises, the calculation method of employee quality is different. This paper refers to (Tang Xueliang, 2016) [56], which is divided into Chinese state-owned enterprises, private enterprises, and foreign-funded enterprises. The 0, 0.43, 0.86, 0.4, 0.36, 0.73, 0.35, 0.69 coefficients reference (Tang Xueliang, 2016) [56]. The cost unit is CNY 1/person.

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