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Research on System Risks of "Internet + Supply Chain Finance" Based on SNA, Dynamic Evolutionary Game, and Bayesian Learning Principle Simulation

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ABSTRACT

Under the background of "Internet +," the supply chain financial model and processes have undergone profound changes. Firstly, through the social network analysis, the correlation between the participants in the Internet + supply chain finance is directly visualized. Secondly, the dynamic risk evolution model of the system is constructed based on the different functions between the participants. Unstable solution and saddle points of the system are calculated; on this basis, Bayesian learning principles are used to build an Internet + supply chain financial credit default risk simulation model, and the simulation model is encapsulated. Finally, a numerical example is used to verify the simulation model operation convenience, efficiency, and reliability.

KEYWORDS

Bayesian Learning Principle Simulation, Dynamic Evolution Game, Internet + Supply Chain Finance

INTRODUCTION

With the development of the Internet and widespread application of corporate network technology, "Internet +" has become a popular term across the globe. Leaders of the central government and state council continue to promote the Internet + strategy through corporate reform and technological innovation.

In 2016, People's Republic of China president Xi Jinping proposed to improve both the country's Internet and its access. State prime minister Li Keqiang, in the 2015 government work report, noted that the Internet, big data, cloud computing, industrial manufacturing, and financial services should be developed in combination through the formulation of an Internet + action plan. China has the most complete and largest industrial supply chain system in the world.

Whether it is Industrial Intelligent Manufacturing 4.0 or China Industrial Intelligent Manufacturing 2025, it is inseparable from the Internet +-based network technology platform. Internet + supply chain + financial services is the future development trend of corporate ecological integration.

China has the most mature industrial chain cluster in the world. However, most corporate financing, which is in a one-on-one state, has not taken advantage of China's industrial chain cluster. The purpose of supply chain finance is to make full use of the credit resources of core enterprises,

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realize the sharing of chain credit resources, and facilitate the financing of small and microenterprises (SMEs). In the context of Internet +, mass entrepreneurship, innovation, and national support for SMEs, the Internet + supply chain finance model can provide financial support and source power for entrepreneurship and innovation. In addition, it can reduce SME financing costs for entrepreneurial innovation while improving financing efficiency.

Internet +, a bold attempt at a new idea, is a technological change in the industrial and financial services fields. On the one hand, the Internet + innovation model may bring improvements in the operating efficiency of the entire supply chain system. On the other hand, Internet + may result in unexpected risks to companies within a system. The development of SME Internet + supply chain finance products is still in the exploratory stage. Therefore, studies on the Internet + supply chain + financial services innovation model should pay attention to the assessment and control of online supply chain financial risks.

RESEARCH STATUS AND GLOBAL COMMENTARY

Many research institutions and scholars promote the urgent development of supply chain finance due to its role as an innovative financial product. *European Currency Journal* (n.d., para. X) described supply chain finance as "the hottest topic in the transactional business of financial institutions in recent years." At the same time, One Springer's report (n.d.) showed that the use of supply chain finance solutions can reduce the purchaser's operating costs by 13% on average.

To enable suppliers to reduce operating costs by 14%, supply chain finance can guide the control of corporate capital flows, accelerate capital flows, reduce transaction costs, and develop good development prospects (Atkinson, W, 2008; Chao & Jianwen, 2015; Hofman, 2005; Weibin & Ke, 2012; Xiaoping & Meng, 2009; Yi & Yan, 2015; Zhiqiang, 2015). Supply chain finance can reduce the risk of SME credit default (Chao & Jianwen, 2015; Ke & Hongwei, 2013). The current demand for financing funds for SMEs is strong; therefore, supply chain financing should be actively pursued in financial services.

The rapid development of domestic and foreign supply chain finance in the past decade has caused scholars to study the innovation model of supply chain finance. Xiangfeng et al. (2005) proposed four supply chain 1 + N financing models: (1) vertical financing position; (2) horizontal financing position; (3) star financing position; and (4) network financing position. Supply chain companies can use trade order or inventory financing models for financing (Guokun et al., 2015; Haoyu, 2015). Under the 1 + N supply chain financial model, scholars further studied the innovative mode of supply chain finance for SMEs. This included the prepayment financing mode, accounts receivable financing mode, financing warehouse financing mode, and confirmed warehouse financing mode. These are based on the repurchase model, ERP financing model, order-to-factoring financing model, and data pledge model (Hui & Yunlin, 2015; Jianjun & Yichen, 2015; Jianmei, 2011; Jianxin & Yongwu, 2015; Jinzhao et al., 2015; Shida et al., 2015; Xiangzheng, 2013; Yajuan et al., 2009). Some scholars have proposed supply chain finance models in other industries, such as pharmaceutical industry supply chain finance, wholesale industry supply chain finance, agricultural supply chain finance, online video platform supply chain finance, and shipping company supply chain finance models (Hongyu, 2015; Lu, 2015; Ning, 2015; Qilei, 2015; Yiming et al., 2015).

The core of supply chain finance is finance. The core of finance is risk. The key link in the development of supply chain finance is the prevention of risks. Some scholars have established their own supply chain financial risk indicator systems based on the analysis and research of the supply chain financial business content (Changbin & Xin, 2013; Dedong & Qiang, 2004; Hao, 2008; Shusheng et al., 2007; Sihu et al., 2015; Xiaoteng & Qingmin, 2005; Xiong et al., 2009; Yingdong & Xiaojie, 2011; Yixue, 2011). Regarding the supply chain financial risk indicator system, some scholars have proposed their own characteristics of supply chain financial risk assessment models. These include Hao (2008) and Shouguo and Li (2009).

The analytic hierarchy process (AHP) builds a credit factor weight evaluation model for SMEs based on supply chain finance. Xiong et al. (2009) proposed a credit risk evaluation method based on the combination of principal component analysis (PCA) of risk factors and logistic regression analysis of risk factor weights based on predecessors. Qi (2010) established a credit risk assessment model for a supply chain financial model based on a decision tree (DMT). Using various risk models, some scholars have studied how to dynamically evaluate and control supply chain risks and risk transfer processes (Brass, 2009; Chongqing et al., 2018; Jiantong et al., 2018; Jinzhao et al., 2015; Juan et al., 2015; Keying, 2018; Lee & Rhee, 2011; Lei & Wenxiao, 2011; Mengyu & Ying, 2015; Xiaoping & Wenli, 2015; Yanzhong, 2007).

Scholars across the globe have significant amounts of research results on supply chain finance; however, there are fewer research results on social networks and the Internet + background, especially research results that use evolutionary games and Bayesian learning theory. This article will attempt to solve the Internet + supply chain finance by social relationship network analysis (SNA) and dynamic game solution. The system simulation model is constructed through Bayesian learning principles to simplify the calculation process. Experiments and results are explained through calculation examples.

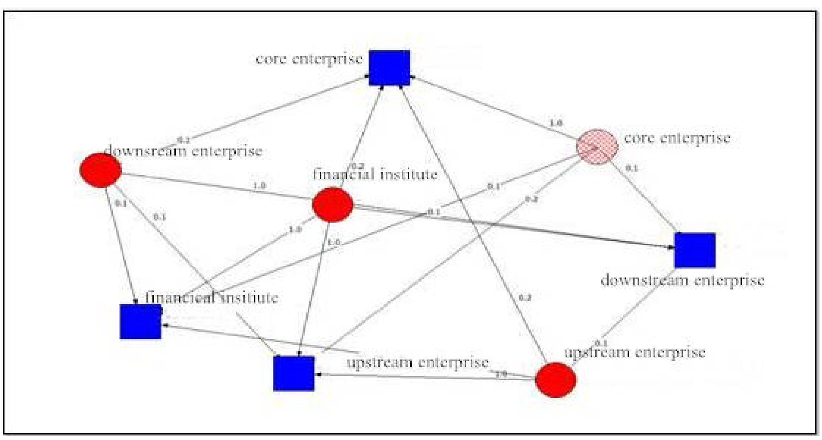
SNA OF INTERNET + SUPPLY CHAIN FINANCE

In the context of Internet +, Internet finance, supply chain finance, enterprise resource management systems (ERPs), and enterprise supply chains (upstream and downstream companies, logistics companies) are intertwined or closely linked. Regarding Internet technology, information flow, logistics, and capital flow, the flows are like the brain and arteries of the system because they continuously deliver nutrition to each node of the system. Internet + supply chain finance is a type of food and nutrient system because it controls the size of credit fund flow and resource allocation efficiency through the transmission of system information.

ANALYSIS OF THE SNA OF A SINGLE INDEPENDENT SUPPLY CHAIN FINANCIAL SUBJECT

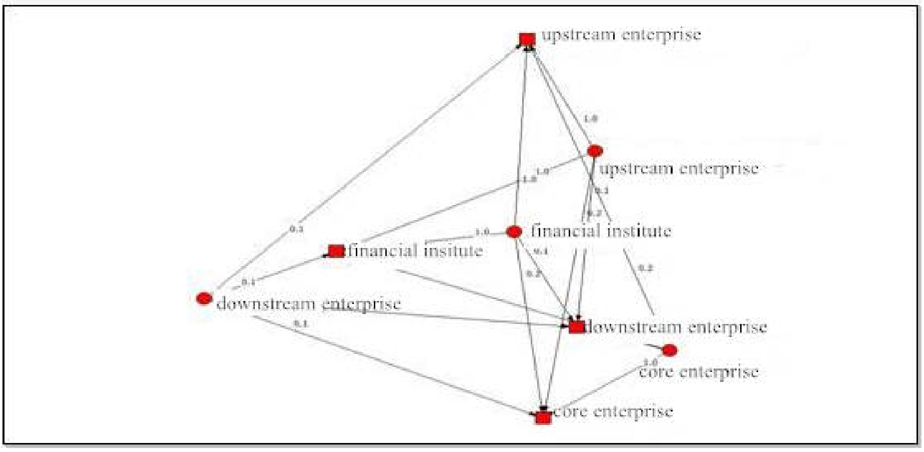
To analyze the correlation between core companies, upstream companies, and downstream companies, this article uses UCINET 6 SNA software to conduct social network relationship analysis. Through expert interviews and literature review, the study quantified the characteristics of communication behavior between subjects. Then, it used NETDRAW for visualization processing (see Figure 1).

Figure 1. Empowered two-node network diagram



Figures 1 and 2 illustrate a weak correlation among financial institutions, upstream enterprises, core enterprises, and downstream enterprises. The correlation coefficients (0.1, 0.2, 0.1, 0.1, etc.) are independent individuals. Finance companies have not benefited from the close relationship between upstream and downstream within the supply chain.

Figure 2. Gower metric scaling layout



On this basis, the study further performs an analysis-centrality measure (see Table 1).

The centrality measurement in Table 1 shows that the upstream enterprise's out-degree is 1.3. The normal out-degree is 0.433. The in-degree is 1.3 and the normal in-degree is 0.433. The core company's out-degree is 0.4. The normal out-degree is 0.133. The in-degree is 0.5 and the normal in-degree is 0.167. The downstream company's out-degree is 0.3, the normal out-degree is 0.1, the in-degree is 0.3, and the normal in-degree is 0.1. Regarding financial institutions, the out-degree is 1.3, the normal out-degree is 0.433, the in-degree is 1.2, and the normal in-degree is 0.4. In general, upstream companies (requiring financing) have the highest centrality. Companies that do not require financing (downstream companies) have the lowest centrality.

Table 1. Degree measures

		1	2	3	4
		Outdeg	Indeg	nOutdeg	nIndeg
1	Upstream enterprises	1.300	1.300	0.433	0.433
2	Core enterprises	0.400	0.500	0.133	0.167
3	Downstream enterprises	0.300	0.300	0.100	0.100
4	Financial institutions	1.300	1.200	0.433	0.400

The row centrality measurement "2-Mode Centrality Measures for ROWS" shows that the degree centrality is 1. 2-Local centrality is 0.5, the eigenvector centrality is 0.5, the closeness centrality is 1, and the betweenness centrality is 0.083. There is no difference between subjects in the social network relationship structure. They are independent of each other. Moreover, the betweenness centrality and feature eigenvector centrality are relatively small. This indicates that the relationship between each node and neighboring nodes is weak.

The column centrality measurement “2-Mode Centrality Measures for COLUMNS” shows that the centrality of the degree is 1 and the centrality of 2-Local is 0.5. The eigenvector centrality is 0.5, the proximity centrality is 1, and the betweenness centrality is 0.083. There is no difference between the subjects in the social network relationship structure. They are independent of each other. Moreover, the betweenness centrality and feature vector centrality are relatively small, indicating that the relationship between each node and the neighboring node is weak.

Table 2. Two-mode centrality measures for ROWS

	1	2	3	4	5
	Degree	2-Local	Eigenvect	Closeness	Betweenness
1	1.000	1.000	0.500	1.000	0.083
2	1.000	1.000	0.500	1.000	0.083
3	1.000	1.000	0.500	1.000	0.083
4	1.000	1.000	0.500	1.000	0.083

Table 3. Two-mode centrality measures for COLUMNS

	1	2	3	4	5
	Degree	2-Local	Eigenvect	Closeness	Betweenness
1	1.000	1.000	0.500	1.000	0.083
2	1.000	1.000	0.500	1.000	0.083
3	1.000	1.000	0.500	1.000	0.083
4	1.000	1.000	0.500	1.000	0.083

ANALYSIS OF SNA OF FINANCIAL SUBJECTS IN SUPPLY CHAIN

Similarly, to visually analyze the correlation between financial institutions and the entire supply chain (i.e., upstream companies, core companies, downstream companies), this study uses UCINET 6 to perform a social network relationship analysis (see Figure 3).

As can be seen from Figure 3, the correlation between financial institutions and the entire supply chain (i.e., upstream, core, and downstream) is strong, with correlation coefficients of 1.0, etc.

On this basis, the study further performs an analysis-centrality measure (see Table 4).

The centrality measurement in Table 4 shows that the out-degree of the entire supply chain is 1. The normal in-degree is 100 and the in-degree is 1.3. The out-degree is 1, the normal out-degree is 100, the in-degree is 1, and the normal in-degree is 100.

When Table 1 is combined with the control group, the normal out-degree of upstream companies (requiring financing) increased from 0.433 to 100. In addition, the normal in-degree increased from 0.433 to 100. The normal out-degree of core companies increased from 0.433 to 100. The normal in-degree increased from 0.4 to 100.

Figure 3. Empowered two-node network diagram

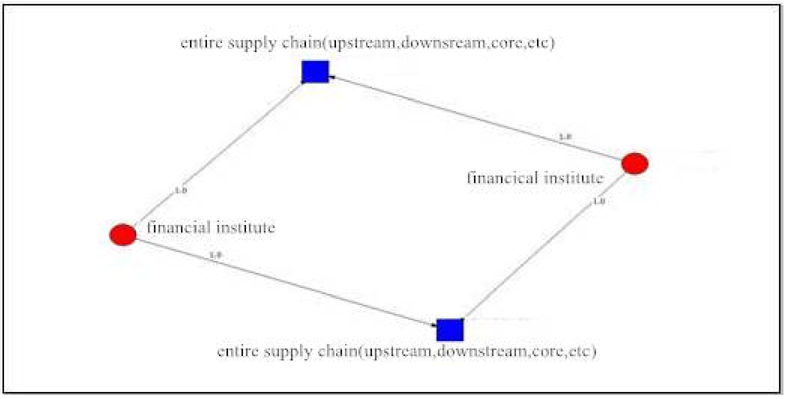


Table 4. Description statistics

		1	2	3	4
		OutDegree	InDegree	NrmOutDeg	NrmInDeg
1	Mean	1.000	1.000	100.000	100.000
2	Std Dev	0.000	0.000	0.000	0.000
3	Sum	2.000	2.000	200.000	200.000
4	Variance	0.000	0.000	0.000	0.000
5	SSQ	2.000	2.000	20000.000	20000.000
6	MCSSQ	0.000	0.000	0.000	0.000
7	Euc Norm	1.414	1.414	141.421	141.421
8	Minimum	1.000	1.000	100.000	100.000
9	Maximum	1.000	1.000	100.000	100.000
10	N of Obs	2.000	2.000	2.000	2.000

Table 5. Two-mode centrality measures for ROWS

	1	2	3	4	5
	Degree	2-Local	Eigenvect	Closeness	Betweenness
1	1.000	1.000	0.707	1.000	0.250
2	1.000	1.000	0.707	1.000	0.250

Regarding the row centrality measurement 2-Mode Centrality Measures for ROWS, the centrality of the degree is 1 and the centrality of 2-Local is 1. The eigenvector centrality is 0.707, the closeness centrality is 1, and the betweenness centrality is 0.25. Combining Table 2 of the control group causes the 2-Local centrality to increase from 0.5 to 1. The eigenvector centrality increased from 0.5 to 0.707. Betweenness centrality increased from 0.083 to 0.25. This indicates the relationship between nodes in the entire social network structure. The compact enhancement reflects the dual-center integration of financial institutions and the entire supply chain.

The column centrality measurement 2-Mode Centrality Measures for COLUMNS shows that degree centrality is 1, 2-Local centrality is 1, eigenvector centrality is 0.707, close is 1, and the betweenness centrality is 0.25. Combined with Table 2 of the control group, 2-Local centrality increased from 0.5 to 1. The eigenvector centrality increased from 0.5 to 0.707. The betweenness centrality increased from 0.083 to 0.25. This indicates that the relationship between nodes in the entire social network structure is closely enhanced. It illustrates the characteristics of the integration of financial institutions. The entire supply chain and resource of core enterprises can be advantaged by other participants.

The study uses the dynamic evolution game model to analyze and study the Internet + supply chain financial system to better understand the microsubjects' interest in the decision mechanism of supply chain finance.

Table 6. Two-mode centrality measures for COLUMNS

	1	2	3	4	5
	Degree	2-Local	Eigenvect	Closeness	Betweenness
1	1.000	1.000	0.707	1.000	0.250
2	1.000	1.000	0.707	1.000	0.250

ESTABLISHMENT AND ANALYSIS OF THE INTERNET + SUPPLY CHAIN FINANCE DYNAMIC EVOLUTION GAME MODEL

Internet + Supply Chain Finance Dynamic Evolution Game Model Assumptions

To simplify the model, it is assumed that the participants are the main entities of various online financial institutions. These include Internet financial institutions, core enterprises, upstream enterprises, and downstream enterprises.

1. It is assumed that the online participants are rational, economic people who aim to maximize corporate profits.
2. N0, N1, and N2, respectively, represent the amount of financing of online core enterprises, upstream and downstream enterprises, and the return on funds for B0, B1, and B2 companies. r1 represents the financial institution's interest rate. K1, K3, and K5 represent loans to financial institutions' business costs, including handling fees. K2, K4, and K6 banks carry out credit investigations on enterprises.
3. Assume that the probability of cooperation among financial institutions is A and the probability of noncooperation is 1-A. The probability of cooperation among supply chain companies is C; the probability of noncooperation is 1-C. Regarding the rate of return on funds, r represents the interest rate of financial institutions and K represents the cost of business like financial credit investigation.

ESTABLISHMENT OF THE INTERNET + SUPPLY CHAIN FINANCIAL MODEL

There is a big game model between financial institutions and core companies, upstream companies, and downstream companies. This includes the game model between financial institutions and the entire online supply chain. See Table 7.

When a financial institution cooperates with an enterprise in an online supply chain (because the enterprises in the online supply chain implement a resource sharing mechanism), the financial institution is cooperating with the entire online supply chain instead of a certain upstream or downstream enterprise.

Table 7. Pairwise game model for a single company

	Financial institutions		
Core companies		Cooperation	Noncooperation
	Cooperation	$N_0 \cdot B_0 - N_0 \cdot r_1$, N0·r1	$-K_1$, 0
	Noncooperation	0, $-K_2$	0, 0
Upstream companies	Cooperation	$N_1 \cdot B_1 - N_1 \cdot r_1$, $N_1 \cdot r_1$	$-K_{3,}$ 0
	Noncooperation	0, $-K_4$	0, 0
Downstream companies	Cooperation	$N_2 \cdot B_2 - N_2 \cdot r_1$, $N_2 \cdot r_1$	$-K_{5,}$ 0
	Noncooperation	0, $-K_6$	0, 0

1. It can reduce the cost of credit investigation, corporate risk monitoring, and credit maintenance by online financial institutions, such as Kb < K1 + K3 + K5, KC < K2 + K4 + K6.
2. In terms of interest rates of financial institutions, due to the enhanced bargaining power of the entire online supply chain, it may make b < b1.
3. In terms of credit lines for financial institutions, N > N0 + N1 + N2 may be caused due to the synergy of the online supply chain.

This aforementioned information is based on in-depth research on game behavior between a single enterprise and financial institution. Table 8 constructs and analyzes the dynamic evolution game model between the entire supply chain finance and financial institutions.

For various financial institutions, if the other party chooses a cooperation strategy, the expected return is:

Table 8. Game model of the entire online supply chain

	Financial institutions		
The entire online supply chain		Cooperation A	Non-Cooperation 1-A
	Cooperation:C	$N \cdot B - N \cdot r - K_b$, $N \cdot r - K_C$	$-K_b$, 0
	Non-Cooperation:1-C	0, $-K_C$	0, 0

M1 = A • (N • r-KC) + (1-A) • 0

If the other party chooses a noncooperative strategy, the expected return is:

M2 = -A • KC

Therefore, the average return is M = C • M1 + (1-C) • M2 = A • C • N • r-A • KC.

This formula also shows that if the offline supply chain finance is changed from the traditional model to the Internet + (online or O2O model) online supply chain finance, then the credit business procedure fees (K1, K3, K5) and credit investigation costs (K2, K4, K6) will decrease. M will gradually increase.

According to the income functions of various financial institutions, dynamic evolution differential equations can be copied:

dC / Ct = C (M1-M) = M • (1-M) • A • N • r

For the entire online supply chain company, if a financial institution chooses a cooperation strategy, the expected return is:

W1 = C (N • B-N • r-Kb) + (1-C) • 0

If various financial institutions choose noncooperative strategies, their expected returns are:

W2 = -C • Kb

So, the average return is W = A • W1 + (1-A) • W2 = A • C • N • (B-r) -C • Kb.

According to the return function, online supply chain, and adding time variable t, the dynamic evolution differential equation can be copied:

dA / Ct = A • (W1-W)
= A • (1-A) • C • N • (B-r)

Let F (A) = dA / Ct, F (C) = dC / Ct. Two equations must be satisfied at the same time to obtain the steady state of the online system.

F (A) = dA / Ct = 0
F (C) = dC / Ct = 0

Solved: (A, C) = (0, 0), (A, C) = (0, 1), (A, C) = (1, 0), (A, C) = (1, 1). Four solutions are found.

The Jacob matrix can be used to test whether these four solutions are evolutionary stable:

$$T = \begin{bmatrix} \partial F\left(A\right) / \partial A & \partial F\left(A\right) / \ \partial C \\ \partial F\left(C\right) / \partial C & \partial F\left(C\right) / \ \partial A \end{bmatrix} = \begin{bmatrix} 1 - 2A) \cdot C \cdot N \cdot \left(B - r\right) & A \cdot \left(1 - A\right) \cdot C \cdot N \cdot \left(B - r\right) \\ A \cdot N \cdot br & C \cdot N \cdot r - KC \end{bmatrix} \tag{1}$$

As can be seen from Table 9, each equilibrium point (A, C) = (0, 0), (A, C) = (0, 1), (A, C) = (1, 0) belongs to the evolutionary game. The point of instability, (A, C) = (1, 1), is the saddle point.

Table 9. Stability of the equilibrium point in the financial evolution game of online supply chain

Equilibrium points	det(T)		tr(T)		Stable judgment
(0,0)	0	0	$-K_C$	-	Unstable point
(0,1)	$N \cdot (B-r) \cdot (N \cdot r-K_C)$	+	$N \cdot B-K_C$	+	Unstable point
(1,0)	0	0	0	0	Unstable point
(1,1)	$-N \cdot (B-r) \cdot (N \cdot r-K_C)$	-	$2N \cdot r-N \cdot B-K_C$	“+”or“-”	Saddle point

Therefore, there is no stable equilibrium solution in this evolutionary game. The online supply chain finance may have default risk; thus, we may need to understand and analyze the default risk of the Internet + supply chain finance by Bayesian learning principles.

ANALYSIS OF DEFAULT RISKS OF CORPORATE INTERNET + SUPPLY CHAIN FINANCE BASED ON BAYESIAN LEARNING PRINCIPLES

The Bayesian learning principle is a basic method for people to infer the posterior probability from the prior probability through new information. The basic meaning of the Bayesian learning principle is that, in mathematics, prior probability refers to the prior probability (peoples' prior judgment before correcting things). Posterior probability refers to the hindsight probability (probability after action).

MODEL ASSUMPTIONS

First, assume that the main body of the supply chain enterprise is upstream and downstream enterprises and financial institutions. The participants of online supply chain enterprises are fully rational and pursue the goal of maximizing benefits.

Second, participants in online supply chain companies cannot know the exact type of each other. They only know the probability distribution type of each other.

Third, participants in online supply chain companies have Bayesian learning capabilities. They can choose action strategies in the later stage by learning from the information in the previous stage.

BAYESIAN LEARNING PRINCIPLES OF SME INTERNET + SUPPLY CHAIN FINANCE

The Bayesian learning method for SMEs integrates the information of each stage of the event in the supply chain. Its basic calculation logic notes that prior information of online supply chain Ú overall event distribution information Ú sample event information ® online supply chain posterior Event distribution information. This plays a good role in predicting the possibility of future occurrences of online supply chain events.

The probability distribution of financial risk events for the online supply chains of SMEs belongs to a binomial distribution. Let x ~ B (n, p). The probability of a fraud event is p; the probability of a no fraud event is q = 1-p. The prior distribution is the Beta distribution. Its distribution function is:

$$\pi (p) = \text{Beta} (a, b) = \{\Gamma (a + b) / \Gamma (a) \Gamma (b)\} \bullet p (a-1) (1-p) (b-1) \tag{2}$$

When any a1 = a + x1, b1 = b + n-x1, the Bayesian formula can be used to find that the posterior probability of online supply chain SMEs also belongs to the Beta distribution. The proof process is as follows:

$$\text{Because: } \pi (x\text{½}p) = \pi (p\text{½}x) \bullet \pi (p) / \pi (x) \tag{3}$$

and:

$$\pi (p\text{½}x) \bullet \pi (p) = \pi (x, p) = \Gamma (a + b) / \Gamma (a) \Gamma (b) \bullet \text{CXN } p (a1-1) (1-p) (b1-1)$$

Marginal distribution of x at the same time:

$$\pi (x) = \text{ò}10 (x, p)\, dp = \{\Gamma (a + b) / \Gamma (a) \Gamma (b)\} \bullet \{\Gamma (a1) \Gamma (b1) / \Gamma (a1 + b1)\} \tag{5}$$

So:

π (p | x1) = π (p½x) • π (p) / π (x) = Beta (a1, b1)

= {Γ (a1 + b1) / Γ (a1) Γ (b1)} • p (a1-1) (1-p) (b1-1) (6)

Therefore, the expected value E (p | x1) and variance Var (p | x1) of the posterior probability distribution of SMEs in the online supply chain can be obtained by the following calculation:

E (p | x1) = a1 / (a1 + b1) 1.

= (a + x1) / {(a + x1) + (b + n-x1)}

= {n / (a1 + b1 + n)} • (x1 / n) + {(a + b) / (a1 + b1 + n)} • {a / (a + b)} (7)

Let n / (a1 + b1 + n) = c. Then (a + b) / (a1 + b1 + n) = 1-c. x1 / n is the sample mean of new default events of SMEs in the supply chain. a / (a + b) is the mean of the prior default events. Then, the original formula E (p | x1) can be simplified into:

E (p | x1) = c • (x1 / n) + (1-c) • {a / (a + b)} (8)

When n is large enough, c = n / (a1 + b1 + n) approaches 1. Then (1-c) • {a / (a + b)} approaches 0.

E (p | x1) »x1 / n (9)

Var (p | x) = a1 • b1 / (a1 + b1) 2 • (a1 + b1 + 1) 2.

= (a + x1) • (b + n-x1) / (a + b + n) 2 • (a + b + n + 1)

= E (p | x1) • {1- E (p | x1)} / (a + b + n + 1) (10)

Therefore, when the prior and posterior probability belong to a conjugate distribution of the same nature, the posterior probability obtained at the t + 1 stage of the SME supply chain can be used as the prior probability at the t + 2 stage. When the t + 2 stage combined with the new information on the online supply chain, the posterior probability of the t + 2 stage of the SMEs can be obtained. Therefore, the posterior probability of the SME online supply chain can be obtained at any stage by the Bayesian learning principles.

BAYESIAN LEARNING SIMULATION MODEL OF SME INTERNET + SUPPLY CHAIN FINANCE

Simulation Model Establishment and Packaging

According to the Bayesian learning principle, when using MATLAB's Simulink function, different parameter modules and operation modules are selected. The system simulation model in Figure 5 is constructed according to the solution process of formulas (7) and (10).

For the sake of safety and space, the model in Figure 4 can also be packaged. Only the input parameters (a, b, x1, and n) and output displays (Display and Display1) are shown. The user can easily use the new model as shown in Figure 5.

ANALYSIS OF BAYESIAN LEARNING SIMULATION MODEL FOR SME INTERNET + SUPPLY CHAIN FINANCE

Assume that a supply chain upstream company has 100 online lending transactions with financial institutions during the 10-year period from 2008 to 2017. b = 100, in which the number of time-period default events is 10 (a = 10). In 2018, it had 20 additional credit transactions with financial institutions (n = 10). At the same time, the online supply chain market environment changed; 2018 term default events total 5 (x1 = 5). If the bank governor or head of other financial institutions want to make predictions for 2019, what percentage of the credit transactions with companies in this supply chain will be in default? How reliable is this result?

a = 10, b = 100, n = 10, and x1 = 5 are entered in the left input terminal (see Figure 6). The run button is started for Simulation. The values of 0.1154 and 0.00077792 are displayed on the two monitors on the right. These are the test probability E (p x1) = 0.1154 and variance Var (p x) = 0.0007792. This shows that in 2019, under the new online supply chain information environment, the credit term default probability of this upstream company in the supply chain is 11 · 54%. The result has a small value of 0.00077792, which approaches 0. It indicates that the posterior probability of 11 · 54% is better.

Similarly, in the Internet + environment, due to the rapid collection, transmission, and introduction of new online information based on prior probability, Bayesian learning simulation models can be used to easily calculate 2020, 2021, and 2022. New information on Internet + supply chain finance iterative Bayesian learning of the posterior default risk probability and reliability.

CONCLUSION

After reviewing previous research results, this article uses the SNA method to study the correlation between supply chain finance research subjects and the dynamic evolution model. It aims to study the stability of the supply chain financial system and determine the saddle point and unstable solution of the system according to the polarity of the solution. Based on the information theory, it introduces Internet + to obtain information through the Bayesian iterative learning principle. It calculates the internal risk of the system based on the continuous external new information input. The situation changed and the Bayesian learning simulation model of this principle was constructed. The model was encapsulated. Finally, the validity of the Bayesian learning principle simulation model of Internet + supply chain finance was demonstrated through an example.

CONFLICT OF INTEREST

The authors of this publication declare there is no conflict of interest.

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Figure 4. Simulation model for Bayesian learning

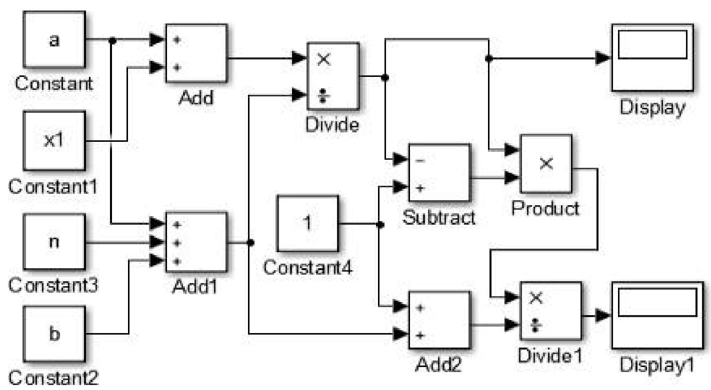


Figure 5. Bayesian simulation model packaging processing results

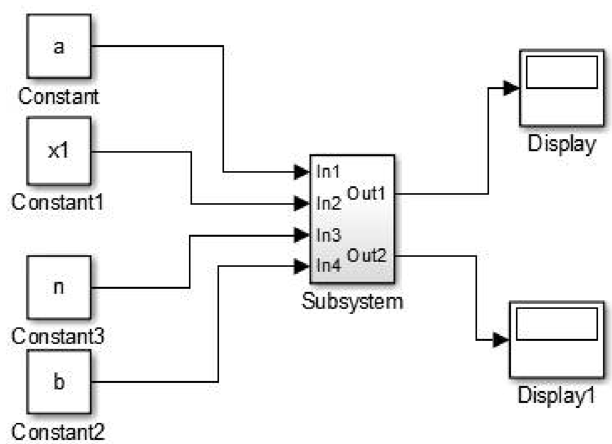
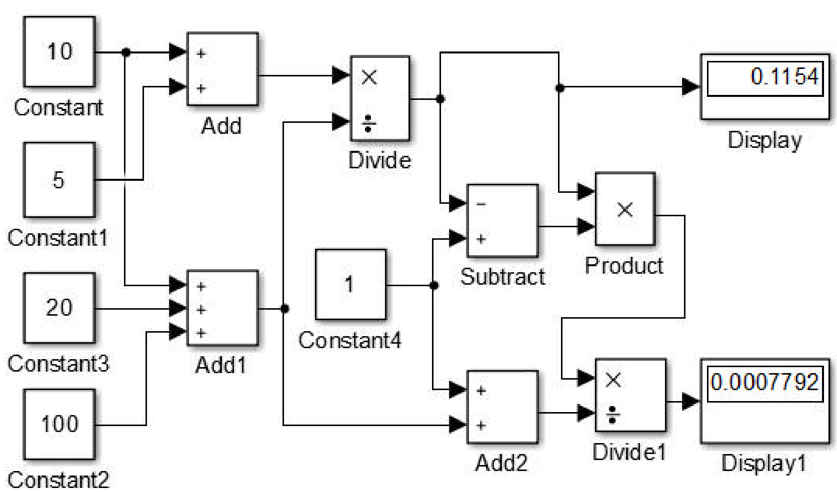


Figure 6. Numerical simulation of Bayesian learning simulation model



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