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Analysing the contagion effect and governance strategy of corporate financialisation based on a SIRS model

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ABSTRACT

Recently, the phenomenon of economic 'moving from reality to virtual' has attracted widespread attention. Based on the principle of infectious disease dynamics, this study constructs a SIRS model to examine the contagion effect of corporate financialisation. Using Chinese manufacturing companies as samples, we verify the contagion of corporate financialisation before performing a simulation analysis and proposing strategies to address financial contagion risks. The results shows that corporate financialisation is contagious in the sample companies. This feature depends on the initial contagion conditions and threshold. When the degree of corporate financialisation does not meet the initial contagion conditions and is within the contagion threshold, contagion will not occur. Otherwise, financialisation behaviour will cause mutual contagion and produce a contagious effect. Meanwhile, the higher the contagion and the second conversion rates of financialisation, the stronger the contagion effect. The larger the financial reversal and self-recovery rates, the weaker the contagion effect. Finally, we propose Multi-dimensional governance strategies of financial contagion risk. This study explores the formation mechanism of corporate financialisation from a new perspective to provide ideas for the financial governance of enterprises and promote benign interaction between entities and finance.

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1. Introduction

In recent years, the phenomenon of 'moving from reality to virtual' has become an important topic both in theory and practice. More non-financial enterprises gradually expand the scale of financial asset allocation and profit from financial channels, aggravating the trend of financialisation, while increasing the risk of companies' separating from the main business. Meanwhile, policy-makers have successively introduced relevant measures, proposing that the focus of economic development should be placed on the real economy, and that the ability of financial service entities should

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be continuously improved. It is suggested that the advanced manufacturing industry is the key to the economy, and that the risk isolation between the industry and the financial industry should be strengthened according to the development needs of the enterprise's main business.

Regarding the phenomenon of corporate financialisation, there are two levels of issues to be considered: the first is the formation of corporate financialisation; while the second is the governance of corporate financialisation. Examining these problems is necessary to grasp the causal logic behind the phenomenon of 'from reality to virtual' and provide an important basis for boosting the economy. Existing research has focused on the motivation for corporate financialisation (Demir, 2009; Opler et al., 1999; Zheng et al., 2019) and the consequences of corporate financialisation (Barradas & Lagoa, 2017; Orhangazi, 2008; Zheng et al., 2019). These literatures usually adopt the perspective of single enterprise and rarely consider the interaction of financialisation behavior between different enterprises. Therefore, this study uses the principles of infectious diseases and explores whether the phenomena of corporate financialisation can infect each other producing contagious effects among companies, and how to deal with the risk of financial contagion. so as to further expands the formation mechanism of financialisation.

This study examines the contagion effect of corporate financialisation considering the following aspects: (1) Based on the theory of infectious disease dynamics, we construct a SIRS model of the contagion effect of enterprise financialisation, revealing the evolution process of enterprises from real to virtual, obtaining the initial infection condition and infection threshold of enterprise financialisation. (2) Using the sample data of manufacturing companies, the contagion effect of enterprise financialisation is simulated and analysed by extracting sample data and setting parameter values, finding that the financial behaviour is contagious and affects the sample enterprises. (3) Lastly, according to the simulation results and considering the possible contagion risks and the stage characteristics, we suggests governance strategies to address the financial contagion risk from different aspects.

The main contributions of this article include the following: First, it provides a new perspective on the formation of financialisation. To utilise the principles of infectious diseases, a medical infectious disease model is introduced into the research. Moreover, simulating the formation process of the phenomenon of corporate financialisation will help to further clarify the underlying mechanism of its formation and development, extending the existing research methods and content. Second, the study provides a basis for research on corporate financial governance. It shows that financialisation is contagious among different enterprises. Coping strategies are then formulated to prevent contagion risk, and further ideas for improving corporate financial governance are provided.

The rest of this paper is as follows. Section two presents the literature review. Section three presents the construction of the corporate financialisation model. Section four presents the simulation analysis. Section five presents further discussion. Section six presents the conclusion.

2. Literature review

The financialisation of enterprises is a micro-level manifestation of the economy's 'moving from reality to virtual'. The existing research literature mainly focuses on

two aspects: the first is the motivation for the formation of corporate financialisation. These studies concentrate on the research of macro-environmental factors and enterprise characteristics. Demir (2009) found that the uncertainty of the economic environment and the increase in the return rate will increase the possibility of companies choosing short-term financial investments. Further, Akkemik and Özen (2014) believed that macroeconomic uncertainty has exacerbated the financialisation of non-financial companies, while Zheng et al. (2019) found that economic financialisation has led to the alienation of corporate investment behaviour. From the perspective of enterprise characteristics. Opler et al. (1999) showed that companies with high growth and cash flow risk tend to hold more cash and invest more in the capital market. Orlik (2013), in turn, believed that maximising shareholder value improves the financial activities of non-financial companies. The second group of studies concerns the consequences of corporate financialisation. Orhangazi (2008) found that financialisation has a negative impact on the enterprises' investment behaviour. Barradas and Lagoa (2017) and Tori and Onaran (2018) also confirmed empirically that financialisation can lead to a decline in the physical investment rate, indicating that the process of financialisation has largely hindered physical investment. Zheng et al. (2019) found that the crowding-out effect of financialisation is relatively strong in smaller companies. In addition, financialisation also impacts corporate innovation investment. Seo et al. (2012) suggested that financialisation has a 'crowding-out' effect on corporate R&D investment. Hahn (2019) believed that it also has different effects on innovation. In addition, some studies have found that corporate financialisation has reduced the economic growth rate and aggravated the process of deindustrialisation (Svilokos & Burin, 2017; Tomaskovic-Devey et al., 2015).

However, existing studies usually adopt the perspective of the enterprise characteristics themselves and rarely consider the perspective of behavioral contagion to explore the phenomenon of financial contagion and its effect among different enterprises.

In addition, although there are few studies directly examining the contagion effect of corporate financialisation, there are numerous references on the topic of contagion effect itself. The existing literature mainly studies the problem of infection from the following two perspectives: the first is the study of contagion at the macroeconomic level. These studies focuses more on financial crises, risks, and market contagion. Rodriguez (2007), for example, found that during the Asian and Mexican financial crises, the dependency structure between the stock market returns of Asian and Latin American countries changed, showing characteristics of financial contagion. Garas et al. (2010) studied the global economic network and further combined it with the SIR model in epidemiology to explore the spread of financial crises among different countries. Acemoglu et al. (2015) believed that financial market risk contagion demonstrated characteristics of stage changes. The second literature perspective focuses on contagion at the micro enterprise behaviour level, analysing the contagious effects of corporate economic activity performance, corporate behaviour, and adverse events. Gleason et al. (2008) found that the enterprises with financial restatement not only have an adverse impact on shareholders' wealth, but also affect the share price of enterprises in the same industry without financial restatement. Banal-Estañol et al.

(2013) suggested that projects with good performance in a business combination will be affected by projects with poor performance, generating a risk of contagion. Chiu et al. (2013) believed that the supervision of the board of directors plays a key role in the quality of the company's financial report. Moreover, regarding research methods, the main ones used in the literature include regression model analysis (Claessens et al., 2012), copula function model analysis (Calabrese & Osmetti, 2019), social network analysis, GRACH model analysis, and infectious disease model analysis. Considering the abundant research on mathematical models of infectious diseases in the field of epidemiology, which can provide new ideas for financial infectious research, this study adopts infectious disease model analysis as its research methods.

3. Enterprise financialisation contagion model

3.1. Model construction

To verify whether financial behaviour has a contagious effect among enterprises—that is, whether the financialisation of one enterprise leads to the similar behaviour of other enterprises—it is necessary to build a theoretical model to demonstrate it. This study uses the infectious disease model in the medical field to simulate the contagion process of corporate financialisation, before formulating countermeasures to prevent excessive financialisation risks. The early infectious disease model was established by Kermack and Mckendrick in 1927 and divides the population into three types—Susceptible (S), Infected (I), and Recovered (R)—to create the SIR model. Numerous follow-up studies have gradually evolved the SIR model and obtained various infectious disease models, including SIRS, SEIR, and SIS. This study mainly uses the model of Kermack and McKendrick (1927), but also refers to Garas et al. (2010), Cui et al. (2017), and Xu and Yu (2018), among others, to establish a SIRS model for the contagion effect of enterprise financialisation.

First, we set the state type in the enterprise financial contagion model. Compared to the SIR infectious disease model, each status type in the corporate financial infection model is set individually, as shown in Table 1. Among them, S includes companies that are easy to financialize, indicating their preference for investment in financial assets; I stands for companies that are 'moving from reality to virtual', showing that they have gradually deviated from the main business and presented a financial state; and R stands for 'moving from virtual to real' enterprises that are gradually returning to their main business.

We then analyse the contagion process of corporate financialisation. As shown in Figure 1, assuming that N is the total number of existing companies, $S(t)$ represents the number of them showing financial investment preferences at time t, satisfying $S(t) \in [0,N]$; $I(t)$ represents the number of enterprises in the state of 'moving from

Table 1. Comparison of infection model state types.

Types	*S* (Susceptible)	*I* (Infected)	*R* (Recovered)
Infectious disease model	Susceptible state	Infected state	Recovered state
Corporate financialisation contagion model	Easily financialised state	'Moving from reality to virtual' state	'Moving from virtual to real' state

Source: Author's own work.

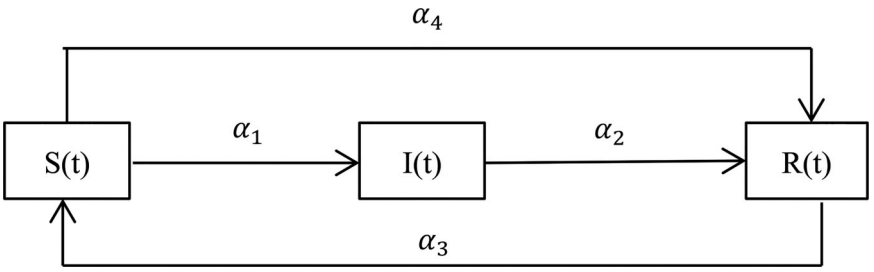

Figure 1. Diagram of the contagion process of corporate financialisation. Source: Author's own work.

reality to virtual' at time t, satisfying $I(t)\in[0,N]$; and $R(t)$ represents the number of enterprises 'moving from virtual to real' at time t, satisfying $R(t)\in[0,N]$. Furthermore, suppose that the above three statements satisfy $S(t) + I(t) + R(t) = N$. In addition, $S(t)$ points to $I(t)$, showing that when the financialisation phenomenon occurs in existing enterprises, the ones that are easily financialised will be in a state of 'moving from reality to virtual' after being infected, with α_1 indicating the contagion rates of financialisation. $I(t)$ points to $R(t)$, meaning that after the financial contagion, enterprises gradually break away from the 'moving from reality to virtual' state and begin the 'moving from virtual to real' state after taking corresponding control measures, with α_2 indicating the financial reversal rate. $R(t)$ points to $S(t)$, showing the restoration of 'from the virtual to the real' when an enterprise fails to obtain a permanent 'reversal' and may become a susceptible state again. α_3 is the second conversion rates of financialisation. $S(t)$ points to $R(t)$, meaning that although companies that are easy to financialise have financial asset investment preferences. They have not yet been infected by financialisation, or they maintain financial asset investment at a moderate level, ultimately avoiding 'moving from reality to virtual', with α_4 defining the financial self-recovery rates.

Finally, we establish the equation set of the corporate financial contagion model. Based on the above-mentioned process and the developed SIRS model, combined with dynamic principles, the ordinary differential equations of the corporate financial contagion model are constructed:

$$\begin{cases} \dfrac{dS(t)}{dt} = -\alpha_1 S(t)I(t) - \alpha_4 S(t) + \alpha_3 R(t) \\ \dfrac{dI(t)}{dt} = \alpha_1 S(t)I(t) - \alpha_2 I(t) \\ \dfrac{dR(t)}{dt} = \alpha_2 I(t) + \alpha_4 S(t) - \alpha_3 R(t) \\ N = S(t) + I(t) + R(t) \end{cases} \tag{1}$$

3.2. Model deduction and analysis

Using the principle of infectious disease dynamics, the contagion model of corporate financialisation constructed is further developed and analysed. Substituting $R(t) = N$

– $S(t)$ – $I(t)$ into the rest of the Equation (1) and setting$\frac{dS(t)}{dt} = 0$, $\frac{dI(t)}{dt} = 0$, after sorting out the ordinary differential Equation (2):

$$\begin{cases} \dfrac{dS(t)}{dt} = -\alpha_1 S(t) I(t) - \alpha_4 S(t) + \alpha_3 [N - S(t) - I(t)] = 0 \\ \dfrac{dI(t)}{dt} = I(t)[\alpha_1 S(t) - \alpha_2] = 0 \\ \dfrac{dR(t)}{dt} = -\left(\dfrac{dS(t)}{dt} + \dfrac{dI(t)}{dt}\right) = 0 \end{cases} \tag{2}$$

From the calculation in Equation (2), when I(t) = 0, we get $S(t) = \frac{N\alpha_3}{\alpha_3+\alpha_4}$; when $I(t) \neq 0$, we get $S(t) = \frac{\alpha_2}{\alpha_1}$, and further calculate $I(t) = \frac{N\alpha_1\alpha_3 - \alpha_2(\alpha_3+\alpha_4)}{(\alpha_2+\alpha_3)}$. Thus, the equilibrium points B_0 and B_1 of equation group (2) are obtained as follows:

$$B_0 : \begin{cases} S_0 = \dfrac{N\alpha_3}{\alpha_3 + \alpha_4} \\ I_0 = 0 \end{cases}, \quad B_1 : \begin{cases} S_1 = \dfrac{\alpha_2}{\alpha_1} \\ I_1 = \dfrac{N\alpha_1\alpha_3 - \alpha_2(\alpha_3 + \alpha_4)}{\alpha_2 + \alpha_3} \end{cases}$$

Meanwhile, referring to the research of van den Driessche and Watmough (2002), the basic reproducible number R_0 is obtained using the regenerative matrix method:

$$R_0 = \frac{N\alpha_1\alpha_3}{\alpha_2(\alpha_3 + \alpha_4)}$$

In the initial stage of financialisation, when a financialised company appears, The basic reproduction number R_0 represents the average number of enterprises that can influence the financial behaviour of other enterprises. It can also be used as an initial indication of whether the contagion effect of enterprise financialisation occurs.

Further analysis show that, when $N\alpha_1\alpha_3 < \alpha_2(\alpha_3 + \alpha_4)$ (i.e. $0 < R_0 < 1$), $I_1 < 0$ contradicts $I(t) \in [0,N]$. Then, there is only one balance point B_0, indicating that there will be no corporate financial contagion. When $N\alpha_1\alpha_3 > \alpha_2(\alpha_3 + \alpha_4)$ (i.e. $R_0 > 1$), the balance points B_0 and B_1 both meet the conditions, which represent the state of the enterprise financialisation phenomenon without contagion and when contagion occurs, respectively. The above analysis shows that the basic reproduction number R_0 can be used as the threshold of whether contagion occurs in corporate financialisation, that is, the financial contagion threshold.

According to Equation (2), let $F(S, I) = -\alpha_1 S(t) I(t) - \alpha_4 S(t) + \alpha_3 [N - S(t) - I(t)]$, $G(S,I) = I(t)[\alpha_1 S(t) - \alpha_2]$. Using this to construct the Jacobian matrix, we obtain

$$J = \begin{bmatrix} \dfrac{\partial F(S,I)}{\partial S} & \dfrac{\partial F(S,I)}{\partial I} \\ \dfrac{\partial G(S,I)}{\partial S} & \dfrac{\partial G(S,I)}{\partial I} \end{bmatrix} = \begin{bmatrix} -\alpha_1 I(t) - (\alpha_3 + \alpha_4) & -\alpha_1 S(t) - \alpha_3 \\ \alpha_1 I(t) & \alpha_1 S(t) - \alpha_2 \end{bmatrix}$$

At the equilibrium point B_0, the matrix $J_0=\begin{bmatrix} -(\alpha_3+\alpha_4) & -\frac{N\alpha_1\alpha_3}{\alpha_3\alpha_4}-\alpha_3 \\ 0 & \frac{N\alpha_1\alpha_3}{\alpha_3\alpha_4}-\alpha_2 \end{bmatrix}$. According to $|\lambda E - J_0|=0$, two characteristic values are calculated: $\lambda_1 = -(\alpha_3+\alpha_4)$, $\lambda_2 = \frac{N\alpha_1\alpha_3-\alpha_2(\alpha_3+\alpha_4)}{\alpha_3+\alpha_4}$, and we obtain

I. When $N\alpha_1\alpha_3 < \alpha_2(\alpha_3+\alpha_4)$ (i.e. $0 < R_0 < 1$), $\lambda_1 < 0$, $\lambda_2 < 0$, both eigenvalues are negative, and the equilibrium point B_0 is gradually stable.

II. When $N\alpha_1\alpha_3 > \alpha_2(\alpha_3+\alpha_4)$ (i.e. $R_0 > 1$), $\lambda_1 < 0$, $\lambda_2 > 0$, that is, there is a positive solution in the two eigenvalues, and the equilibrium point B_0 is unstable.

Similarly, at the equilibrium pointB_1, the matrix

$J_1 = \begin{bmatrix} -\frac{N{\alpha_1}^2\alpha_3-\alpha_1\alpha_2(\alpha_3+\alpha_4)}{\alpha_2+\alpha_3} & -(\alpha_3+\alpha_4)-(\alpha_2+\alpha_3) \\ \frac{N{\alpha_1}^2\alpha_3-\alpha_1\alpha_2(\alpha_3+\alpha_4)}{\alpha_2+\alpha_3} & 0 \end{bmatrix}$, according to $|\lambda E - J_1|=0$, the two eigenvalues have the following relationship:

$$\begin{cases} \lambda_1+\lambda_2 = -\alpha_1[N\alpha_1\alpha_3-\alpha_2(\alpha_3+\alpha_4]-(\alpha_3+\alpha_4)(\alpha_3+\alpha_2) \\ \lambda_1 * \lambda_2 = \alpha_1[N\alpha_1\alpha_3-\alpha_2(\alpha_3+\alpha_4)] \end{cases}$$

Meanwhile, we obtain,

III. When $N\alpha_1\alpha_3 < \alpha_2(\alpha_3+\alpha_4)$ (i.e. $0 < R_0 < 1$), ${\lambda_1}^*\lambda_2 < 0$, that is, one of the two eigenvalues is positive and the other is negative, the equilibrium point B_1 is unstable.

IV. When $N\alpha_1\alpha_3 > \alpha_2(\alpha_3+\alpha_4)$ (i.e. $R_0 > 1$), ${\lambda_1}^*\lambda_2 > 0$ and $\lambda_1+\lambda_2 < 0$, that is, both eigenvalues are negative, the equilibrium point B_1 is stable.

Combining the above situations I to IV, excluding the unstable situations II and III, when situation I is met, it indicates that the contagion of corporate financialisation does not occur in the market. When situation IV is met, it shows that the contagion of corporate financialisation has occurred in the market. In other words, the financialisation of one enterprise will lead to the financialisation of others, and the robustness of the basic regeneration number R_0 as the contagion threshold of corporate financialisation is further verified. Furthermore, the above situation can be used as an initial condition for examining whether corporate financialisation is contagious.

4. System dynamics simulation analysis of corporate financial contagion model

4.1. Model parameter setting

To further verify the model, this study uses China's listed manufacturing companies from 2007 to 2018 as the research sample. After excluding samples such as missing data and anomalies, 18,327 observations are finally obtained. Among them, 2169

(11.83%) were state-owned enterprises and 16,158 (88.17%) were non-state-owned enterprises.

Through sample statistical analysis, it is found that the proportion of financial asset allocation of state-owned enterprises is about 3.68% lower than the sample of non-state-owned enterprises, while the proportion of fixed asset allocation is significantly higher than that of non-state-owned enterprises by about 7.04%. At the same time, the profitability of state-owned enterprises from financial channels is about 0.21% lower than that of the sample of non-state-owned enterprises, which indicates that the level of financialisation of non-state-owned enterprises is higher than that of state-owned enterprises. In terms of return on investment, the return on financial assets and fixed assets of state-owned enterprises are on average lower than that of non-state-owned enterprises by approximately 1.12% and 1.30%, respectively. From the perspective of the volatility of the two types of return, non-state-owned enterprises are greater than state-owned enterprises. It shows that the samples of non-state-owned enterprise face higher operating risks than state-owned enterprises. In addition, the financial leverage ratio of state-owned enterprises is higher than that of non-state-owned enterprises, but the degree of financing constraints is lower than that of non-state-owned enterprises, which indicates the tendency of non-state-owned enterprises to strengthen investment in financial assets.

From the perspective of relevant policy, the government has always attached great importance to the development of the real economy, and emphasized that economic development must not be moved from reality to virtual at any time. At the same time, a series of investment management requirements for different types of enterprises have been issued to standardize investment behavior, including various types of high-risk investments. Combining with the annual change trend in Figure 2, it can be seen that the proportion of financial assets of the sample companies has an overall

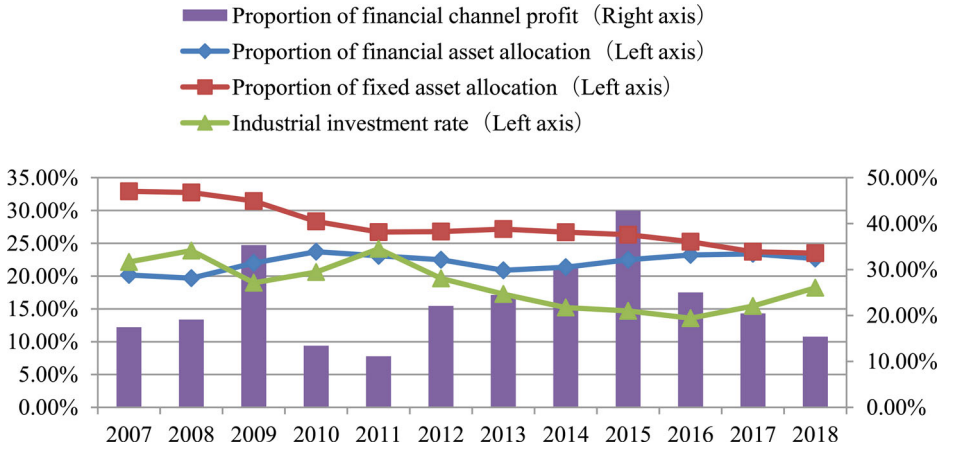

Figure 2. Financial assets and industrial investment of manufacturing enterprises from 2007 to 2018. Notes: Proportion of financial asset allocation = financial assets/Total assets × 100%; Proportion of financial channel profit = Financial asset income/Operating profit × 100%; Proportion of fixed asset allocation = financial assets/total assets × 100%; Industrial investment rate = Cash paid for purchase and construction of fixed assets, intangible assets and other long-term assets/fixed, intangible and other long-term × 100%. Source: Data comes from China Stock Market & Accounting Research Database, Author's own work.

Table 2. SIRS model parameters of enterprise financialisation.

Parameter	Group I	Group II	Group III
α_1	0.75	0.5	0.25
α_2	0.25	0.5	0.75
α_3	0.75	0.5	0.25
α_4	0.25	0.5	0.75

Source: Author's own work.

upward trend during the period 2007–2018, the proportion of fixed assets has declined overall, and the proportions of the two types of assets have gradually approached. The industrial investment rate showed a volatile trend and began to pick up after 2016. The proportion of financial channel profits also shows a dynamic trend and is related to the trend of financial asset allocation and industrial investment rate. In addition, the sample of state-owned enterprises and non-state-owned enterprises is consistent with the trend in Figure 2. Among them, the sample companies have different degrees of peaks and troughs in the allocation of financial assets and the profit from this channel, which is similar to the epidemic trend of infectious diseases.

Next, we divide the sample data into 1/4, 1/2, and 3/4 quantiles to distinguish the transformation results of each corporate financialisation stage, and the model parameter values are extracted and set. The obtained parameter groups are marked as group I, group II, and group III, respectively. Regarding the S state, above the quantile is state I, α_1 is calculated, and the state R1 below the quantile is calculated to obtain α_4. In the enterprise in I, below the quantile is state R2, calculated to obtain α_2. In the state (R1 + R2) enterprise, the secondary transformation state S is above the quantile, and α_3 is calculated. After calculation, the final parameter values are obtained, as shown in Table 2.

To meet the initial conditions for the contagion of corporate financialisation, that is, $N\alpha_1\alpha_3 > \alpha_2(\alpha_3 + \alpha_4)$ $(R_0 > 1)$, at this time, the larger the R_0, the stronger the contagion effect of corporate financialisation, as group I is selected as initial parameter value, with $\alpha_1 = 0.75$, $\alpha_2 = 0.25$, $\alpha_3 = 0.75$, $\alpha_4 = 0.25$.

4.2. System dynamics simulation analysis

The corporate financial contagion threshold derived from the contagion model shows that the greater the financial contagion rate α_1 and the secondary conversion rate α_3, the larger R_0 represents stronger contagion effect of corporate financialisation. The larger the financialisation reversal rate α_2 and the self-recovery rate α_4, the smaller the R_0, and the weaker the contagion effect. Therefore, it is necessary to reduce the contagion rate and secondary conversion rate of corporate financialisation and increase the rate of financialisation reversal and self-recovery rate. Moreover, according to the equilibrium point B_0, the calculation formula of R_0 can evolve into $R_0 = \frac{\alpha_1}{\alpha_2} \times S_0$. Furthermore, when the contagion rate of financialisation is higher than its turning rate, financialisation begins to spread its contagious effect among enterprises, and the higher the infection rate, the stronger this effect. Meanwhile, according to the principles of system dynamics and initial parameter values, Vensim software is used

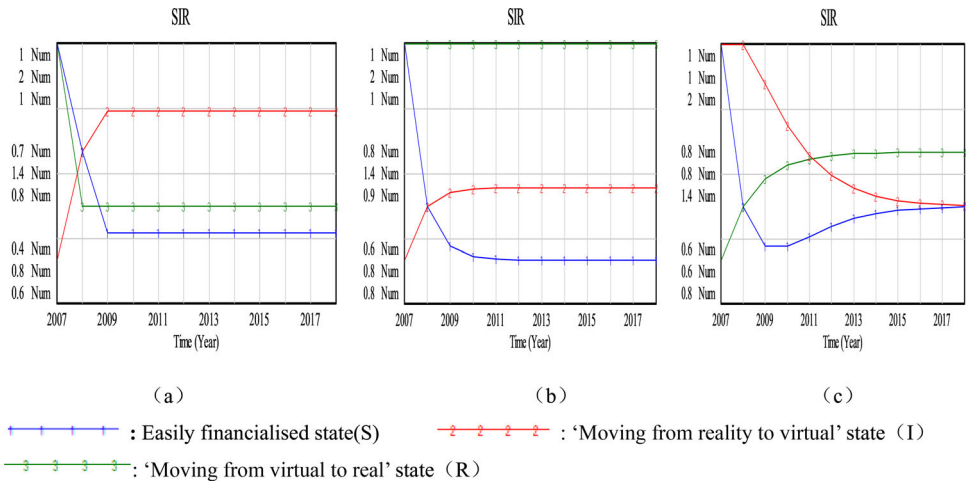

Figure 3. *S*(*t*), *I*(*t*), *R*(*t*) state curve (changes in $\alpha 1$ and $\alpha 3$). Source: From Vensim software, Author's formation.

to simulate the financial contagion model, and the following simulation results are obtained under different situations.

4.2.1. Simulation analysis of changes in financial contagion and secondary conversion rates

Assuming that other parameters remain unchanged, the financial infection rate α_1 and the secondary conversion rate α_3 changed simultaneously. Thus, the data sets including the parameters of α_1, α_2, α_3, and α_4 are *a*(0.75, 0.25, 0.75, 0.25), *b*(0.5, 0.25, 0.5, 0.25), *c*(0.25, 0.25, 0.25, 0.25), and the simulation results show that the state type changes in *S*(*t*), *I*(*t*), and *R*(*t*), as shown in Figure 3. Furthermore, the graphs corresponding to data sets *a*, *b*, and *c* are marked as Case 1, Case 2, and Case 3, respectively.

Case 1: As time changes, the number of companies in state (*S*) keep a steady trend after quickly dropping to the lowest point. In contrast, the number of companies in state (*I*) shows a rapid upward trend. After reaching the highest point, it begins to stabilise, indicating that there is a high financial contagion effect in existing enterprises. At this time, the financial contagion rate is still high, further illustrating that enterprises in state (*S*) are extremely susceptible to infection, and numerous enterprises have turned to state (*I*). Moreover, changes in the secondary conversion rate of financialisation have further aggravated its contagion effects.

Case 2: With the decrease in rates of α_1 and α_3, it becomes clear that the three types of state curve trends have changed. The curve *S*(*t*) generally shows a downward trend. Meanwhile, the number of enterprises in this state is relatively small, indicating that the decrease in the secondary conversion rate of financialisation reduces the number of enterprises in state (S), and indirectly shows that the number of enterprises in state (R) increases. Similarly, curve *I*(*t*), which represents 'moving from reality to virtual', develops steadily after rising to a high point, indicating that financial contagion still exists, but with weakened effect.

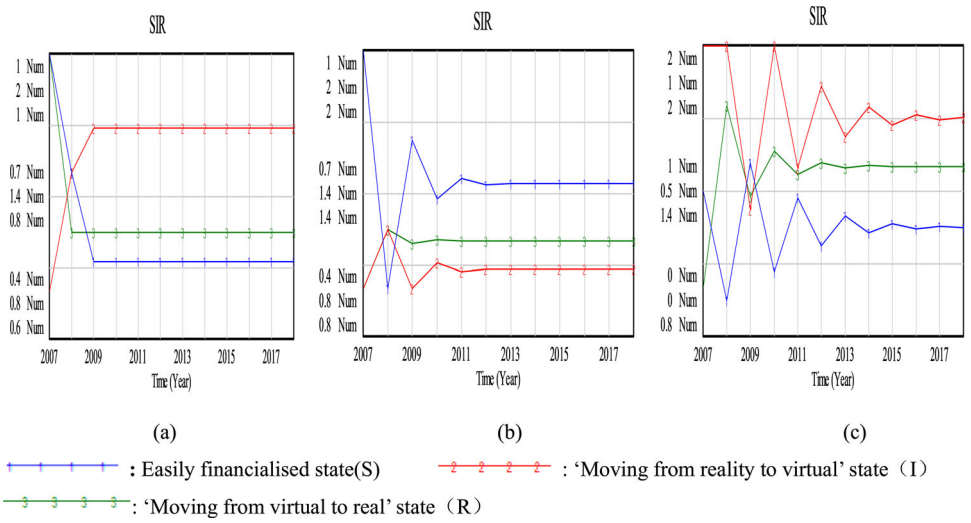

Figure 4. *S*(*t*), *I*(*t*), *R*(*t*) state curves (changes in α2 and α4). Source: From Vensim software, Author's formation.

Case 3: Here, α_1 and α_3 continue to decrease. Curve $I(t)$ shows a clear downward trend. The financial situation of enterprises is still infectious, but it remains at a low level, and the number of enterprises in state (I) is significantly reduced. Curve $S(t)$ begins to rise slowly after falling to a certain position; however, as the financialisation contagion rate and secondary conversion rates continue to decrease, the signs of recovery tend to stabilise. At the same time, the number of companies in state (R) gradually increases.

Combining the above three situations, we see that as rates of α_1 and α_3 continue to decrease, the number of companies in state (I) gradually decreases, while those in state (R) increase and the number of enterprises in state (S) remained steady level, but decreasing. R_0 gradually became smaller and the contagion effect weakens. Conversely, as α_1 continues to rise, the number of companies in state (S) increases. As a result, the number of companies that turned into state (I) increases significantly and the contagion effect of financialisation increases.

4.2.2. Simulation analysis of changes in financialisation reversal rate and self-recovery rate

If other parameters remain unchanged, the financial reverse rate α_2 and the self-recovery rate α_4 changed concurrently. The data sets containing the parameters of α_1, α_2, α_3, and α_4 are a(0.75, 0.25, 0.75, 0.25), b(0.75, 0.5, 0.75, 0.5), c(0.75, 0.75, 0.75, 0.75). The curves of $S(t)$, $I(t)$, and $R(t)$ obtained by simulation are shown in Figure 4. The discussion of Case 1, Case 2, and Case 3 correspond to the graphs of the data sets a, b, and c, respectively.

Case 1: The curve $S(t)$ shows a downward trend and maintains it steadily after reaching the lowest point. Compared with the curve $I(t)$ and curve $R(t)$, fewer enterprises are in state (S). Some turn into state (I) after being infected by financialisation, while others are not infected or maintain the financial asset investment behaviour at

a moderate level, which represents state (R). Curve $R(t)$ also maintains a stable state after dropping to the lowest point. Compared with curve $I(t)$, the financial contagion rate is much higher than the reversal rate and the contagion effect continues to spread.

Case 2: As the rates of α_2 and α_4 increase, the number of companies in state (R) begins to rise steadily, and the ones in state (I) decrease before gradually turning to state (R). The trend of financial contagion still exists, but it is relatively slower.

Case 3: Rates of α_2 and α_4 continue to rise. In the existing market, the number of companies in state (R) increases significantly. Combining the trend of curve change, curve $I(t)$ and curve $R(t)$ change in similar directions, indicating that the increasing financialisation reversal and contagion rates tend to be at the same frequency, thereby reducing the overall corporate financialisation contagion effect. Curves $S(t)$ and $R(t)$ change in the opposite direction, showing that the number of companies that are prone to financialisation turn to state (R) increases when α_4 is constantly increasing.

Combining the above three situations, we observe that as the rates of α_2 and α_4 increase, the number of enterprises changing from state (S) and (I) to state (R) gradually increases. Compared with the financialisation contagion rate, when α_2 continues to rise toward the financial contagion one, it will reduce R_0, weaken the contagion effect, and help alleviate the phenomenon of 'moving from reality to virtual' in manufacturing enterprises.

5. Further discussion

5.1. An economic explanation of the contagion of corporate financial behavior

As a type of investment behavior of enterprises, financialisation is also affected by many factors. Traditional financial theory assumes that the financial decision-making of a single enterprise is independent and rational. However, it may be faced with mutual imitation or influence of behavior and decision-making between enterprises to produce contagious effects and affect the degree of enterprise financialisation in reality. The occurrence of behavioral infection requires three basic conditions: source of infection, route of transmission, and susceptibility. The above three links will be affected by subjective and objective factors, including various policy requirements and corporate investment motives. Existing literatures have verified the impact of environmental or policy uncertainty, savings motives, and profit-seeking motives on corporate financialisation. Therefore, from the perspective of behavioral contagion, this study attempts to use the infectious disease model to discuss the contagion process and the effects of corporate financialisation. At the same time, the complex system theory believes that the above-mentioned behaviors can be regarded as the consistency and convergence between enterprises through coupling and association.

At the same time, narrative economics theory (Shiller, 2017) can also provide a corresponding explanation for the contagion of corporate financialisation. When a belief, a trend, an investment decision, or a performance will directly or indirectly affect economic behavior, this feature makes narrative communication an important dimension to explain economic phenomena, while economic narrative changes the communicability of economic decisions issue. The theory holds that the spread mode

of economic narratives is similar to that of disease epidemics, and that epidemiological models can be applied to economic narratives and the spreading process can be simulated. Corporate financialisation is an economic narrative that affects investment behavior. Through the use of infectious disease model in this study, it is found that the narrative is contagious and corporate financial behavior will further contagion between different corporate entities and form a contagious effect.

5.2. Governance strategies to address the risk of corporate financial contagion

Based on the simulation results of the different situations, when the financial asset investment or financial channel profit of manufacturing enterprises rise, the financial contagion rate is higher than the reversal rate, indicating that corporate financialisation behaviour is contagious among enterprises. When the asset investment or channel profits decline, the financialisation contagion rate is lower than the reversal one, which means that the contagiousness of corporate financialisation behaviour has begun to weaken, and the enterprises turn to rely on the development of their main business. Therefore, it is necessary to reduce the contagion rate and secondary conversion rate of corporate financialisation and increase the rate of financialisation reversal and self-recovery rate.

From the perspective of enterprise risk management, in order to cope with the contagion risk of corporate financialisation, four strategies can be used to distinguish different situations, including risk tolerance (Strategy I), risk aversion (Strategy II), risk reduction (Strategy III), and risk sharing (Strategy IV).

Strategy I: Risk tolerance. This strategy is mainly aimed at situations where the degree of corporate financialisation does not meet the initial contagion conditions and is within the contagion threshold. At this time, the company has not made financial asset investment and has not profited from financial channels, or the company's financialisation has been controlled within a moderate range, meaning that it has not yet constituted a state of 'moving from reality to virtual'. To follow the development of the main business of the enterprise and to comply with the corresponding laws and regulations, the principle of appropriate financial asset investment should be applied.

Strategy II: Risk aversion. This strategy is aimed at situations in which the degree of corporate financialisation reaches the initial contagion condition and exceeds the threshold, when the financial contagion rate is higher than the reversal rate. This means that the corporate financialisation phenomenon has become contagious, leading to a 'move from reality to virtual'. At national level, relevant policies should be formulated to curb excessive or blind investment in financial assets. On the one hand, relevant policies should be formulated to curb excessive or blind investment in financial assets to optimise the industrial development environment. On the other hand, the capabilities of innovation-driven should be enhanced by enterprises to avoid the risk of 'moving from reality to virtual'.

Strategy III: Risk reduction. This strategy is committed to reducing the contagion rate of corporate financialisation to an acceptable level of risk, so that the degree of financialisation is in a state where the initial contagion conditions are not met, and

the contagion threshold is not exceeded. It mainly reflects the following aspects: First, prevention is required. To avoid enterprises 'moving from reality to virtual', the economy and the investment environment are optimised, and financial investment supervision is strengthened. The second step is suppression. It is necessary to resolve the essential problems of corporate financialisation, optimise corporate investment portfolios, weigh the risks and returns of different investment types, and minimise the adverse consequences of excessive financialisation.

Strategy IV: Risk sharing. This strategy also aims to reduce the rate of financial contagion, in terms of risk transfer or risk dilution. Improving the economic ability of financial services and advancing the development of the industry-finance integration model will help dilute the contagion risks of corporate financialisation and promote the benign interaction between entities and finance. It is worth noting that in the process of coordinated development of the industry-finance integration model, it is also necessary to use the principle of appropriateness to avoid blindly integrated development leading to excessive financialisation.

From the perspective of the influencing factors of financialisation behavior, through distinguishing the different driving mechanisms behind the financial behavior and provides the basis for the classification of governance strategies. One is objective factors, such as various systems and ownership structure. When there are signs of 'moving from reality to virtual', a risk aversion strategy is adopted. While formulating various measures to boost the development of the economy, the ability to become 'immune' and deal with financial contagion risks of enterprises should be strengthened through various innovative means, so as to avoid corporate financial contagion risks. The other is subjective factors, such as the arbitrage motivation of the enterprise, investment preference, etc. When there is an over-financialisation trend, a risk reduction strategy is adopted. Which can optimise the investment portfolio and improve the development capabilities of the main business continuously.

6. Conclusion

6.1. Main conclusion

This study examines the formation and governance of corporate financialisation. Based on the principle of infectious disease dynamics, we construct a SIRS contagion model to study corporate financial contagion effects, verify the contagiousness of corporate financialisation, and conduct a simulation analysis on this basis in order to propose governance strategies preventing contagion risk. The study finds that the financial behaviour of sample companies is contagious with strong effects. When the degree of corporate financialisation does not meet the initial contagion conditions and is within the threshold, the contagion will not occur; however, it will cause mutual infection between enterprises, producing contagion effects. Moreover, the higher the infection threshold, the stronger the infectivity. Meanwhile, the higher the financial contagion and secondary conversion rates of financialisation, the stronger the effect; the greater the financialisation torsion and financial self-recovery rates, the weaker the contagion effect. In addition, we proposes different types of strategies to further improve financial governance.

6.2. Implications

This study holds both theoretical value and practical significance. First, its use of the contagion model of infectious diseases provides a new perspective for the formation of corporate financialisation and extends previous literature on financialisation. Furthermore, simulating the formation process of corporate financialisation will help to further clarify its formation and development mechanism, enriching existing research results. Second, combining the research results, we propose strategies to prevent financialisation risks on different aspects, before further providing ideas for improving corporate financial governance. This will help optimise the development environment of the economy, continuously improve the value-creation capabilities of enterprises and provide impetus for sustainable economic development.

6.3. Limitations and future research

This study has some limitations that offer fruitful directions for future research. First, select samples of manufacturing companies and fail to discuss the sample of non-manufacturing companies. It is necessary to consider the heterogeneity of sample selection in future research, including samples by industry and region. Second, the research is only carried out from the perspective of behavioral contagion, while the different driving mechanisms behind behavior have not been discussed in depth. For future research, it is necessary to distinguish the effects of corporate financialisation under different driving factors. At the same time, different situations need to be included in the argumentation which will help systematise the research topic of financialisation and provide an important decision-making basis for preventing financialisation risks.

Disclosure statement

No potential conflict of interest was reported by the authors.

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