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Research on Credit Risk Contagion in Energy Supply Chain Finance under the Constraint of "Double Carbon" Targets

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Abstract: *There is a correlation between the "double carbon" target constraint and the contagion effect of energy supply chain finance credit risk. In order to analyze the credit risk contagion characteristics of energy supply chain finance, the influence variables of technological innovation, environmental responsibility, information disclosure degree, business volume scale and credit risk intensity are introduced. Combining the virus transmission mechanism and Fourier heat conduction principle, we constructed the energy supply chain financial credit risk contagion model (SIS-HTM) to measure the state and degree of credit risk contagion, and studied the influencing factors and degree of credit risk contagion of energy supply chain financial credit risk under the goal of "dual-carbon". The study shows that the "dual-carbon" goal indirectly positively affects the credit risk intensity of energy supply chain finance, and the degree of information disclosure, technological innovation, and sense of environmental responsibility of energy enterprises are inversely proportional to their credit risk contagion intensity, while the scale of the business volume and credit risk intensity of energy enterprises are positively proportional to their credit risk contagion intensity.*

Keywords: *Energy supply chains; "dual-carbon" targets; financial credit risk contagion; heat transfer models; viral contagion models*

1. Introduction

In 2020, General Secretary proposed for the first time in the United Nations General Assembly the goal of "carbon peak and carbon neutrality"; in 2021, the "dual carbon" goal centered on "carbon peak and carbon neutrality" was written into the government work report, which is China's solemn commitment to the international community to reduce carbon emissions. The goal of "carbon peak and carbon neutrality" has been written into the Government's work report, which is China's solemn commitment to the international community to reduce carbon emissions. Achieving the "dual-carbon" goal is not only an important part of ecological civilization construction, but also a powerful driving force for the profound change of enterprise supply chain. The current development situation in China and the achievement of the "double carbon" goal must be supported by the energy supply chain, in which the control of energy supply chain financial credit risk contagion is a powerful support to help the realization of the "double carbon" goal.

In order to smooth the industrial chain and realize the top-level design of the supply chain under the goal of "dual-carbon", the government work report from 2021 onwards has repeatedly mentioned that a series of means should be adopted to prevent and resolve the financial risks of the supply chain of enterprises. To realize the goal of "dual carbon", energy is the focus and supply chain is an important carrier. The efficient operation of energy enterprises is the key to realizing the "double carbon", and through the interconnection of the upstream and downstream supply chain of the energy chain, it promotes the development and innovation of new energy, thus improving the speed of the industry and slowing down the transmission of risks [1]. Therefore, the study of energy supply chain financial credit risk contagion is conducive to the prevention and control of supply chain risk, improve the financial risk management system to achieve the quality and efficiency of energy enterprises.

The control of supply chain financial risk has received the attention of many scholars at home and abroad. Accompanied by the development and utilization of new energy, institutional transformation and technological innovation, energy supply chain financial credit risk and its contagion effect is becoming more and more complex. However, few scholars have explored the risk contagion among enterprises in the energy market under the goal of "dual carbon". Based on the characteristics of energy supply chain finance in the context of "dual-carbon" goal, this paper describes the credit risk contagion process of energy supply chain finance and analyzes the influencing factors of credit risk contagion and their degree of influence with the improved model combining the heat conduction model and viral contagion model. To a certain extent, it makes up for the shortcomings of the existing research on credit risk contagion, and provides an innovative and improved modeling method for the research on credit risk contagion in the energy supply chain.

2. Literature Review

2.1 Research related to supply chain finance and its credit risk

About the definition of supply chain finance. Xia Yu et al [2] combed the existing research literature to define supply chain finance as a set of programs to provide financial services for supply chain enterprises based on the overall credit of the supply chain. Han Hongxin et al [3] proposed that supply chain finance is a kind of closed capital activity that integrates enterprise business flow, logistics, capital flow and information flow, and pursues the overall value of the supply chain instead of individual value.

On the mechanism of supply chain finance credit. Zhang Cheng [4] used system dynamics theory to simulate and compare the financial credit risk of supply chain SMEs and found that supply chain finance increases the stability of SMEs and reduces their credit default risk; Mou et al [5] used quantitative analysis methods to propose that the exchange of information flow, capital flow, and logistics of core enterprises in the supply chain can reduce the credit risk of supply chain finance and improve its efficiency and effectiveness.

2.2 Research related to credit risk contagion in energy supply chain finance

On energy supply chain finance credit risk contagion. Dong Ming [6] proposed an integrated framework for distributed modeling of energy supply chain, which optimizes the decision-making of the whole supply chain based on its three main characteristics: large scale, high stochasticity and complexity. Mo Aoran [7] used principal component analysis to identify the main factors affecting the energy supply chain in Beijing, and used dynamic optimization theory to model and analyze the dynamic optimization of the energy supply chain. Liu Pingkuo [8] utilized the value-driven tree method to sort out the risk source transfer relationship and constructed a complete indicator system using the value-driven tree method. In-depth study of the performance and risk management mechanism of this supply chain provides systematic analytical tools and strategies for the sustainable development of the industry.Wang [9] constructed a spillover index by variance decomposition of prediction errors to reveal the asymmetric spillover effects of the energy supply chain market and the carbon market in terms of the sequence of return and volatility.Ma [10] examined the risk contagion of the energy supply chain by using Copula modeling and found that time-varying price spillovers and linkages are very sensitive to economic shocks from China's steelmaking overcapacity cuts and coronavirus contagion.Gong [11] used a time-varying vector parameter autoregressive model with stochastic volatility (TVP-VAR-SV model) and impulse response functions to investigate the risks associated with the energy supply chain and carbon markets. It is found that there is an obvious spillover effect between the carbon market and the fossil energy market, the intensity and direction of which are time-varying and asymmetric. Zhang Keqin [12] constructed a risk evaluation system for China's energy financial market, analyzed energy financial risks and their influencing factors, and found that the energy financial market is vulnerable to major events.

2.3 Research Methods on Credit Risk Contagion in Supply Chain Finance

Research methods on credit risk contagion in supply chain finance. In order to realize the goal of "double carbon", some unexpected events will affect the stability of the supply chain system, and have an impact on the risk contagion effect among the node enterprises in the chain, Pan et al. [13] used the ternary VAR-GARCH(1)-BEKK model to analyze the risk contagion analysis of the supply chain network composed of the three levels of energy, transportation and industrial enterprises, and found that the supply chain network from the upstream to the industrial enterprises is susceptible to the risk contagion analysis of energy finance. Risk contagion analysis, found that the supply chain risk from upstream to downstream enterprises is not only one-way contagion, but also jump contagion. Wang Dingxiang et al [14] studied the mechanism of credit risk contagion by taking the accounts receivable financing model in supply chain finance as an example, and used the SIR viral contagion model for simulation, and found that the probability of credit risk is positively correlated with the average degree of credit risk conduction and contagion source nodes, and that an efficient supply chain early warning model is able to effectively prevent and control the credit risk when the credit risk occurs. Li Zhanlei et al[15] used heat conduction model to simulate the risk contagion of supply chain accounts receivable pledge financing, and verified its influencing factors and degree of influence through numerical simulation.Chen et al[16] used SIS contagion model to construct supply chain financial network, and explored the transmission speed and steady-state characteristics of the credit risk when it is affected by external influences, so as to understand more comprehensively the supply chain financial ability of resisting risks.

Supply chain credit risk control has received the attention of many scholars, but there is a lack of research on the impact factors and degree of contagion, and few scholars have explored the issue of energy supply chain financial credit risk contagion under the "double carbon" constraint. Most of the existing literature uses network model, infectious disease model and other methods to explore the supply chain financial credit risk contagion. Based on the existing research, this paper makes the following additions: (1) Based on the credit status of enterprises and the economic environment of the energy market, this paper studies the contagion mechanism and influencing factors of supply chain financial risk under the "dual-carbon" goal, in order to better promote the financial management of supply chain risk of enterprises under the "dual-carbon" goal, and to broaden the perspective of the existing research. This will broaden the perspective of the existing research. (2) Combine the heat conduction model and the viral contagion model to form an improved model, which can more accurately reflect the dynamics and contagious characteristics of risk contagion, and construct an analytical framework for risk contagion, so as to enrich the application of the methodology of financial credit risk contagion.

3. SIS-HTM Credit Risk Transmission Model for Supply Chain Finance

3.1 Applicability of SIS-HTM model

In SIS model, the samples are divided into three states, namely, risk stable state S (susceptible), risk state I (infected) and the state that has been freed from risk but can be infected S (susceptible).SIS model can describe the process of supply chain financial credit risk contagion, and the node enterprise state in the simulation process is represented by the above three states. The heat conduction model is based on Fourier's law and the law of energy conservation to describe the heat conduction process, the mechanism of supply chain financial credit risk contagion between energy enterprises is very similar to the process of heat conduction between objects, so the heat conduction model can be used to simulate the energy supply chain financial credit risk contagion.

The heat conduction model can not fully express the process of supply chain financial risk contagion, the SIS model can simulate the change of the number of infected enterprises in the process of risk contagion, but for the enterprises in the risk contagion, only two states are indicated, and there is no indication of the degree of contagion; and the recovery time of the infected people in the construction of the SIS model is fixed, which is not in line with the reality; the SIS model does not have directionality in the process of contagion, and is not suitable for the supply chain financial credit risk contagion process. The SIS model simulates the contagion process without direction, which is not adapted to the credit risk contagion in supply chain finance. The SIS-HTM model, which combines the heat conduction model and the SIS model, can well solve these problems and achieve more realistic simulation results.

3.2 Credit risk contagion model

Referring to Chen Dongling's [17] research on credit risk contagion factors of supply chain finance under the perspective of complex network, this paper sets that factors such as technological innovativeness of energy enterprises, sense of environmental responsibility, credit risk intensity, information disclosure degree, and scale of business volume also affect the contagion process of credit risk of energy supply chain finance to a certain extent while affecting the development of the energy enterprises internally.

(1) Technological innovativeness of energy enterprises. This reflects the core competitiveness and market position of energy enterprises, as well as the ability to adapt to market changes and customer needs and other issues.

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(2) Environmental responsibility of energy enterprises. This reflects the energy enterprise's environmental protection and energy saving and emission reduction, as well as whether it is in line with national policies and social responsibility and other issues.

(3) Credit risk intensity of energy enterprises. Enterprise risk intensity refers to the possibility and degree of credit loss caused by various uncertain factors in the operation process of energy enterprises.

(4) The degree of information disclosure of energy enterprises. This reflects issues such as the reputation and image of the energy enterprise and whether it meets social expectations and legal norms.

(5) The scale of the energy company's business volume. The scale of business volume refers to the share or influence that an energy enterprise occupies in energy supply chain finance, which is related to factors such as the scale, status and relevance of the energy enterprise.

Basic assumptions:

(1) Energy supply chain system relationship assumption: the relationship between enterprises that incur credit risk, enterprises that are affected by credit risk and supply chain finance business in the energy supply chain is analogous to the heat source, heat receiver and heat conduction medium in heat conduction.

(2) Structure invariant assumption: In order to highlight the research focus and reduce the complexity of the model, this paper assumes that the network structure of supply chain finance does not change with the contagion of credit risk.

(3) Factor Assumptions: The intensity of the "double carbon" target is expressed as e as a constraint. It is assumed that the risk contagion intensity of risk contagion is equivalent to the intensity of heat conduction, denoted by v. The degree of information disclosure of energy enterprises is equivalent to the thermal conductivity coefficient, denoted by P; the scale of business volume is equivalent to the thermal conductivity area, denoted by G; the intensity of credit risk is equivalent to the endothermic source, denoted by O; the innovativeness is equivalent to the specific heat capacity in the Fourier's law, denoted by D; and the sense of corporate environmental responsibility is equivalent to the density of the medium in the Fourier's law, denoted by S. The internal variables of credit risk contagion intensity in energy supply chain finance are shown in Table 1.

Table 1: Internal variables of credit risk contagion intensity in energy supply chain finance.

Variables	Meaning
Credit risk contagion intensity (v)	Amount of credit risk per unit time of the contagion process
Technological innovativeness (D)	Capacity and level of technological innovation at a given moment
Environmental responsibility (S)	Awareness of the responsibility of the enterprise to protect and improve the environment and the power of action
Credit risk intensity (O)	The value of credit risk generated by the enterprise itself at a certain moment in time
Degree of information disclosure (P)	The ratio of the amount of information disclosure to the total amount of information at a certain moment in time
Scale of business volume (G)	The number and scale of business activities accomplished in a certain period of time
Intensity of "dual carbon" target (e)	Strength of the constraints of the "dual-carbon" target at a certain moment in time

3.3 Model construction

The SIS-HTM model is based on the SIS virus model and adds the concept of heat transfer model. The SIS-HTM model is based on the SIS virus model and adds the concept of heat conduction model, which is used to describe the degree of risk to the enterprise in the risk state of the SIS model; calculate the recovery time according to the degree of contagion; and in the direction of contagion, introduce the direction of heat conduction model to indicate the direction of contagion.The SIS-HTM model describes the dynamic process of the contagion and recovery of the credit risk of the energy supply chain finance in a more reasonable way. The following are the detailed steps:

(1) Generate network

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The basic network model of simulation is generated, and a scale-free BA network is built with MATLAB. The number of nodes N affecting the supply chain finance network is set to 100 in advance, and the average node degree m is 5.

(2) Determine the initial contagion point

In the network, a node is randomly selected as the contagion point, and the degree of contagion is 40, which is similar to the supply chain financial risk contagion process, the initial contagion point should not be too much, otherwise it is difficult to clearly and intuitively describe the heat transfer process, and the initial contagion point in this paper is set to one.

(3) Contagion process

1) Shock: find out the suspected infectious points connected to the infectious point, count the number of infectious points in the neighboring nodes of the suspected infectious point and its degree of contagion, and estimate the shock suffered by the suspected infectious point.

$$\beta_i = \max \beta_{ij} \tag{1}$$

The number of infected nodes in the neighboring nodes of the suspected infected point and their degree of infection are counted to estimate the impact of the suspected infected point.

2) Judge whether the node is infected or not: Compare with the risk threshold of the suspected infected point.

$$C_i = 37 + (1 + c_i + \eta) * \frac{k_i}{2m} \tag{2}$$

c_i is the post-risk asset status, which represents the assets remaining under the financing project after the enterprise itself suffers some normal or unpredictable losses in normal production and operation activities. For ease of analysis, randomly generated values in (0, 1) are used instead.

η is the general financing ratio, and its initial value is set at 0.8 based on the test results after several tests.

k_i is the node degree of contagious dubious points.

$$\text{If } \beta_i > C_i \tag{3}$$

then the requirement of contagion is reached and the contagion is started.

$$\begin{cases} P' = P * (\mathbf{1} + e / \mathbf{2}) \\ S' = S * (\mathbf{1} - e / \mathbf{4}) \\ D' = D * (\mathbf{1} - e / \mathbf{4}) \end{cases} \tag{4}$$

$$V_i = \frac{G}{P'D'S'} + \frac{O}{D'S'} \tag{5}$$

e is the policy intensity of "double carbon" target, the value range is (0, 1).

e is the proportion of contagion, the degree of information disclosure (P), the scale of business volume (G), the intensity of credit risk (O), the sense of environmental responsibility (S), and technological innovation (D).

$$T_i = 37 * (1 - V_i) + \beta_i V_i \tag{6}$$

T_i is the degree of contagion of suspected contagion points, β_i is the shock to the node, and V_i is the proportion of contagion.

(4) Recovery of infected nodes

The model of this paper is based on the SIS model, and there is the phenomenon of recovery of infected nodes, and the recovery process is borrowed from the concept of heat dissipation process in the

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heat conduction model, and the recovery time is calculated according to the degree of infection and the recovery coefficient. It is because of the existence of the recovery state that the whole network realizes the steady state state.

$$a=T_i-37 \tag{7}$$

$$k'=k*(1-e/6) \tag{8}$$

$$T_i(t)=37+ae^{-k't} \tag{9}$$

$T_i(t)$ is the degree to which the node is infected, a is the difference between the initial temperature and the ambient temperature, and k is the recovery coefficient.

(5) Continuous risk contagion

When a risky node appears in the network, it will be repeatedly infected according to the fourth and fifth processes mentioned above until it reaches the steady state of the network. 50 time steps, all the contagion models reach the steady state, and at the same time, setting a fixed time period is also conducive to the subsequent analysis, so the risk contagion processes in this chapter are all based on the 50 time steps as the time of contagion.

The above analysis of node contagion has elaborated the specific influence mechanism of each influencing factor on the diffusion of network credit risk, and the following section will simulate the above contagion algorithm by simulation and visualize the results of contagion.

4. Numerical Simulation

The MATLAB software is utilized for simulating and analyzing the credit risk contagion mechanism in energy supply chain finance. Drawing upon Li Zhanlei et al.'s [18,19] research on financing default risk contagion and associated credit risk contagion, we set the initial number of infectious enterprises (X0) as 1. The technical innovation level of energy enterprises is 6, with an information disclosure degree (P) of 0.4, a credit risk intensity (O) of 30, an environmental responsibility score (S) of 6, a business volume scale of 15, a recovery coefficient (k) of 0.3, and a "double carbon" target intensity (e) of 0.2. These aforementioned values are substituted into the financial credit risk contagion model as initial parameters.

4.1 Impact of the "dual-carbon" target

The "dual-carbon" goal requires the energy sector to transform into clean energy, reduce carbon emissions and promote low-carbon development. This transformation challenge requires large capital investment and technological transformation, which increases the financial pressure and uncertainty of enterprises and raises their credit risk. Therefore, in the context of the "dual-carbon" target, the technological innovativeness of energy enterprises is set at 5, the sense of environmental responsibility is set at 5, the credit risk intensity is set at 35, the general financing ratio is set at 0.6, the recovery coefficient is set at 0.2, the intensity of the "dual-carbon" target is set at 0.4, and the initial contagion point is set at 2, which gives the following results. The target intensity of "dual-carbon" is set as 0.4, and the initial number of contagious points is set as 2, and the graph of the change of the number of contagious enterprises in the background of "dual-carbon" and general background is obtained, as shown in Fig. 1.

Figure 1 shows that the "dual-carbon" goal promotes financial risk transmission in the energy supply chain, increasing both the speed of risk transmission and the number of steady state firms in the network. Realizing the "dual carbon" goal will change the structure of the energy supply chain, which needs to be more diversified and increase the sources of energy. Energy supply chains need to consider the need for energy-saving technologies and high-efficiency energy conversion equipment to reduce energy waste and carbon emissions.

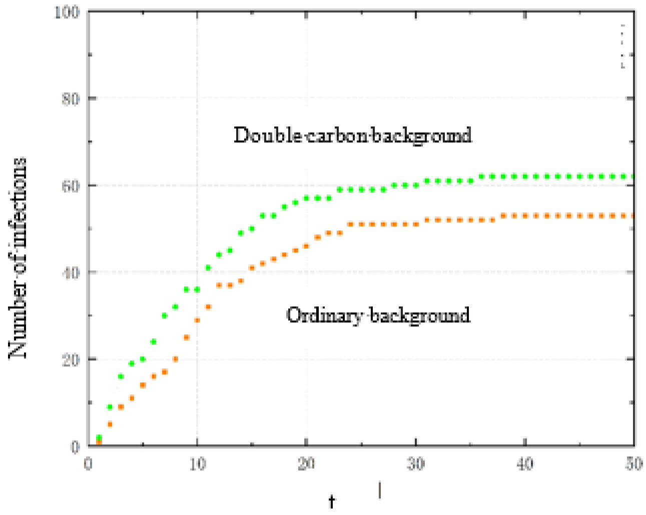

Figure 1: Implications of "dual-carbon" targets.

4.2 Impact of internal factors in energy supply chain enterprises

(1) Impact of technological innovativeness

Keeping other parameters unchanged, the values of technological innovativeness of energy enterprises were set as 2, 4, 6 and 8, respectively, and substituted into the model for solving, and the graph of the number of infectious enterprises with time under different technological innovativeness of energy enterprises was obtained, as shown in Fig. 2.

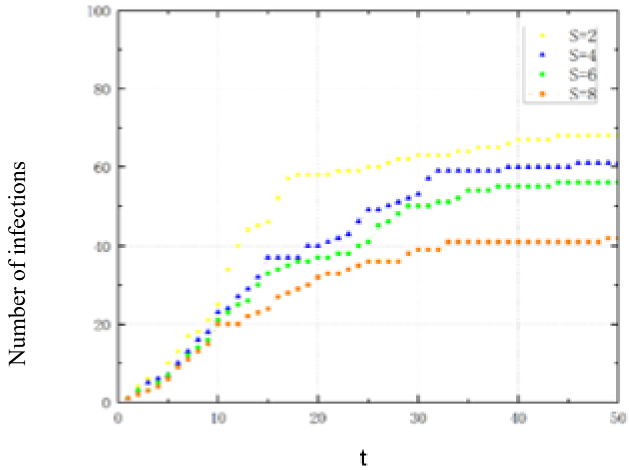

Figure 2: Impact of technological innovativeness.

From Figures 2, it can be seen that the technical innovativeness of energy enterprises has a negative impact on the degree of credit risk in energy supply chain finance. Technological innovation can improve the efficiency and resilience of the energy supply chain, reduce energy costs and carbon emissions, enhance the competitiveness and profitability of energy enterprises, thereby reducing the occurrence and probability of financial risk contagion.

(2) Impact of environmental responsibility

Holding other parameters unchanged, respectively, the value of energy enterprises' sense of environmental responsibility is set to 2, 4, 6, 8, and substituted into the model for solving, to obtain the graph of the number of contagious enterprises over time under the different sense of environmental responsibility of energy enterprises, as shown in Figure 3.

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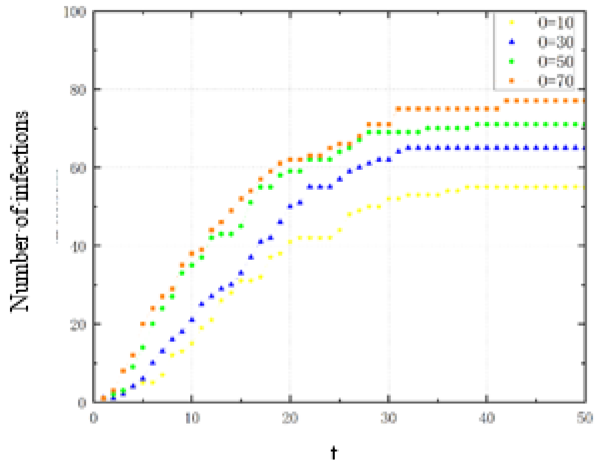

Figure 3: Impact of environmental responsibility.

From Figures 3, it can be seen that the sense of environmental responsibility of energy enterprises has a negative impact on the degree of credit risk in energy supply chain finance. The sense of environmental responsibility can promote the implementation of low-carbon technology and management of energy enterprises, reduce energy consumption and emissions, improve energy efficiency and environmental performance, thereby reducing the occurrence of financial risk and the probability of contagion. The sense of environmental responsibility can enhance the social reputation and brand image of energy enterprises, improve the trust and support of customers and investors, increase market share and profit margins, and thus reduce the sensitivity and vulnerability of financial risks.

(3) Impact of enterprise risk intensity

Keeping other parameters unchanged, the values of risk intensity of energy enterprises were set to 10, 30, 50 and 70, respectively, and substituted into the model for solving, to obtain the graph of the number of contagious enterprises over time under different risk intensities of energy enterprises, as shown in Figure 4.

From Figures 4, it can be seen that the risk intensity of energy enterprises has a positive influence on the credit risk level of energy supply chain finance. A low level of corporate credit risk can improve the financing capacity and conditions of energy enterprises, reduce borrowing costs and interest rates, increase capital liquidity and flexibility, thereby reducing the occurrence of financial risks and the probability of contagion.

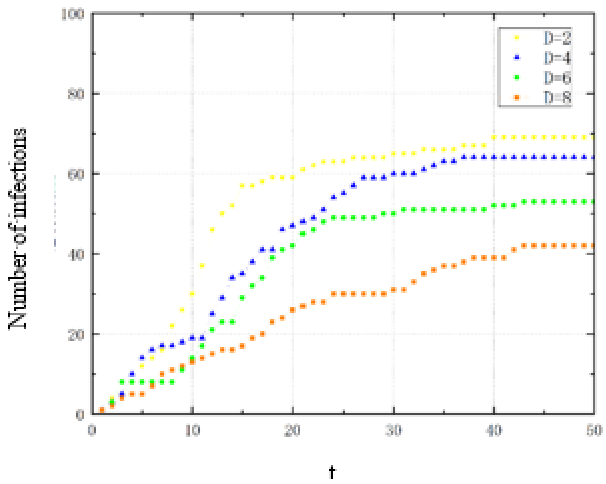

Figure 4: Impact of credit risk intensity.

(4) Impact of the degree of information disclosure

Keeping other parameters unchanged, respectively, the value of the degree of information disclosure

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of energy enterprises was set as 0.1, 0.4, 0.7, 1, and substituted into the model for solving, and the number of contagious enterprises under different degrees of information disclosure of energy enterprises was obtained. The graph of change over time is shown in Figure 5.

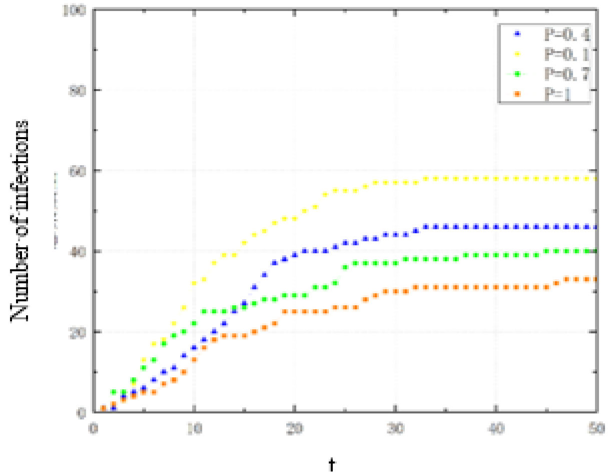

Figure 5: Impact of the degree of information disclosure.

From Figures 5, it can be seen that the degree of information disclosure of energy enterprises and the degree of credit risk of energy supply chain finance are negatively affected. A high degree of information disclosure can improve the transparency and trust of energy enterprises, increase external supervision and evaluation, and promote the fulfillment of corporate social and environmental responsibility, thus reducing the probability of the occurrence and transmission of financial risks.

(5) Impact of business volume size

Keeping other parameters unchanged, the values of the business volume scale of energy enterprises were set to 5, 15, 25 and 35, respectively, and substituted into the model for solving, to obtain the graph of the number of contagious enterprises over time under different business volume scales of energy enterprises. In the steady state of the network, the evolution of the number of infectious enterprises, the intensity of "double carbon" and the scale of business volume is shown in Figure 6.

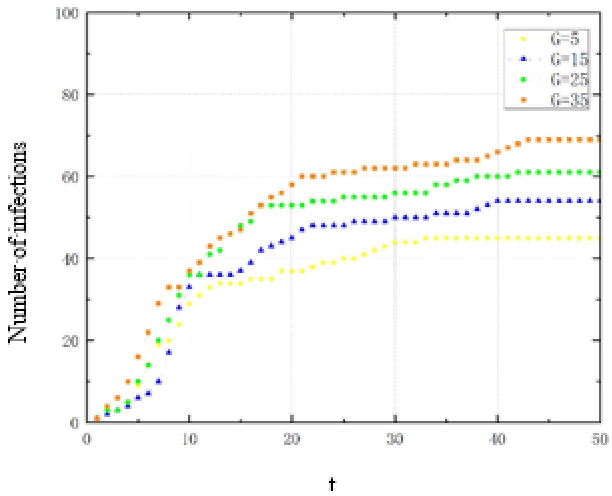

Figure 6: Impact of business volume size.

From Figure 6, it can be seen that the scale of business volume of energy enterprises and the degree of credit risk of energy supply chain finance are positively affected. The scale of business volume of energy enterprises will directly affect the capital flow and logistics of upstream and downstream enterprises in the supply chain, leading to supply chain disruption or tension, and increasing the operating costs and risks of other enterprises; it also reflects their credit demand and scale of borrowing from financial institutions, which will directly affect the quality of financial institutions' assets and capital adequacy, and the financing channels and financing costs of upstream and downstream enterprises in the supply chain.

5. Conclusions and recommendations

This paper is the first to construct a risk contagion model based on SIS-HTM in the context of the "double carbon" goal to study the state and degree of credit risk contagion in energy supply chain finance, and analyze the influencing factors and contagion mechanism. The study shows that the "dual-carbon" goal indirectly positively affects the credit risk intensity of energy supply chain finance, and the degree of information disclosure, technological innovation, and sense of environmental responsibility of energy enterprises are inversely proportional to their credit risk contagion intensity, while the scale of business volume and credit risk intensity of energy enterprises are positively proportional to their credit risk contagion intensity; and the external shocks increase the number of initially contagious enterprises and the credit risk intensity. External shocks will increase the number of initially contagious enterprises and the speed of credit risk contagion, while policy interventions have a significant inhibiting effect on the risks caused by external shocks, and their effectiveness depends on the intensity, time and targeting of policy responses. With regard to the credit risk contagion problem of energy supply chain finance under the goal of "double carbon", the following suggestions are put forward from the perspectives of energy supply chain enterprises, financial regulators and policy making:

First, energy supply chain enterprises should improve information disclosure, strengthen technological innovation and environmental responsibility, and enhance their ability to resist financial credit risk contagion. Energy supply chain enterprises should disclose their financial, business, technological and environmental information to reduce information asymmetry and improve their credit risk assessment and pricing ability; at the same time, they should invest in technological innovation and environmental protection to improve energy efficiency and carbon emission reduction, reduce operating costs and environmental risks, and enhance their competitive advantages and market reputation.

Secondly, financial regulators should strengthen financial supervision and risk disposal of credit risk in energy supply chain finance. Financial regulators should establish and improve the monitoring and assessment system of energy supply chain financial credit risk, collect and analyze the relevant data of energy supply chain enterprises, and regularly release risk reports and early warning information to improve the risk identification and prevention ability; at the same time, they should formulate and implement an effective risk disposal mechanism, and carry out timely intervention and rescue for enterprises with credit risk events, so as to avoid greater losses caused by risk contagion.

Third, the government should formulate a reasonable "dual-carbon" target policy. The government should formulate a realistic "dual-carbon" target policy based on national conditions and international situation, and make clear the timetable, roadmap and action plan of "dual-carbon", so as to provide energy supply chain enterprises with clear policy guidance and expectations; at the same time, according to the real-time situation of credit risk contagion in energy supply chain, the government should formulate a "dual-carbon" target policy based on the real-time situation of credit risk contagion in energy supply chain. At the same time, according to the real-time situation of financial credit risk contagion, we should flexibly adjust the intensity, time and targeting of policy intervention, so as to ensure the realization of the "dual-carbon" goal and safeguard the financial stability of energy supply chain enterprises.

Credit risk contagion in supply chain finance is a complex issue involving many parties, and some aspects of this paper have not been considered completely, which can be improved in the subsequent research. First, this paper ignores the specificity of different energy supply chain financial networks, roughly unifies the characteristics of energy supply chains, and chooses the same probability of contagion, and subsequent studies can further explore the characteristics of specific energy supply chain networks. In addition, this paper assumes that the size of the network remains constant and does not consider the entry and exit mechanisms of the nodes. Subsequent studies can further discuss the research in these aspects.

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