

Research on the influence of supply chain relationship reconfiguration on enterprise innovation performance

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Abstract: In view of the impact of supply chain restructuring on enterprise innovation performance, the impact mechanism of changes in internal and external environmental factors on enterprise innovation is unclear, and the relevant theories of supply chain are comprehensively applied. Theories such as relational contract theory, innovation theory, resource theory and information asymmetry theory collect the data of supply chain relationship reconstruction of listed companies in recent years, establish a data regression analysis model, analyze the influence law of supply chain reconstruction caused by financial distress, tariff barriers, financing constraints and customer relationship on enterprise technological innovation, and put forward rectification suggestions. The research results are conducive to reducing risks and improving innovation efficiency.

1. Introduction

Under the guidance of supply-side structural reform and innovation-driven economic development strategy, in order to integrate capital and technical resources and improve enterprise performance, it is of great significance for enterprise management and high-quality development to study the mechanism of supply chain integration on enterprise technological innovation, integrate into supply chain integration and innovation, and develop new quality productivity and other development goals.

The supply chain takes the product from the merchant to the consumer. Supply chain is an important social relationship network of resource coordination, including interests, competition, trust, friends and other relationships [1]. Similar to supply chain integration, supply chain integration is to solve the strategic cooperation among manufacturers, suppliers, customers, and internal functions to meet environmental requirements [2]. Krolikowski and Yuan (2017) believe that higher customer concentration is conducive to more R&D activities and improved innovation efficiency of suppliers, but due to the existence of "rip-off" problem, suppliers will strategically reduce R&D investment to reduce customer bargaining power [3]. Affected by the internal and external environment of the enterprise, the supply chain relationship is not completely static, and the change of the supply chain relationship often occurs, and the enterprise often needs to reconstruct the supply chain relationship. Good financing ability can guarantee enterprises to carry out continuous and stable innovation activities (Hsu et al., 2014) [4]. However, when the supply chain relationship changes, the original production and operation plan of enterprises may be broken, affecting product production and sales, leading to a decline in sales revenue and an aggravation of business risks (Cao Wei et al., 2019) [5]. Thus, the innovation level of enterprises will be reduced (Jiang Dianchun and Lu Dayu, 2022) [6, 7].

This paper studies the influence of supply chain internal integration, supplier integration and customer integration on enterprise innovation, considers supply chain digital transformation and environmental uncertainty, builds a theoretical model of supply chain integration and enterprise green, and discusses the influence path between variables. The influence of the reconfiguration of

supply chain relationship on technological innovation caused by different reasons is discussed from internal financial environment factors and external social environment factors respectively. Considering the changes of investment behavior, information asymmetry and financing constraints caused by the reconfiguration of supply chain relations, this paper analyzes the mechanism of the influence of the reconfiguration of supply chain relations on the technological innovation of enterprises.

2. Supply chain related theory

2.1. Supply chain relationship

Supply chain refers to the network chain structure formed by enterprises that provide products or services to end users in the process of production and circulation, that is, the whole chain of products from merchants to consumers.

Partnersourcing Ltd (1993) further defines supply chain relationships as the commitment of suppliers and customers to develop long-term partnerships that share trust and common goals, with the aim of increasing international capability and competitiveness.

Michael J. Malon (1997) defined supply chain partnership as a relationship that improves the financial and operational performance of member companies by reducing costs and inventory and increasing information sharing. George Baker (2002) believes that companies with supply chain cooperation are more able to help and understand each other after emergencies.

In 2004, China Federation of Logistics and Purchasing authoritatively defined supply chain cooperation as an informal long-term agreement between upstream and downstream enterprises in the supply chain to share information, share risks and share profits in a certain period of time to ensure the realization of a specific goal or benefit. This informal agreement relationship means that the supply chain companies are more humane, and the relationship maintenance is more dependent on trust, so the supply chain relationship has gradually become one of the main relationship transactions in China.

Trust among supply chains, unity of purpose and win-win results are essential elements. Especially in the context of China's "relationship" based social and economic background, it is more necessary to combine environmental factors and cultural factors to consider the study of supply chain relations.

2.2. Contract theory

Contract theory is a theory that analyzes the economic behavior and results between different contractors in a specific transaction environment. It simplifies transaction attributes by assuming conditions, builds models to analyze and get theoretical views. Contract theory mainly focuses on the design, execution and potential defects of contracts, which is of great significance for understanding contracts and institutions in real life.

Contract theory is of great value for understanding contracts and institutions in real life. Help design more effective contracts and reduce potential defects. Contribution to economics : Contract theory is an important branch of economics, which has far-reaching influence on economic development and institutional design.

Well-known contract theorists Oliver Hart and Bent Holmstrom have been awarded the 2016 Nobel Prize in Economics for their work on contract theory.

2.3. Transaction cost theory

The transaction cost theory was put forward by Nobel Laureate economist Coase (R.H., 1937). The fundamental argument of the transaction cost theory lies in explaining the essence of the firm.

Transaction costs refer to various costs related to a transaction incurred by both parties before and after a transaction is completed. These costs include the costs of disseminating information, advertising, market-related transportation, and negotiating, negotiating, contracting, and supervising the execution of contracts. Transaction costs mainly include the cost of using the price mechanism

and the negotiation, supervision, performance and other costs required to complete the transaction.

There are six sources of transaction cost: bounded rationality, opportunism, uncertainty and complexity, and specific investment. These factors will increase the cost in the transaction process and reduce economic efficiency.

In real life, individuals often fall into a state of limited rationality due to insufficient cognitive ability or insufficient information acquisition. In addition, people have the tendency of opportunism, resulting in traders tend to maximize their own interests in the transaction process, and even take improper means to maximize the interests, which leads to the complexity of the transaction, aggravate the transaction risk, and increase the transaction cost.

Supply chain relationships can effectively reduce transaction costs. The establishment of long-term partnerships within the supply chain helps to reduce search costs, reduce information asymmetry, and reduce opportunistic behavior. Secondly, in order to maintain a good supply chain relationship, suppliers/customers will invest a lot of specific assets to deepen cooperation and reduce transaction costs. Finally, supply chain relationships also help reduce transaction uncertainty and ensure transaction frequency. Once the supply chain relationship is reconstructed, the above advantages will no longer exist, resulting in higher transaction costs. Therefore, this paper attempts to explore how the reconfiguration of supply chain relations affects the technological innovation of enterprises from the perspective of transaction costs.

2.4. Resource orchestration theory

Resource Orchestration Theory (ROT) was proposed by Sirmon et al. It is used to explain how managers organize, bundle and utilize enterprise resources in dynamic and uncertain environment. This theory is an extension of resource-based theory, holding that it is necessary for enterprises to have resources, but resources must be effectively managed, otherwise they are not enough to become competitive advantages.

Resource arrangement theory emphasizes that resources do not depend on how much, but on how to reasonably "use" resources to create value. The nature of resource arrangement is a sequential action process in which external resources break through organizational boundaries, enter the enterprise, and integrate and expand resources, with obvious sequential characteristics. Resource orchestration activities are integrated into different stages of enterprise life cycle development, and the coupling mechanism and cross-process collaboration mechanism of resource orchestration process are analyzed.

According to resource scheduling theory, resource acquisition is only one of the preconditions to improve enterprise performance, and dynamic management of resources is the key to transform resources into capabilities and improve enterprise performance. Therefore, the resource arrangement theory constructs a dynamic model covering three ascending links of resource structuring (constructing resource combination), resource capabilization (forming ability of bundled resources) and resource leverage (creating value by using ability), and describes the resource action process in detail.

Resource scheduling theory reveals how enterprises effectively arrange resources, then promote the formation and evolution of capabilities, and finally gather competitive advantages. It Outlines the complete path from resource acquisition to value output, clarifies the relationship between resources and capabilities, and their roles in the process of achieving sustainable competitive advantages, thus effectively making up for the shortcomings of resource-based theory. It provides a new research perspective for exploring the relationship between enterprise resources and value creation activities.

2.5. The origin and definition of innovation theory

Innovation theory, proposed by economist Joseph Schumpeter in 1912, emphasizes that the essence of innovation is the entrepreneur's new combination of production factors, which is not limited to invention, but also includes the practical application of new ideas or products to create real value.

The five cases of innovation include the introduction of new products or features, the adoption of

new production methods, the opening of new markets, the control of new raw material supply sources, and the realization of new industrial organization. The innovation process involves identifying problems, proposing hypotheses, designing solutions, implementing validation and popularizing applications. Its influencing factors are divided into internal and external, the former is related to corporate culture and organizational structure, the latter is related to market demand and technological progress.

Innovation has three meanings: renewal; Create something new; For a change. Innovation is a means of using existing natural resources to create new things. However, with the progress of science and technology and the development of society, the understanding of innovation is also constantly evolving. Especially with the advent of knowledge society, the change of innovation model has been further studied and recognized.

3. Research on supply chain integration

3.1. Literature review

The economic benefit of supply chain relationship is affected by integration effect, risk effect and spillover effect. The supply chain relationship is not invariable and often changes, so enterprises need to reconstruct the supply chain relationship. There are few studies on the influence of supply chain relationship reconfiguration on investment decision and technology innovation investment. The reconfiguration of supply chain relationship is not only a risk, but also has a promoting effect.

Supply chain relationship is a relational transaction. Based on the two perspectives of information asymmetry and financing constraints, the static concentration degree of supply chain and the dynamic change of supply chain relationship affect the technological innovation of enterprises.

The reconstruction of supply chain relations has multi-dimensional causes, which are not only affected by internal environment such as financial environment, but also interfered by external social environment. In terms of internal environment, financial environment involves capital chain problems. Once an enterprise encounters financial difficulties, it will affect the supply and demand environment and normal production and operation of all enterprises in the supply chain. In terms of the external environment, tariff barriers have a particularly far-reaching impact on China's politics and economy. As a method to restrict the import of goods, high tariffs increase the cost and price of foreign goods and weaken their market competitiveness, so as to limit the import of these goods and protect the competitive advantage of domestic products in the domestic market.

The reconstruction of supply chain relations causes the change of investment behavior of enterprises, affects financing, and affects the investment in technological innovation of enterprises.

In the long run, technological innovation can bring higher profits to enterprises. However, as an investment activity, the high returns brought by innovation are accompanied by high risks. The risk of innovation failure is relatively high, and the uncertainty of returns is relatively high. It is difficult for outsiders with information disadvantage to comprehensively evaluate the advantages and disadvantages of innovation activities, which makes external investors become more conservative when deciding whether to participate in innovation projects, thus affecting the ability of companies to obtain funds from outside. Resource constraints directly limit innovation intensity and initiative and hinder enterprise innovation. Especially in the special institutional background of China, "difficult financing" and "expensive financing" have restricted enterprises to carry out innovation. Only when financial resources are available will companies innovate. External financing is difficult, and internal financing has become the main channel for enterprise innovation. Under the background of vigorously developing mixed ownership economy, the reform of state-owned enterprises can significantly improve the efficiency of patent output by reducing the financing constraints of enterprises.

3.2. Innovation model design and variable definition

Based on the research design of Jiang Dianchun and Lu Dayu (2022) and other scholars, the following model (1) is constructed to test the impact of supply chain relationship reconstruction on enterprise technological innovation:

$$\text{Innovation}_{it} = a_0 + a_1 \text{Restr_S}_{it} + \text{Controls}_{it} + \sum \text{Ind}_{it} + \sum \text{Year}_{it} + \varepsilon_{it} \quad (1)$$

Variable Innovation, representing enterprise technological innovation, and Restr S on the right side of equal sign, representing supply chain relationship reconstruction. With reference to existing research ideas (Wu Qiang and Yao Yuxiu, 2023), the overall reconstruction index of supply chain relationship is constructed. The main observed variable is Restr S. If the regression coefficient a_1 of the main observed variable Restr S is significantly positive, it indicates that the reconfiguration of supply chain relations promotes the technological innovation level of enterprises; if a_1 is significantly negative, it indicates that the reconfiguration of supply chain relations inhibits the technological innovation level of enterprises.

Variable Innovation represents enterprise technological innovation, which is measured from two aspects: innovation input and innovation output. Among them, innovation investment (RD) is measured by the proportion of R&D expenditure to total assets. The larger the index, the higher the level of innovation investment. Innovation output (Lnpat) is measured by the natural logarithm of the number of patents granted by the enterprise in the future period plus 1. The larger the index, the higher the level of innovation output of the enterprise.

The variable Restr S represents the reconstruction of supply chain relations, including the following two meanings: First, the enterprise will no longer cooperate with the original supplier/customer, and build the supply chain relationship with the new supplier/customer, and the former will withdraw from the top five suppliers/customers; Second, the enterprise increases or decreases the contract signing share with existing suppliers/customers, that is, the enterprise increases or decreases the purchase amount/sales volume with existing suppliers/customers. According to the above definition, by referring to Jiang Dianchun and Lu Dayu, 2022, and by referring to existing research ideas, Wu Qiang and Yao Yuxiu, 2023, the supply chain relationship reconstruction index is constructed. (1) Restr S1: measured by the average of the number //5 of the top five suppliers disclosed by the enterprise at the end of the year that did not appear in the previous year and the number //5 of the top five customers disclosed by the enterprise at the end of the year that did not appear in the previous year. (2) Restr S2: Measured by the mean of the ratio of changing supplier purchases/customer sales among the top five suppliers/customers to the total purchases/total customer sales of the top five suppliers.

3.3. Design of financing constraint model

Theoretical analysis holds that the reconfiguration of supply chain relations also intensifies the problem of corporate financing constraints, thus limiting the technological innovation of enterprises. The reconfiguration of supply chain relations leads to "internal troubles and external troubles" for enterprises. The shortage of internal funds and external financing restrictions lead to a large capital gap and intensified financing constraints, which cannot provide a large amount of funds for innovative activities, thus inhibiting enterprise innovation. Therefore, this section refers to the research of Jiang Dianchun and Lu Dayu (2022) and uses KZ index to measure financing constraints. The KZ index is calculated as follows:

$$\text{KZ} = -1.002\text{Cfo} - 39.368\text{Div} - 1.315\text{Cash} + 3.139\text{Lev} + 0.283\text{Q}$$

In the KZ index calculation formula, Cfo is the ratio of net operating Cash flow to total assets, Div is the stock payment ratio, cash represents the ratio of cash holdings to total assets, Lev is the asset-liability ratio, and Q is Tobin's Q value. The results of the above mechanism tests verify that the reconfiguration of supply chain relations reduces the technological innovation level of enterprises by increasing business risks, increasing transaction costs and intensifying financing constraints.

3.4. The role of supply chain relationship on innovation

In the current supply chain relationship in China, the buyer has a higher position and more right to speak. Therefore, when enterprises face the reconstruction of customer relationship, more business risks will be caused, more transaction costs will be paid, financing constraints will be intensified, and technological innovation of enterprises will be affected. In summary, the inhibitory effect of supply chain relationship reconstruction on enterprise technological innovation is mainly reflected in downstream client relationship reconstruction.

According to theoretical analysis, the restructuring of supply chain relations indicates that enterprises are facing greater uncertainty, and various risks are constantly rising, which leads to the inability of enterprises to carry out innovation activities and weak innovation willingness. This paper holds that when an enterprise has a certain anti-risk ability, it can resist the risks brought by the reconfiguration of supply chain relations, so as to alleviate the inhibition of the reconfiguration of supply chain relations on the enterprise technological innovation. In the face of supply chain relationship reconstruction, enterprises with strong anti-risk ability can mitigate the adverse effects of the relationship reconstruction through their own resources or strong market position, and quickly cope with the supply chain relationship reconstruction. However, it is difficult for enterprises with weak anti-risk ability to cope with the reconstruction of supply chain relations in a timely manner, and strive to maintain the main business on which they rely for survival, and have no time to take into account the development of innovative activities.

The anti-risk ability of enterprises with different property rights is different. State-owned enterprises are naturally related to the government and have an implicit guarantee mechanism. Due to China's special property rights system, after the restructuring of the supply chain relationship of state-owned enterprises, their subsidies incline and financing convenience enable them to grab economic benefits. At this time, they can timely deal with risk problems or fund shortage problems by virtue of their resource advantages and strong anti-risk ability. Thus, the inhibition effect of supply chain relationship reconstruction on enterprise innovation can be alleviated. However, non-state-owned enterprises do not have resource advantages, and their ability to obtain factor resources is weak, and their ability to resist risks is poor. When the reconfiguration of supply chain relations occurs in non-state-owned enterprises, it is difficult for them to obtain relevant resources through the government, and they are faced with more severe financing constraints, which makes it difficult to flexibly and quickly respond to the risks brought by the reconfiguration of supply chain relations, thus reducing the willingness to invest in R&D and innovation and inhibiting the technological innovation of non-state-owned enterprises.

4. The influence of internal financial environment on technological innovation

4.1. Theoretical analysis and research hypothesis

Finance involves various economic relations in the production and management activities of enterprises, and closely links with each link of production and management of enterprises. Financial distress is an important internal factor affecting the reconstruction of supply chain relations. According to resource theory, information asymmetry theory and other theories, the reconstruction of supply chain relations caused by financial distress will affect the technological innovation of enterprises.

Financial distress is a problem that most enterprises will face in the process of survival and development. In the life cycle of enterprises, due to problems such as poor operation and management and declining income, the cash flow of enterprises is difficult to pay off debts, the capital flow is broken, or the current assets are difficult to match the current liabilities, resulting in the financial distress of enterprises. Especially in the context of the global economic contraction and the strengthening of market competitiveness, the phenomenon of enterprises falling into financial distress is becoming more and more prominent. If the problem of financial distress cannot be effectively alleviated, it will lead to bankruptcy, trigger the risk of supply chain interruption, and make enterprises reconstruct the supply chain relationship.

When enterprises face financial difficulties, due to the shortage of funds, they often examine the established supply chain relationship from the perspective of reducing transaction costs, in order to pursue economic optimization. On the one hand, when the financial situation of an enterprise deteriorates, its external uncertainty will increase the complexity of the transaction. At this time, it is difficult for the enterprise to bear high transaction risks, so it usually gives up complex supply chain relations and turns to simpler supply channels with lower risks.

Compared with other general investment activities, technological innovation is often accompanied by higher risks and potentially higher rates of return. Due to the existence of uncertainty, innovative capital investment aggravates the financial difficulties of enterprises. Due to their own financial difficulties, enterprises are forced to reconstruct the supply chain relationship, and suffer from the double blow of financial difficulties and supply chain relationship reconstruction, resulting in lack of funds, insufficient solvency, declining financing capacity, and no funds to invest in innovative activities. In order to avoid risks, financing constraints are intensified, and enterprises will make conservative investment decisions and lack sufficient motivation and financial resources for innovation, thus inhibiting the investment in technological innovation of enterprises.

4.2. Model design and variable definition

The reconstruction of supply chain relationship caused by financial distress affects the technological innovation of enterprises. The first step is to verify whether financial distress leads to the restructuring of supply chain relationships. Taking the measurement of financial distress as the main factor, and considering other factors, the coefficient is set according to the impact degree, weighted cumulative, and the comprehensive coefficient of enterprise supply chain relationship reconstruction is calculated. Therefore, the following linear regression model (2) is designed.

$$\text{Restr_S}_{it} = a_0 + a_1 \text{FD}_{it} + \text{Controls}_{it} + \sum \text{Ind}_{it} + \sum \text{Year}_{it} + \varepsilon_{it} \quad (2)$$

In the above model (2), Restr S, the explained variable, represents the reconstruction of enterprise supply chain relations. Based on existing research ideas (Wu Qiang and Yao Yuxiu, 2023), the overall reconstruction index of supply chain relations is constructed to measure. On the right side of the equal sign, FD is the explanatory variable, representing financial distress. Z-score is used to measure financial distress, and enterprises whose Z-score is less than 1.81 are defined as financial distress enterprises, and the value is 1, otherwise it is 0. By observing the regression coefficient of the dummy variable FD, we can judge whether financial distress leads to the reconstruction of supply chain relations. If the regression coefficient a_1 of the main observed variable FD is significantly positive, it indicates that financial distress causes the reconstruction of supply chain relations.

4.3. Financial distress and technological innovation

Content to be studied: To examine whether the restructuring of supply chain relations caused by financial distress will affect the technological innovation of enterprises. Based on the research ideas of Bai Jun et al. (2022) [8], the following OLS model (3) is designed.

$$\text{Innovation}_{it} = \beta_0 + \beta_1 \text{Reason_S}_{it} + \text{Controls}_{it} + \sum \text{Ind}_{it} + \sum \text{Year}_{it} + \varepsilon_{it} \quad (3)$$

The variable Innovation represents the technological innovation level of the enterprise, and the Reason S on the right side of the equal sign is the explanatory variable, which is the coefficient a_1 FD obtained by the regression of the model (3), representing the part of the supply chain relationship reconstruction caused by financial distress. The main observed variable is Reason S. If the regression coefficient β_1 of the main observed variable Reason_S is significantly positive, it indicates that the restructuring of supply chain relations caused by financial distress promotes the enterprise technological innovation; if β_1 is significantly negative, it indicates that the restructuring of supply chain relations caused by financial distress inhibits the enterprise technological innovation.

The variable in the model is Restr S, which represents the reconstruction of supply chain

relations. Specifically, it includes the following two meanings: First, the enterprise will no longer cooperate with the original supplier/customer, and build a supply chain relationship with the new supplier/customer, and the former will withdraw from the top five suppliers/customers; Second, the enterprise increases or decreases the contract signing share with existing suppliers/customers, that is, the enterprise increases or decreases the purchase amount/sales volume with existing suppliers/customers. According to the above definition, the supply chain relationship reconstruction index is constructed. (1) Restr SI: it is measured by the average of the number /5 of the top five suppliers disclosed by the enterprise at the end of this year that did not appear in the previous year and the number //5 of the top five customers disclosed by the enterprise at the end of this year that did not appear in the previous year. (2) Restr S2: Measured by the mean of the ratio of changing supplier purchases/customer sales among the top five suppliers/customers to the total purchases/total customer sales of the top five suppliers.

4.4. Financial distress affects technological innovation

The supply chain relationship is affected by its own environment, and the supply chain relationship will be reconstructed. As an important internal environmental factor, financial environment has a profound impact on the reconstruction of supply chain relations. When an enterprise has financial difficulties, on the one hand, in order to reduce its own risk as much as possible, the enterprise will actively choose to interrupt the cooperation relationship with the supplier/customer, or reduce the contract share signed with it. On the other hand, in order to prevent the enterprise risk from infecting itself through the supply chain, the other end of the supply chain chooses to stay away rather than help, and the enterprise is forced to interrupt the cooperation relationship with the supplier/customer, which leads to the reconstruction of the supply chain relationship.

The reconfiguration of supply chain relations caused by financial distress significantly inhibits the technological innovation level of enterprises, because it inhibits the innovation input and output of enterprises.

The reconstruction of supply chain relations caused by financial difficulties intensifies financing constraints, affects innovation capital investment, and thus reduces the level of technological innovation.

Through subsample regression analysis, it is found that: the development degree of supply chain finance, enterprise's ability to resist risks, financing ability, financial development level and other factors determine the reconstruction of supply chain relationship caused by financial distress and the inhibitory effect on enterprise technological innovation.

5. The influence of external environment on technological innovation

5.1. Theoretical analysis and research hypothesis

Tariff barriers are measures to restrict the import of goods with high tariffs. Imposing high import tariffs on foreign goods in order to increase their cost and weaken their competitiveness, so as to limit the import of these goods and protect the competitive advantage of domestic products in the domestic market.

Tariff barriers directly increase the procurement costs of enterprises, resulting in a surge in China's export costs and rising prices of imported products. In addition, the tariffs imposed will be transferred to upstream and downstream enterprises through the supply chain, damaging the interests of the supply chain and the welfare of customers. In order to avoid the uncertainty caused by tariff barriers and cause adverse chain reactions, enterprises have to give up cooperation with their original suppliers/customers, choose countries without tariff barriers or turn to China to build new cooperative relations, which results in the reconstruction of supply chain relations.

Due to the restructuring of supply chain relations caused by tariff barriers, enterprises are faced with greater market uncertainty, which forces enterprises to carry out innovative activities. Strategic growth option theory holds that market uncertainty will also promote innovation. In the context of

trade friction, enterprises reconstruct supply chain relations, seize opportunities, improve their own value, break through technological blockades, enhance their own innovation capabilities, and expand market share with new products. In order to avoid risks and timely respond to problems such as technology bottlenecks, enterprises introduce new ideas, invest in research and development, and improve independent innovation capabilities to improve the dependence on raw material supply or improve product quality and performance, so as to improve the level of enterprise innovation. Tariff barriers make enterprises realize the importance of independent innovation, in order to help enterprises break through the innovation bottleneck, improve the ability of independent research and development, the government gives corresponding policy support, increase research and development subsidies and government subsidies. Government subsidies bear part of the financial pressure for enterprises, provide financial support for corresponding innovation activities, and make up for the lack of innovation funds for enterprises to a certain extent.

From the perspective of inhibiting effect, tariff barriers face greater uncertainty and will also inhibit technological innovation of enterprises. Affected by tariff barriers and under the pressure of high risk and high cost, enterprises reconstructing supply chain relations lack sufficient confidence, willingness and ability to make sustained and large investments in innovation activities, thus reducing the level of innovation investment.

5.2. Supply chain relationship model design

The premise that the reconfiguration of supply chain relations caused by tariff barriers affects the technological innovation of enterprises is that tariff barriers lead to the reconfiguration of supply chain relations of enterprises. Therefore, the first step is to verify whether tariff barriers lead to the reconfiguration of supply chain relations. In 2018, a new round of trade frictions between China and the United States kicked off, with the United States imposing tariffs and setting tariff barriers on goods imported from China. At the same time, China also issued a corresponding tariff list in response to the US tariff increase. The Sino-US trade friction event in 2018 provides a good natural experiment scene for exploring the impact of the reconfiguration of supply chain relations under tariff barriers on the technological innovation of enterprises. Based on this, a differentially differential model (DID model) is used to investigate the impact of the reconfiguration of supply chain relations caused by tariff barriers on enterprises' technological innovation by taking the Sino-US trade friction event in 2018 as an exogenous impact. Based on this, the following differential model (4) is designed:

$$\text{Restr_S}_{it} = a_0 + a_1 \text{TdXPost}_{it} + \text{Controls}_{it} + \sum \text{Ind}_{it} + \sum \text{Year}_{it} + \varepsilon_{it} \quad (4)$$

The variable Restr S, representing the reconstruction of enterprise supply chain relations, is measured by referring to existing research ideas (Wu Qiang and Yao Yuxiu, 2023, constructing the overall reconstruction index of supply chain relations). On the right side of the equal sign, Td XPost is the explanatory variable, where Td is the dummy variable of whether trade frictions occur in the industry in that year, and Post is the dummy variable of time. 2018 is set as the year when tariff barriers occur, that is, the year when Sino-US trade frictions occur in 2018 and subsequent years, and otherwise, 0. The first step focuses on the impact of tariff barriers on the reconfiguration of supply chain relations (Td XPost). If the regression coefficient a_1 of the main observed variable Td XPost is significantly positive, it indicates that tariff barriers cause the reconfiguration of supply chain relations.

5.3. Innovation and tariff barrier model design

This paper studies the impact of the reconfiguration of supply chain relations caused by tariff barriers on the technological innovation of enterprises, draws on the research ideas of Bai Jun et al. (2022) [8], and designs the following differential model (5).

$$\text{Innovation}_{it} = \beta_0 + \beta_1 \text{Reason_S}_{it} + \text{Controls}_{it} + \sum \text{Ind}_{it} + \sum \text{Year}_{it} + \varepsilon_{it} \quad (5)$$

The variable Innovation represents the technological innovation level of the enterprise, and the

Reason S on the right side of the equal sign is the explanatory variable, which is the coefficient α_1 Td Post obtained by the regression of the model (1), representing the part of the supply chain relationship reconstruction caused by tariff barriers. The main observed variable is Reason S. If the regression coefficient β_1 of the main observed variable Reason_S is significantly positive, it indicates that the restructuring of supply chain relations caused by tariff barriers promotes enterprise technological innovation; if β_1 is significantly negative, it indicates that the restructuring of supply chain relations caused by tariff barriers inhibits enterprise technological innovation.

5.4. The relationship between tariff barriers and technological innovation

The reconfiguration of supply chain relations caused by tariff barriers has a significant impact on the technological innovation of enterprises. Specifically, the reconfiguration of supply chain relations caused by tariff barriers significantly promotes the innovation input of enterprises, but inhibits the innovation output, that is, reduces the innovation performance of enterprises. This conclusion is mainly influenced by industry characteristics.

The reconfiguration of supply chain relations caused by tariff barriers mainly improves the innovation input of enterprises by reducing the information asymmetry and increasing the government subsidies obtained by enterprises. The reconfiguration of supply chain relations caused by tariff barriers mainly inhibits the innovation output of enterprises by increasing the uncertainty of micro and macro environment and aggravating financing constraints. Government subsidies increase the confidence of enterprises to invest in innovation, but they have not completely solved the problem of corporate financing constraints.

Industry characteristics are the main reason that the reconfiguration of supply chain relations caused by tariff barriers has opposite effects on innovation input and innovation output. The largest supplier/customer remains the same, state-owned enterprises, strong debt financing capacity and high level of regional intellectual property protection, and the restructuring of supply chain relations has less interference on innovation output.

5.5. Policy implication

Adhere to the "double cycle" development path, establish and improve the supply chain risk management system. High-quality supply chain relationships can promote resource sharing and integration, form a trend of mutual support, and promote enterprises to carry out innovation. However, the reconfiguration of supply chain relations has a negative effect on the technological innovation of enterprises and hinders the high-quality development of enterprises. To a certain extent, China's promotion of the new development pattern of "double cycle" can help enterprises to reconstruct supply chain relations to tide over difficulties and enhance supply chain resilience.

While preventing supply chain risks, it is necessary to improve the efficiency of bank credit allocation, give enterprises the corresponding credit support and financing facilities to carry out innovation, and solve the problem of financing difficulties of enterprises, especially small and medium-sized enterprises. Financing constraint is an important factor that restricts technological innovation of enterprises. This study confirms that the reconfiguration of supply chain relations caused by whatever environmental factors intensifies financing constraints and inhibits technological innovation of enterprises, while enterprises with strong financing ability can mitigate the negative effects of supply chain relationship reconfiguration on enterprise innovation.

We will improve the regional business environment, improve the intellectual property protection system, accelerate the marketization process, and promote coordinated development among regions. When the local market process is high, the level of financial development is high, and the level of intellectual property protection is strong, it can effectively resist the risk effect of the reconfiguration of supply chain relations on technological innovation.

6. Conclusion

The reconfiguration of supply chain relations significantly inhibits the technological innovation of enterprises. The reconfiguration of supply chain relationship has the risk effect, which inhibits

the technological innovation of enterprises. The reconfiguration of supply chain relations mainly inhibits technological innovation through three ways: intensifying business risks, increasing transaction costs and intensifying financing constraints.

The negative effect of supply chain relationship reconstruction on enterprise technological innovation is mainly reflected in the downstream customer relationship reconstruction, that is, customer relationship reconstruction significantly inhibits enterprise technological innovation. When enterprises have poor anti-risk ability, weak financing ability and low marketization process, the reconfiguration of supply chain relations has a stronger inhibitory effect on enterprise technological innovation.

The reconstruction of supply chain relations caused by financial distress reduces the technological innovation of enterprises by intensifying financing constraints. The degree of development of supply chain finance, strong anti-risk ability and financing ability, and high level of regional financial development can effectively resist the inhibitory effect of the reconstruction of supply chain relations caused by financial difficulties on technological innovation.

The reconfiguration of supply chain relations caused by tariff barriers significantly promotes innovation input, but inhibits innovation output. The mechanism test shows that the reconfiguration of supply chain relations caused by tariff barriers mainly promotes the innovation input of enterprises by reducing the information asymmetry and increasing the government subsidies obtained by enterprises.

The restructuring of supply chain relations caused by financial distress and the restructuring of supply chain relations caused by tariff barriers significantly reduce the quality of innovation. Enterprises should focus on how to better exert the effect of supply chain integration, and try to avoid the risk effect of having to reconstruct the supply chain relationship due to various internal and external reasons.

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