

ORIGINAL RESEARCH ARTICLE

Effects of ecological dominance of chain-leading enterprises on supply chain innovation performance: The mediating role of supply chain resilience

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Abstract

Growing supply chain volatility highlights the need for chain-leading enterprises to drive industrial collaborative innovation and upgrading. This study investigates how the ecological dominance of chain-leading enterprises affects supply chain innovation performance through three dimensions of ecological dominance: development leadership, industrial integration, and industrial responsibility. Additionally, the capability type dimension of supply chain resilience is introduced to explore its mediating role in the relationship between the ecological dominance of chain-leading enterprises and supply chain innovation performance. Data from 219 valid samples revealed that each dimension of chain-leading enterprises' ecological dominance has a significant positive effect on supply chain innovation performance. Supply chain resilience has a significant positive effect on innovation performance and plays a partial mediating role between chain-leading enterprises' ecological dominance and supply chain innovation performance. The conclusions provide new perspectives on the mechanisms underlying ecological dominance and enrich the research on antecedents of supply chain innovation performance. However, this study has limitations: the adoption of cross-sectional data fails to fully reflect the dynamic interaction of variables across different enterprise development stages; the dimensional structure of chain-leading enterprises' ecological dominance remains controversial, and this study's division needs further verification; due to the difficulty in obtaining data and the scarcity of existing quantitative research, related concepts and data collection rely more on qualitative assessments and lack rigorous quantitative validation.

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1. Introduction

At present, the global supply chain is entering a period of adjustment featured by high uncertainty, transformation, and restructuring. On the one hand, frequent external shocks, such as geopolitical conflicts,¹ energy price fluctuations,² public health emergencies,³ and extreme climate events,⁴ led to a marked rise in global uncertainty,

making supply chain disruptions a normal occurrence and exacerbating supply chain vulnerability. Data released by Resilinc⁵ show that the number of global supply chain disruption events in 2024 rose by 38% year-on-year.

On the other hand, the integration of digital technological innovation and the global green transition has profoundly reshaped the logic of global industrial competition. A report by the Organisation for Economic Cooperation and Development (OECD, 2024)⁶ indicates that over 90% of OECD member states and partner economies have formulated or are formulating national digital strategies.

Against this backdrop, how chain-leading enterprises can improve the overall innovation efficiency of supply chains through ecological influence while strengthening supply chain risk response capability has become a cutting-edge issue attracting widespread attention from academic and industrial communities worldwide.

As a pivotal hub of global industrial and supply chains, China is currently at a critical stage of industrial transformation, upgrading, and high-quality supply chain development, offering a unique local context to address the aforementioned global research gaps. The 14th Five-Year Plan of China aims to cultivate a group of chain-leading enterprises with ecological dominance and core competitiveness. Chain-leading enterprises exert significant influence across the entire supply chain in terms of research and development (R & D) innovation, resource integration, and industrial ecosystem construction. Supply chain innovation serves as an essential underpinning for achieving high-quality development. When responding to external market competition pressures and internal long-term development needs, enterprises rely on innovation to drive sustainable evolution. Accordingly, supply chain innovation performance has become a core indicator for measuring the modernization level of industrial and supply chains. Supply chain members have reached a growing consensus on collaborating to jointly enhance innovation performance, thereby advancing the overall modernization of supply chains.

As a “super node” and growth engine within the supply chain, the chain-leading enterprise leverages its ecological dominance to reconcile differences among member firms. Furthermore, its advanced R&D capabilities, knowledge base, and innovative capacity facilitate collaborative innovation across the supply chain.

The supply chain is changing rapidly, and new models have emerged. These have increased supply chain efficiency but also increased risks in supply chain operations.⁷ Innovation and R & D activities of enterprises often require

continuous investment in human resources, capital, and materials. If disrupted, enterprise innovation processes will stop, and recovery costs may be high. Therefore, supply chain enterprises must develop the capability to swiftly resume operations after a risk event and to minimize its impact on their innovation processes. This ensures that business continuity and R & D activities can be maintained during emergencies.

Currently, most existing studies focus on the direct and indirect effects of supply chain innovation on enterprise performance, as well as antecedents of enterprise innovation performance. Goffnett and Goswami⁸ and Oke *et al.*⁹ confirmed through enterprise surveys and data analysis, respectively, that both an enterprise's own innovation capability and the innovation capability of its supply chain partners can positively affect supply chain innovation performance. Kumar *et al.*¹⁰ showed that an enterprise's flexibility strategy exerts a positive effect on its innovation performance and supply chain integration. Asree *et al.*¹¹ found that although both supply chain responsiveness and supply chain collaboration directly and positively affect innovation performance, supply chain collaboration, as a mediating variable, exerts a greater effect on innovation performance. Additionally, Wang and Hu¹² and Hong *et al.*¹³ verified the positive relationship between inter-enterprise collaborative innovation and supply chain innovation performance. Liu *et al.*¹⁴ studied the influencing factors of smart supply chain innovation performance in commodity distribution enterprises, showing that smart supply chain innovation can improve an enterprise's performance and innovation capability in areas such as structure, management, and services. Zeng and Yu¹⁵ conducted a survey of domestic manufacturing enterprises using partial least squares–structural equation modeling. They found that digital transformation positively affects supply chain innovation performance and supply chain resilience, and that supply chain resilience positively affects innovation performance.

Although most scholarly findings indicate that supply chain resilience has a positive effect on enterprise performance, current studies mainly focus on its effect on the financial and operational performance of circulation enterprises, with limited research on other performance dimensions, such as supply chain innovation performance, market performance, and strategic performance. Meanwhile, few studies have explored whether supply chain resilience plays a mediating role in the pathways through which other factors influence supply chain performance.

In summary, taking China's industrial chain practice as the research context, this study constructs an analytical framework of “chain-leading enterprises' ecological

dominance–supply chain resilience–supply chain innovation performance,” and focuses on addressing two core research questions: first, the influence of chain-leading enterprises’ ecological dominance on supply chain innovation performance; and second, whether supply chain resilience plays a mediating role between the two.

This study not only addresses the general research theme of the ecological function and resilience construction of core enterprises in the global supply chain, but also provides a localized analysis of the functional positioning of Chinese chain-leading enterprises. The findings can offer empirical references for economies worldwide to cultivate core industrial chain enterprises and enhance supply chain innovation and resilience, while providing theoretical support and practical pathways for the modernization of China’s supply chains.

2. Literature review and research hypothesis

2.1. Ecological dominance of chain-leading enterprises

The concept of ecological dominance of chain-leading enterprises was first proposed in the Outline of China’s 14th Five-Year Plan, which clearly states that the government should foster a group of chain-leading enterprises with ecological dominance and core competitiveness. At present, there is no authoritative unified definition for chain-leading enterprises. Nevertheless, several analogous concepts have been adopted in prior literature, such as flagship firms, core enterprises, leading enterprises, industry-dominant enterprises, and industrial chain leading enterprises.

In foreign literature, the concept of the flagship firm, proposed by Rugman and D’Cruz,¹⁶ is highly consistent with the connotation of chain-leading enterprises in this study, referring to enterprises that exert constraints on the operational activities of upstream suppliers, downstream customers, and industry competitors. Defee *et al.*¹⁷ argued that supply chain leadership plays a vital role in strategic supply chain management and contributes to the improvement of supply chain performance. Previous studies have demonstrated that supply chain leadership enhances supply chain learning capability,¹⁸ strengthens relational commitment,¹⁹ and promotes sustainable development.²⁰ Lockstrom *et al.*²¹ defined supply chain leadership as the capability of manufacturers to guide and influence retailers to achieve common goals. From the perspective of manufacturers and suppliers, this definition highlights the existence of inter-firm leadership, whereby the leadership of one enterprise can exert substantial influence on other firms in the supply chain.

Domestic scholars have produced substantial research on the ecological dominance of chain-leading enterprises. In terms of the connotation of chain-leading enterprises, Huang²² pointed out that a chain-leading enterprise in a supply chain refers to a firm that holds a dominant and controlling position. In addition, most chain-leading enterprises are located in the downstream of the industrial chain, enabling them to exert significant influence over resource allocation across the entire supply chain. Zhang and Zhang²³ and Wang *et al.*²⁴ integrated domestic and foreign research findings and concluded that a chain-leading enterprise is an entity that occupies a core or dominant position in the supply chain, controls the most value-added links, and holds the final discourse power in industrial chain governance. Shi²⁵ indicated that chain-leading enterprises exert strong direct or indirect influence on the resource allocation and utilization of most firms within the industrial chain and substantially shape overall industrial chain performance. Wang *et al.*²⁶ defined chain-leading enterprises as leading firms that occupy a core position in the supply chain and achieve competitive advantage through long-term market competition and cooperation, regarded as the “core organization” of the industrial chain from the perspective of industrial competition.

In summary, by sorting through existing studies on chain-leading enterprises, this study preliminarily defines chain-leading enterprises as firms that rely on their comparative advantages—such as mastering core technologies and ranking first among all chain members in production scale or capital scale—to occupy a core, dominant, and governing position in the supply chain. Such enterprises can exert strong influence on the majority of supply chain resource allocation and utilization, as well as on overall supply chain performance, and possess final discourse power in industrial development, technological progress, market operation, and industrial ecosystem construction.

The ecological dominance of chain-leading enterprises is a China-localized concept with both policy orientation and practical implications. Relevant research has not yet reached consistent conclusions and remains at the early stage of qualitative analysis. Chen and Yu²⁷ defined the ecological dominance of chain-leading enterprises as the influence, control, and leadership of an enterprise within its industrial ecosystem, encompassing four core capabilities: industrial collaboration and integration capability, technological innovation leadership, target market creation capability, and digital transformation enabling capability. Bai *et al.*²⁸ argued that the ecological dominance of chain-leading enterprises comprises three core dimensions:

resource integration capability, advantage transformation capability, and value chain dominance. In addition, chain-leading enterprises are required to hold dominant control over technology, industrial standards, brand development, and market operations. Sheng²⁹ further proposed that the ecological dominance of chain-leading enterprises embodies six types of power: discourse power over industrial standards, dominance in product technology, control over end markets, capacity to construct industrial ecosystems, leadership in guiding industrial development direction, and the right to allocate industrial benefits. Ji *et al.*³⁰ adopted grounded theory to conduct exploratory research and constructed an evaluation index system for the ecological dominance of chain-leading enterprises covering three dimensions: technological innovation leadership, industrial collaboration and integration capability, and industrial development leadership. Taking BYD Company Limited and the industrial chains of China's new energy enterprises as research samples, Wang *et al.*³¹ explored the mechanism by which chain-leading enterprises' ecological dominance influences industrial chain resilience. Their study suggested that ecological dominance comprises three dimensions: technological innovation leadership, industrial collaboration and integration capability, and digital transformation enabling capability, all of which can effectively enhance industrial chain resilience. Based on resource orchestration theory and a longitudinal case study of Sany Group, Zhu and Lu³² classified the ecological dominance of chain-leading enterprises into three dimensions: technological innovation driving force, product market guidance, and resource integration and coordination capability. They also revealed the internal mechanism through which digital intelligence empowerment and resource orchestration drive its evolution from individual nodes to an interconnected industrial network.

In summary, combined with interviews and communications with university academic experts and enterprise senior executives, this study argues that the ecological dominance of chain-leading enterprises is mainly reflected in leading technological and product innovation within the industry, integrating and optimizing resource allocation across the supply chain, and establishing a sound industrial ecosystem. Accordingly, the ecological dominance of chain-leading enterprises is divided into three dimensions: development leadership, industrial integration capability, and industrial responsibility capability.

Development leadership measures the influence exerted by chain-leading enterprises on supply chain members in terms of technological leadership, talent

and institutional management, knowledge spillover, and digital transformation. Industrial integration capability mainly reflects the ability of chain-leading enterprises to integrate supply chain resources, respond to changes in market demand and the competitive environment, and timely adjust supply chain integration strategies. Industrial responsibility capability evaluates the role of chain-leading enterprises in fostering the industrial ecosystem, promoting industrial responsibility governance, guiding industrial development, and optimizing the overall industry environment.

2.2. Ecological dominance of chain-leading enterprises and supply chain innovation performance

The supply chain and the innovation performance of enterprises, as important indicators for measuring the development status of enterprises, have already been studied, leading to the conclusion that there is a close correlation between supply chain leadership and supply chain innovation performance.³³ Therefore, the relationship and mechanism of action between the two have become a research hotspot. First, in the supply chain, there is collaboration between leading enterprises and member enterprises. In addition, better cooperation between supply chains can improve the quality of market intelligence and achieve more significant product innovation effects.³⁴ Especially, R & D cooperation can have a positive effect on the innovation of enterprises.³⁵ It can also foster a positive innovation atmosphere in the industrial environment, enhancing the innovation performance of enterprises.^{36–38} In the digital economy, data and knowledge are updated and shared among various production factors. Under the leadership of chain-leading enterprises, in terms of digital transformation, enterprises in the supply chain can be integrated into the global innovation network³⁹, thereby driving the development of the digital economy in related industries and improving the innovation performance of regions.^{40,41}

In addition, many current studies have shown that supply chain integration can improve the performance of supply chains and enterprises, such as their growth,⁴² financial⁴³ and market.^{44,45} Integration and coordination of resources can reduce operating costs, improve logistics efficiency, strengthen supply chain partnerships, and improve response capability. The chain-leading enterprise is dominant in the chain and can improve the supply chain integration level of the entire industry by integrating resources, information, processes, technologies, and other aspects.

Previous studies have shown that enterprises can improve their financial performance,^{46,47} innovation performance,⁴⁸ and green performance,⁴⁹ and that they also have corresponding industrial responsibility capabilities within industries (e.g., those in the leading position of the chain). These responsibilities include contributing to the development of the industry ecosystem, as well as fulfilling social and cultural responsibilities within the industry.⁵⁰ If the chain-leading enterprise creates a positive corporate image and takes responsibility for it, it can proactively take on future development responsibilities and innovate products and services that meet social needs. This study refers to the research methods of Xie *et al.*⁵¹ and Li *et al.*,⁵² decomposes ecological dominance and innovation performance of chain-leading enterprises into dimensions, and proposes hypotheses. Based on the above analysis, this study holds that development leadership, industrial integration, and industrial responsibility are the key capabilities demonstrated by the ecological dominance of chain-leading enterprises, and the performance of supply chain innovation can also be measured from two dimensions: process innovation performance and output innovation performance. These findings led to the following hypothesis (H):

H1: The ecological dominance of the chain-leading enterprise has a positive effect on the innovation performance of the supply chain.

2.3. The ecological dominance and supply chain resilience of the chain-leading enterprise

Supply chain resilience refers to the capacity of a supply chain to maintain continuity and to rapidly restore normal operations when disruptions occur.⁵³ As such, it plays a critical role in strengthening the core competitiveness of the supply chain. Consequently, this study categorizes supply chain resilience into two dimensions: coping ability and resilience ability, based on the specific type of capability associated with supply chain resilience.

Current studies have validated the pivotal role of core enterprises in enhancing the performance of individual enterprises and the entire supply chain.^{54,55} However, under the leadership of a chain-leading enterprise, member enterprises of the supply chain may depend more on the leading and integrating capabilities of the chain-leading enterprise, underestimate the possibility and impact of supply chain disruptions, such as the loss of benefits and resources, and be unable to recover quickly from supply chain risk events. The ecological dominance of chain-leading enterprises limited its impact on the innovation performance of the supply chain. Therefore, supply chain resilience is a dynamic capability to cope with supply chain risk events.

According to Brusset,⁵⁶ the development of dynamic capabilities requires firms to possess strong resource-allocation competencies, ensure transparency of information with upstream and downstream supply-chain partners, and establish a logistics network capable of supporting effective risk management. These capacities can reduce the negative impact of supply chain risk events on enterprises. In summary, this study holds that the ecological dominance of the chain-leading enterprise is an important ability for each enterprise in the supply chain to enhance supply chain resilience, thereby promoting the formation of this dynamic ability and enabling it to cope with various unknown market changes. Therefore, the ecological dominance of the chain-leading enterprise can promote supply chain resilience, and supply chain resilience can improve the performance of supply chain innovation. Based on this foundation, the following hypothesis was proposed:

H2: The ecological dominance of the chain-leading enterprise has a positive effect on the resilience of the supply chain.

2.4. The mediating role of supply chain resilience

From the perspective of dynamic capabilities, supply chain resilience is the main ability of the supply chain to manage disruptive events and restore the enterprise to its pre-disruption production and operational status by regrouping and reallocating resources during and after a disruption. Consequently, supply chain resilience qualifies as a dynamic capability that aligns with the principles of dynamic theory, enabling enterprises to enhance performance across various rapidly changing environments. Current studies have shown that supply chain resilience has a positive effect on a company's financial performance,⁵⁷ market performance,⁵³ and supply chain performance,⁵⁸ among others. However, the effects of different dimensions of resilience on supply chain innovation performance remain insufficiently understood. This study therefore aims to examine how coping capability and adaptive resilience—two key components of supply chain resilience—shape the innovation performance of supply chains.

To better deal with supply chain risk events, supply chain enterprises need to be capable of responding, that is, predicting potential risk events and planning ahead.⁵⁹ When faced with risk events and after the event ends, enterprises need to mobilize the strength of each organizational structure of the supply chain to distill and integrate resources and capabilities of the enterprise, quickly restore product flow and logistics system, gradually bring business level back to the expected level,⁶⁰ and provide

a stable operating environment for innovation activities. By strengthening supply chain resilience, enterprises can mobilize their strengths when faced with supply chain risk events, minimize the impact of risk events on innovation and R & D activities, and improve the innovation performance of the supply chain. Based on the above analysis, this study holds that the coping and resilience capabilities of supply chain resilience have a positive effect on the innovation performance of the supply chain. Based on the argument and analysis of the relationship between the ecological dominance of chain-leading enterprises and the performance of supply chain innovation and supply chain resilience, supply chain resilience is the dynamic ability to deal with supply chain disruptions. Supply chain resilience plays a mediating role between the ecological dominance of chain-leading enterprises and the performance of supply chain innovation. Therefore, it was proposed that supply chain resilience plays a role in the creation of dynamic capability:

H3: Supply chain resilience has a positive effect on supply chain innovation performance.

H4: Supply chain resilience is a mediating variable between the ecological dominance of the chain-leading enterprise and the performance of supply chain innovation.

In conclusion, this study constructs the theoretical model shown in [Figure 1](#).

3. Methodology

3.1. Questionnaire design

This study adopted a questionnaire survey method to collect data for empirical research. Based on the literature review and theoretical conceptualization above, corresponding research hypotheses were proposed, and a formal questionnaire was designed accordingly.

All measurement items in the questionnaire were adapted from mature scales that have been validated in previous domestic and international empirical studies. Appropriate revisions were made in light of the actual research context to ensure consistency with the theoretical hypotheses. Prior to the formal large-scale survey, a pre-survey was conducted to test the reliability and validity of the research scales.

All questionnaire items were measured using a 5-point Likert scale, with 1 indicating strongly disagree and 5 indicating strongly agree. To ensure the representativeness of the research sample, the questionnaire was mainly distributed electronically. Respondents were invited from chain-leading enterprises and their upstream and downstream partner enterprises across various supply

chains, especially managerial and professional staff.

3.2. Scale design

The research model involved three core constructs: ecological dominance of chain-leading enterprises, supply chain resilience, and supply chain innovation performance. Specifically, the three dimensions of ecological dominance of chain-leading enterprises—development leadership, industrial integration capability, and industrial responsibility capability—were taken as independent variables. The two dimensions of supply chain innovation performance, process innovation performance and output innovation performance, were set as the dependent variable. Meanwhile, the two dimensions of supply chain resilience, response capability and recovery capability, served as mediating variables.

To operationalize and quantitatively measure these abstract constructs, this study reviewed relevant domestic and international literature. Established validated scales from foreign studies were translated into Chinese and further integrated with existing domestic scales. This design enables respondents to fully understand the connotation of each variable and guarantees the authenticity and reliability of the questionnaire. The detailed scale design is presented in [Table 1](#).

This study considers that research results may be affected by control variables—primarily organizational-level factors, which could interfere with the chain-leading enterprises' exertion of ecological dominance and the degree to which other supply chain members are influenced by it, thereby affecting the accuracy and credibility of the results. Therefore, at the organizational level, firm operating time and firm size were selected as control variables to avoid such interference.

At the organizational level, firm operating time and size affect chain-leading enterprises' ecological dominance. For chain-leading enterprises, those with shorter operating time and smaller size face problems such as low technical level, insufficient resources, and weak industry discourse power, failing to play a leading role in the supply chain or achieve technology and knowledge spillover, industrial resource integration, and industrial ecological culture construction. For supply chain member enterprises, smaller and younger firms require more resources from chain-leading enterprises for support; they are also the more vulnerable links in the supply chain, which need to be addressed to improve overall supply chain resilience and innovation performance.

In this study, firm size was classified into four levels (coded numerically):

Table 1. Measurement items

Variable dimension	Observation indicators	Reference
Development leadership	Our company (or the dominant partner) often shares relevant knowledge, such as technologies and skills, with other enterprises through training, seminars, and exchange meetings.	12,61,62
	Our firm (or the dominant partner) regularly disseminates advanced talent management systems and development experience to other enterprises.	
	Our firm (or the dominant partner) frequently develops new products with other partners and provides technical support to them (or other enterprises) during the development process.	
	Our firm (or the dominant partner) has a clear medium- and long-term digital strategy for the supply chain and leads other enterprises in formulating phased implementation plans.	
Industrial integration capability	Our firm (or the dominant partner) can effectively integrate internal knowledge and knowledge from industry partners to respond to changes in the external environment.	63,64
	Our firm (or the dominant partner) can realize the shared allocation and utilization of resources within the industry.	
	Our firm (or the dominant partner) can monitor the performance of industrial chain members to adjust the industrial chain planning.	
Industrial responsibility capability	Our firm (or the dominant partner) is adept at driving the industrial chain to fulfill responsibilities through strategy and business, fostering a sound industry ecosystem, and achieving co-creation and win-win outcomes with stakeholders.	50
	Our firm (or the dominant partner) emphasizes transparent operations, fully discloses social responsibility information, promotes stakeholder participation, and facilitates the continuous improvement of industrial responsibility management and practices.	
	Our firm (or the dominant partner) has a holistic view of the industry and a corporate culture that represents the progressive development of the industry, plays a role in leading industry development and transforming the industry environment, and achieves greater development for itself based on the healthy development of the industry.	
Response capability	The firm's supply chain system continuously assesses process vulnerabilities.	65,66,67
	Members of the firm's supply chain have clear visibility into information such as inventory, procurement, and production plans.	
	The firm's supply chain can maintain its original structure and function when disruptions occur.	
	When the environment (demand, supply, technology, etc.) changes, the firm's supply chain has sufficient lead time to consider reasonable responses.	
Recovery capability	The firm can take reasonable and efficient measures to reduce the scope and impact of supply chain disruptions.	68,69,70
	The firm's supply chain can quickly restore product flow to fully respond to unexpected disruptions.	
	The firm's supply chain has manufacturing systems and logistics networks that can quickly recover from disruptions.	

(Cont'd...)

Table 1. (Continued)

Variable dimension	Observation indicators	Reference
	The supply chain in which the firm operates has built an efficient inter-firm innovation cooperation network.	
Process innovation performance	The supply chain in which the firm operates has a strong innovation climate and high innovation vitality. The production equipment or processes in the firm's supply chain have been improved.	71,72
	The total number of innovative products in the firm's supply chain has increased.	
Outcome innovation performance	The development cycle for new products (services) in the firm's supply chain has been shortened. The sales revenue from new products (services) accounts for a high proportion of total sales in the firm's supply chain.	73,74

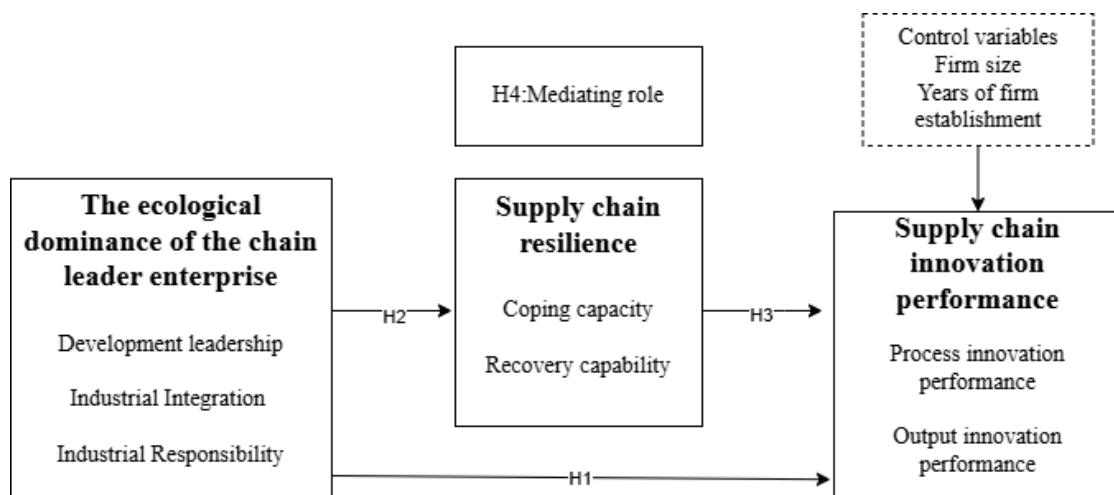


Figure 1. Theoretical model

- (i) 1 = Fewer than 100 employees
- (ii) 2 = 101–500 employees
- (iii) 3 = 501–1,000 employees
- (iv) 4 = More than 1,000 employees

Similarly, firm operating time was divided into five categories (coded numerically):

- (i) 1 = less than 5 years
- (ii) 2 = 5–10 years
- (iii) 3 = 11–15 years

- (iv) 4 = 16–20 years
- (v) 5 = more than 20 years

3.3. Pre-survey

A total of 80 questionnaires were distributed during the pre-survey, and 64 were returned as valid. SPSS software (version 25.0, IBM, United States) was used to conduct descriptive statistics, reliability analyses, and validity analyses on the valid questionnaires. Based on the reliability and validity test results, some questionnaire items were

removed or revised, and the formal questionnaire was eventually finalized.

The descriptive statistical results of the pre-survey data show that the mean values for all items ranged from 3.6 to 4.1, indicating a relatively uniform distribution. All standard deviations were within 1.12, which is far lower than 3, indicating low data dispersion. Meanwhile, the absolute values of skewness and kurtosis were all within a reasonable range. Accordingly, the sample data collected in the pre-survey followed a normal distribution.

The reliability results of the pre-survey indicate that the questionnaire designed in this study has good reliability. The Cronbach's α value of each item was above 0.8, and the corrected item total correlation values all exceeded 0.4. In addition, the α coefficient after deleting any single item was lower than that of the original scale. These findings verify that the scale adopted in this study meets the reliability standard.

The validity results of the pre-survey indicate that the Kaiser–Meyer–Olkin values of each sub-scale and the overall scale were all greater than 0.7, suggesting satisfactory construct validity for the questionnaire.

3.4. Sample data

Leading enterprises in China's manufacturing supply chains, as well as their upstream and downstream cooperative enterprises, constituted the target population/respondents of this study. Questionnaires were distributed electronically to middle and senior managers, supply chain directors, and employees in relevant functional positions. All respondents have practical experience in supply chain operations, collaborative cooperation, or innovation management, enabling them to make valid evaluations of corporate ecological dominance, supply chain resilience, and innovation performance, thus ensuring that the content validity of the data meets the research requirements.

During the field survey, relying on accessible sample sources, including enterprise cooperation channels, Master of Business Administration alumni networks, and industry connections, a total of 250 questionnaires were distributed. After eliminating invalid questionnaires with overly short completion times, regular response patterns, and logical contradictions, 219 valid samples were finally obtained, yielding an effective response rate of 87.6%. The demographic characteristics of the sample are presented in Table 2.

From the perspective of applicability, convenience sampling is reasonable and feasible for this study. First, chain-leading enterprises and their supply chain partners are widely distributed across diverse industries, making

it difficult to establish a complete sampling frame; thus, random sampling is practically inoperable. Second, this study focuses on relational and capability variables at the supply chain level, requiring respondents to possess professional supply chain knowledge and management experience. Convenience sampling can accurately target qualified participants and improve data validity. Third, in research on supply chain collaboration and chain-leading governance, convenience sampling is a widely accepted and mature approach in domestic and international literature. It ensures research feasibility while reflecting the actual characteristics of supply chain enterprises. Fourth, the sample covers enterprises with different ownership types, industry sectors, establishment years, and firm sizes. The sample structure presents good diversity and representativeness, which can compensate for the limitations of non-probability sampling and enhance the robustness of the research conclusions.

4. Results

4.1. Reliability and validity analyses

The reliability of the questionnaire was evaluated using Cronbach's α coefficient. As shown in Table 3, all dimensions exhibited Cronbach's α values near 0.8, indicating satisfactory internal consistency. Convergent validity was assessed using standardized factor loadings, average variance extracted (AVE), and composite reliability (CR). The results indicate that the factor loadings, AVEs, and CRs for all items met the recommended thresholds, demonstrating strong convergent validity of the constructs.

As shown in Table 4, to test the construct validity of the scales, this study conducted confirmatory factor analysis on the overall measurement model. The results show that $\chi^2/\text{degree of freedom (DF)} = 2.206$, root mean square error of approximation (RMSEA) = 0.074, root mean square residual (RMR) = 0.042, comparative fit index (CFI) = 0.910, incremental fit index (IFI) = 0.911, and Tucker–Lewis index (TLI) = 0.891. Among these indices, χ^2/DF , RMSEA, RMR, CFI, and IFI met the ideal criteria, while TLI fell within the acceptable range. All fit indices satisfied the model fit standards, indicating that the measurement model of this study fits the data well, and the dimensional structure of the variables is reasonable and valid.

4.2. Hypothesis testing

4.2.1. Main effect test

To investigate the effects of the ecological dominance of the chain-leading enterprise on the innovation performance of the supply chain, the performance of the supply chain process innovation and the supply chain

Table 2. Sample statistics (N = 219)

Category	Attribute	Sample size	Proportion (%)
Nature of enterprise	State-owned or State-controlled enterprises	60	27.4
	Sino-foreign joint ventures or wholly foreign-owned enterprises	45	20.5
	Private enterprises	114	52.1
Industry type	Electronic and communication equipment manufacturing	28	12.8
	Software industry	14	6.4
	Pharmaceutical manufacturing	25	11.4
	Medical devices and instruments	5	2.3
	Electronic computer and office equipment manufacturing	6	2.7
	Chemical products industry	10	4.6
	Automobile and parts manufacturing	19	8.7
	Electrical machinery manufacturing	9	4.1
	Non-electrical machinery manufacturing	2	0.9
	Textile and apparel manufacturing	18	8.2
	Special equipment manufacturing	5	2.3
	Iron, steel, metallurgy and energy industry	5	2.3
	Food manufacturing industry	15	6.8
	Other manufacturing industries	11	5.0
	Non-manufacturing Industry	47	21.5
Firm size	Less than 100 employees	44	20.1
	101–500 employees	83	37.9
	501–1,000 employees	37	16.9
	More than 1,000 employees	55	25.1
Years of enterprise establishment	Less than 5 years	45	20.5
	5–10 years	56	25.6
	11–15 years	44	20.1
	16–20 years	18	8.2
	More than 20 years	56	25.6

Table 3. Reliability and validity analysis results (*N* = 219)

Variable	Item	Factor loadings	Validity and reliability measures
The ecological dominance of the chain-leading enterprise	Development leadership 1	0.732	$\alpha = 0.807$ AVE = 0.52 CR = 0.81
	Development leadership 2	0.745	
	Development leadership 3	0.692	
	Development leadership 4	0.702	
	Industrial integration 1	0.730	$\alpha = 0.780$ AVE = 0.54 CR = 0.78
	Industrial integration 2	0.755	
	Industrial integration 3	0.728	
	Industrial responsibility 1	0.687	$\alpha = 0.738$ AVE = 0.48 CR = 0.73
	Industrial responsibility 2	0.638	
	Industrial responsibility 3	0.744	
Supply chain resilience	Coping capability 1	0.674	$\alpha = 0.780$ AVE = 0.49 CR = 0.79
	Coping capability 2	0.634	
	Coping capability 3	0.724	
	Coping capability 4	0.751	
	Recovery capacity 1	0.790	$\alpha = 0.798$ AVE = 0.59 CR = 0.81
	Recovery capacity 2	0.805	
	Recovery capacity 3	0.704	
Supply chain innovation performance	Process innovation performance 1	0.819	$\alpha = 0.854$ AVE = 0.66 CR = 0.85
	Process innovation performance 2	0.816	
	Process innovation performance 3	0.803	
	Output innovation performance 1	0.803	$\alpha = 0.864$ AVE = 0.68 CR = 0.86
	Output innovation performance 2	0.860	
	Output innovation performance 3	0.808	

Abbreviations: AVE: Average variance extracted; CR: Composite reliability.

Table 4. Overall model fitting coefficients

Statistic	Result	Critical value	Judgment
χ^2/DF	2.206	<3	Ideal
RMSEA	0.074	<0.08	Ideal
RMR	0.042	<0.05	Ideal
CFI	0.910	>0.9	Ideal
IFI	0.911	>0.9	Ideal
TLI	0.891	>0.9	Acceptable

Abbreviations: CFI: Comparative fit index; DF: Degree of freedom; IFI: Incremental fit index; RMR: Root mean square residual; RMSEA: Root mean square error of approximation; TFI: Tucker–Lewis index.

output innovation were taken as dependent variables, and the independent variables were the firm size, years of enterprise establishment, development leadership, industrial integration, and industrial responsibility. The results of the regression analysis are shown in Table 5. According to the model shown in Table 5, each dimension of ecological dominance of the chain-leading enterprise has a positive effect on the innovation performance of the supply chain. Therefore, H1 holds.

4.2.2. Indirect effect test

This study used hierarchical regression in SPSS to test the mediating role of supply chain resilience. From Models 2–2 and 2–4 in Table 6, it can be concluded that all three dimensions of ecological dominance in chain-leading enterprises have a significant positive effect on the coping and resilience of the supply chain. Therefore, H2 is valid.

Furthermore, it can be concluded from Models 3–2 and 3–4 in Table 7 that supply chain resilience has a significant positive effect on both the process and output innovation performance of the supply chain. Therefore, H3 holds.

Lastly, Models 4–2 and 4–3 in Table 8 indicate that each dimension of the ecological dominance of the chain-leading enterprise and the mediating variable supply chain resilience influences the innovation performance of the supply chain process. The regression coefficients for the independent variables were lower than before, and those for each dimension of supply chain resilience were significant. Supply chain resilience partly mediates the ecological dominance of the chain-leading enterprise and innovation performance of the supply chain process. Models 4–5 and 4–6 indicate that each dimension and mediating variable of supply chain resilience influence the ecological dominance of the chain-leading enterprise on the output innovation performance of the supply chain. The regression coefficients for the independent variables were lower than before, and the coefficient for supply chain resilience was significant. The regression coefficient of each dimension of supply chain resilience partially mediates the ecological dominance of the chain-leading enterprise and innovation performance of supply chain output. Thus, H4 holds.

4.2.3. Bootstrap method for testing mediating effects

For the mediation effect ratio, the Bootstrap method was adopted to analyze and test the mediation proportion of responsiveness capability and recovery capability in supply chain resilience across the following paths:

(i) Supply chain process innovation performance $\leftarrow$ Development leadership;

- (ii) Supply chain process innovation performance $\leftarrow$ Industrial integration;
- (iii) Supply chain process innovation performance $\leftarrow$ Industrial responsibility;
- (iv) Supply chain output innovation performance $\leftarrow$ Development leadership;
- (v) Supply chain output innovation performance $\leftarrow$ Industrial integration;
- (vi) Supply chain output innovation performance $\leftarrow$ Industrial responsibility.

The test results are shown in Tables 9 and 10. The results show that the indirect effects in all paths did not include 0 within the 95% confidence interval, indicating that the indirect effects of supply chain resilience are statistically significant. Meanwhile, the direct effects across all paths also did not include 0 within the 95% confidence interval, suggesting that supply chain resilience plays a partial mediating role in the relationship between ecological dominance of chain-leading enterprises and supply chain innovation performance.

5. Discussion

This study constructed a model of “ecological dominance of chain-leading enterprises–supply chain resilience–supply chain innovation performance” based on resource-based theory and dynamic capability theory, and empirically examined the influence mechanism of ecological dominance on supply chain innovation performance, as well as the mediating role of supply chain resilience. The main conclusions and discussions are presented in this section.

First, development leadership, industrial integration capability, and industrial responsibility capability all exerted significant positive effects on supply chain innovation performance. This finding is consistent with the literature emphasizing that core enterprises in the supply chain can drive overall innovation through technological leadership, resource allocation, and ecological governance. Among the three dimensions, development leadership showed the strongest effect, indicating that the technological orientation, R & D guidance, and innovation layout of chain-leading enterprises are the most critical drivers for improving supply chain innovation performance. Industrial integration and industrial responsibility also played stable roles, but their effects were relatively weaker, reflecting that innovation performance depends more on forward-looking technological guidance than on resource coordination or social responsibility commitment alone. This result supplements and extends research on the dimensional differences in ecological dominance, and clarifies which capability plays a leading role in improving innovation performance.

Table 5. Regression analysis of chain-leading enterprises' ecological dominance on supply chain innovation performance

Independent variable	Supply chain process innovation performance		Supply chain output innovation performance	
	Model 1–1	Model 1–2	Model 1–3	Model 1–4
Firm size	0.067	–0.082	0.082	–0.073
Years of enterprise establishment	–0.003	0.003	0.005	0.013
Development leadership		0.304**		0.337**
Industrial integration		0.274**		0.269**
Industrial responsibility		0.259**		0.268**
R^2	0.004	0.472	0.007	0.518
ΔR^2	0.004	0.468	0.007	0.510
F	0.462	38.068**	0.788	45.714**

Note: ** $p < 0.01$.

Table 6. Regression analysis of the ecological dominance of chain-leading enterprises and supply chain resilience

Independent variable	Coping capacity		Recovery capacity	
	Model 2–1	Model 2–2	Model 2–3	Model 2–4
Firm size	0.043	–0.114	0.077	–0.073
Years of enterprise establishment	0.061	0.068	0.029	0.036
Development leadership		0.343**		0.313**
Industrial integration		0.269**		0.275**
Industrial responsibility		0.279**		0.249**
R^2	0.009	0.539	0.009	0.478
ΔR^2	0.009	0.530	0.009	0.469
F	0.930	49.809**	1.010	39.072**

Note: ** $p < 0.01$.

Second, supply chain resilience plays a partial mediating role between ecological dominance and supply chain innovation performance. This result suggests that ecological dominance improves innovation performance not only directly but also indirectly by enhancing the responsiveness and recovery capability of the supply chain. The partial mediation implies that other potential

mechanisms beyond supply chain resilience remain, such as knowledge integration, digital collaboration, network governance, or policy guidance. This finding echoes the view of dynamic capability theory that resilience helps enterprises maintain operational stability amid risks and ensures sustainable innovation investment. In addition, the stronger the ecological dominance, the more smoothly

Table 7. Regression analysis of supply chain resilience and supply chain innovation performance

Independent variable	Process innovation performance		Output innovation performance	
	Model 3–1	Model 3–2	Model 3–3	Model 3–4
Firm size	0.067	0.029	0.082	0.038
Years of enterprise establishment	–0.003	–0.040	0.005	–0.031
Coping capacity		0.494**		0.444**
Recovery capacity		0.215**		0.325**
R^2	0.004	0.437	0.007	0.505
ΔR^2	0.004	0.433	0.007	0.498
F	0.462	41.585**	0.788	54.565**

Note: ** $p < 0.01$.

Table 8. The mediating role of supply chain resilience on the ecological dominance of chain-leading enterprises and supply chain innovation performance

Independent variable	Process innovation performance			Output innovation performance		
	Model 4–1	Model 4–2	Model 4–3	Model 4–4	Model 4–5	Model 4–6
Firm size	0.067	–0.048	–0.071	0.082	–0.037	–0.054
Years of enterprise establishment	–0.003	–0.018	–0.003	0.005	–0.008	0.003
Development leadership		0.201**	0.255**		0.231**	0.255**
Industrial integration		0.193**	0.231**		0.186**	0.197**
Industrial responsibility		0.175**	0.219**		0.182**	0.203**
Coping capacity		0.302**			0.309**	
Recovery capacity			0.159*			0.262**
R^2	0.004	0.514	0.485	0.007	0.562	0.554
ΔR^2	0.004	0.510	0.481	0.007	0.554	0.546
F	0.462	37.345**	33.286**	0.788	45.267**	43.807**

Notes: * $p < 0.05$, ** $p < 0.01$.

technologies, knowledge, and resources flow within the supply chain, helping enterprises respond to risks more quickly and reduce interruptions to R & D and production. Therefore, supply chain resilience acts as a “stabilizer” and “accelerator” in the innovation process.

Third, from the perspective of theoretical contributions, this study enriches the theoretical framework of chain-leading enterprises’ ecological dominance and clarifies its three-dimensional structure. It also extends the antecedent research of supply chain innovation performance and

Table 9. Results of bootstrap mediation effect ratio analysis for supply chain resilience–coping capability

Path relationship	Effect type	Effect value	Boot SE	LLCI	ULCI	Effect ratio (%)
Supply chain process innovation performance ← Development leadership	Total effect	0.610	0.064	0.489	0.741	
	Direct effect	0.318	0.072	0.182	0.462	52
	Indirect effect	0.291	0.060	0.180	0.413	48
Supply chain process innovation performance ← Industrial integration capability	Total effect	0.643	0.077	0.491	0.791	
	Direct effect	0.334	0.084	0.171	0.498	52
	Indirect effect	0.309	0.064	0.192	0.447	48
Supply chain process innovation performance ← Industrial responsibility capability	Total effect	0.630	0.084	0.468	0.796	
	Direct effect	0.292	0.097	0.121	0.498	46
	Indirect effect	0.338	0.061	0.214	0.455	54
Supply chain output innovation performance ← Development leadership	Total effect	0.599	0.064	0.485	0.733	
	Direct effect	0.323	0.067	0.203	0.460	54
	Indirect effect	0.275	0.058	0.165	0.390	46
Supply chain output innovation performance ← Industrial integration capability	Total effect	0.617	0.081	0.455	0.778	
	Direct effect	0.316	0.083	0.165	0.487	51
	Indirect effect	0.301	0.062	0.188	0.428	49
Supply chain output innovation performance ← Industrial responsibility capability	Total effect	0.610	0.070	0.472	0.744	
	Direct effect	0.283	0.083	0.126	0.455	46
	Indirect effect	0.327	0.062	0.202	0.466	54

Abbreviations: LLCI: Lower limit of the 95% confidence interval; SE: Bootstrap standard error (calculated via resampling for robust estimation); ULCI: Upper limit of the 95% confidence interval.

verifies the important role of core enterprise governance capabilities. Meanwhile, this study introduces supply chain resilience into the analysis framework, revealing the transmission mechanism from ecological dominance to innovation performance, and connecting macro industrial ecology with micro enterprise innovation activities. In terms of practical implications, the results remind enterprises that improving development leadership should be the core strategy while strengthening industrial integration and industrial responsibility. Building resilient supply chains is also crucial to maintain continuous innovation in uncertain environments.

Nevertheless, this study has several limitations. First, cross-sectional data cannot reflect the dynamic evolution of relationships over time. Future research can use longitudinal data or multi-stage surveys to capture long-term effects. Second, the dimensionality of ecological dominance still needs further empirical testing. Future studies may explore other potential dimensions, such as digital dominance, ecological governance, and policy influence. Third, the identification of chain-leading enterprises mainly relies on subjective judgment. Future research can adopt more objective quantitative criteria, such as market share, R & D investment, and industrial driving force.

Table 10. Results of bootstrap mediation effect ratio analysis for supply chain resilience–recovery capability

Path relationship	Effect type	Effect value	Boot SE	LLCI	ULCI	Effect ratio (%)
Supply chain process innovation performance ← Development leadership	Total effect	0.610	0.066	0.483	0.742	
	Direct effect	0.418	0.075	0.274	0.567	69
	Indirect effect	0.192	0.066	0.069	0.327	31
Supply chain process innovation performance ← Industrial integration capability	Total effect	0.643	0.077	0.493	0.794	
	Direct effect	0.431	0.075	0.294	0.585	67
	Indirect effect	0.211	0.064	0.098	0.347	33
Supply chain process innovation performance ← Industrial responsibility capability	Total effect	0.630	0.083	0.467	0.792	
	Direct effect	0.391	0.112	0.109	0.629	62
	Indirect effect	0.239	0.076	0.092	0.390	38
Supply chain output innovation performance ← Development leadership	Total effect	0.599	0.065	0.479	0.737	
	Direct effect	0.371	0.065	0.245	0.500	62
	Indirect effect	0.228	0.060	0.121	0.358	38
Supply chain output innovation performance ← Industrial integration capability	Total effect	0.617	0.081	0.462	0.780	
	Direct effect	0.362	0.076	0.221	0.519	59
	Indirect effect	0.255	0.063	0.140	0.385	41
Supply chain output innovation performance ← Industrial responsibility capability	Total effect	0.610	0.071	0.469	0.747	
	Direct effect	0.336	0.086	0.175	0.508	55
	Indirect effect	0.273	0.069	0.147	0.415	45

Abbreviations: LLCI: Lower limit of the 95% confidence interval; SE: Bootstrap standard error (calculated via resampling for robust estimation); ULCI: Upper limit of the 95% confidence interval.

6. Conclusion

In conclusion, this study confirms that the ecological dominance of chain-leading enterprises significantly promotes supply chain innovation performance, and supply chain resilience partially mediates this relationship. The findings deepen understanding of how core enterprises lead supply chain innovation and provide theoretical references for cultivating chain-leading enterprises, building resilient supply chains, and improving innovation performance.

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Conflict of interest

The authors declare that they have no competing interests.

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Investigation: Xin Liu

Methodology: Mulin Qin

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Ethics approval and consent to participate

Each participant provided written informed consent to take part in this research.

Consent for publication

Not applicable.

Availability of data

The data presented in this study are derived from surveys and can be obtained by requesting them from Xin Liu (liuxin9924@126.com).

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