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Article

Supply chain finance and enterprise innovation performance: The mediating roles of supply chain concentration

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Abstract: Innovation has always been a key driver of economic development, particularly in the context of small and medium-sized enterprises (SMEs). Despite their significant contributions, many of these enterprises currently lack strong research and development capabilities, face challenges in innovation investment, and struggle to produce high-quality innovative results. To address these issues and overcome funding obstacles, many SMEs are turning to supply chain finance (SCF) as a supplementary financing method. This study utilizes stata16 and fixed effects models to analyze the impact and mechanism of SCF on enterprise innovation performance (EIP), focusing on companies listed on the SME Board and GEM in Shenzhen, China from 2011 to 2020. The findings reveal that SCF can effectively enhance enterprise innovation output, facilitating the conversion of resources into high-quality innovation results. Additionally, the study demonstrates that supply chain concentration acts as a mediator between SCF and EIP. Moreover, SCF is found to significantly boost EIP with low supplier concentrations and high customer concentrations. This suggests that SMEs encounter obstacles to innovation from suppliers and customers, and SCF may not fully address the challenges posed by these relationships. Overall, this research offers new empirical insights into the economic implications of companies adopting SCF, providing valuable guidance for enterprises in optimizing innovation decisions and for the government in enhancing supplier and customer information disclosure systems.

Keywords: supply chain finance; enterprise innovation performance; supply chain concentration; enterprise innovation; middle and small-sized enterprises

1. Introduction

Supply chain finance (SCF), as a new financial tool, aims to support sustainable projects by small and medium-sized enterprises (SMEs) to promote coordinated progress in the economy, society, and supply chain management. Innovation is identified as the primary driver of development, with scientific and technological innovation capabilities being crucial for any country's competitiveness. SMEs are at the forefront of technological and comprehensive innovation, not only in terms of research and development of technology and new products, but also in nurturing and producing high-tech talent. These responsibilities are essential for enterprises to fulfill in the present and serve as a catalyst for future growth. SMEs play a vital role in the economic growth and development of a country, often being referred to as its backbone (Abbasi et al., 2018). However, limited access to funding has significantly impeded innovation in SMEs. The reliance on a singular financing method, such as loans from financial institutions, is a common challenge for SMEs due to their small scale, low credit ratings, and uncertain growth prospects (Bozintan, 2022). This reliance can be

further complicated by information asymmetry between SMEs and financial institutions, leading to financial constraints (Beck, 2007). Enterprise R&D activities entail high investment risks and long investment cycles, leading to highly uncertain output results, exacerbating information asymmetry issues (Sun et al., 2019). SMEs are keen on a new financing channel to mitigate information asymmetry and access low-cost, substantial funds. SCF has emerged as a viable financing option, garnering attention from governments and businesses worldwide. Essentially, SCF involves financial services and products where multiple organizations in the supply chain coordinate operating funds, facilitate transaction information connectivity, mitigate financing risks, and foster sustainable transactions (Hofmann, 2005). At its core, SCF aims to facilitate the flow of financial capital to projects and enterprises that struggle to secure financing, are innovative, and prioritize sustainability. While both SCF and enterprise innovation performance (EIP) are pivotal in current developments, their interplay remains underexplored in academia. Particularly in China's unique economic and cultural context, the impact of the interaction between SCF and enterprise innovation on the competitive positioning of SMEs remains uncharted territory, warranting further investigation.

The increasing technical complexity of high-tech products and the accelerated pace of product updates pose challenges for enterprises to innovate effectively (De Jong et al., 2015). Resource dependence theory suggests that organizations, lacking all necessary resources internally, must engage in social relationships and resource exchange to achieve their goals (Schiele et al., 2015). This has led to a shift from closed innovation to open innovation and collaborative innovation, where enterprises seek external innovation resources and engage in deep partnerships. Upstream and downstream stakeholders in the supply chain, such as suppliers and customers, play crucial roles in enterprise innovation. Supply chain concentration (SCC), reflecting procurement and sales focus, is a key aspect of supply chain partnerships (Chen et al., 2023). It highlights the frequency of transactions between enterprises and supply chain members, encompassing supplier concentration (SC) and customer concentration (CC). Wei et al. (2024) took Chinese listed enterprises as the research object, explored the influence of SC and CC on enterprise performance, and expressed SC as the number of raw material suppliers and the concentration of procurement. CC is expressed as the number of business customers and the degree of concentration of sales. Therefore, SCC reflects the dependence of enterprises on large suppliers and customers.

Based on existing research, the general consensus among scholars is that SCF has a positive impact on driving enterprise innovation. Previous studies have examined the intermediary role of financing constraints (Chen et al., 2020) and the moderating influence of CC (Ma and Han, 2021) on the relationship between SCF and EIP. However, there are some notable gaps in the literature. Firstly, most existing research has focused on all listed companies without considering the potential differences in the effects of SCF on large enterprises versus SMEs. Limited attention has been given to exploring how SCF affects innovation in SMEs. Secondly, the current literature primarily discusses the impact of CC on enterprise innovation, neglecting the role of SC in driving innovation. Thirdly, few scholars have integrated the 'supplier-customer' relationship into the research framework when examining the connection between

SCF and EIP. Therefore, it is imperative to conduct comprehensive research on how SCF influences innovation performance specifically in SMEs.

This study utilizes data from China's Shenzhen SME Board and GEM listed companies spanning from 2011 to 2020, sourced from the CSMAR database, to empirically examine the influence of SCF on EIP within the context of SCC. The findings of the research support the assertion that SCF has a positive impact on EIP. SCC acts as an intermediary variable that affects EIP through SCF. Additionally, further analysis reveals that the impact of SCC on EIP exhibits two different directions (Huang and Sutunyarak, 2024). This study makes significant contributions to the literature in several aspects. Firstly, it explores the impact of SCF on EIP by utilizing up-to-date data. The findings suggest that SCF plays a crucial role in enhancing EIP, offering a fresh perspective on this relationship. Secondly, this study delves into the influence of supply chain concentration on both SCF and EIP. Hottenrott and Lopes-Bento (2016) indicates that smaller, younger enterprises, and those with limited resources can gain from increased R&D collaboration. This study emphasizes the importance of examining this relationship from both supplier and customer perspectives, underscoring their role as essential external entities that impact the development of SMEs. Secondly, this study indicates that SC and CC can influence the willingness of enterprises to share knowledge and information within SCF platforms, ultimately affecting EIP. Thirdly, this study takes the companies listed on the SME Board and GEM in Shenzhen, China as the research object, enriching the research results on SCF and EIP. Finally, this study provides theoretical and empirical basis for the government to rationally use supply chain financial tools to improve the innovation quality of SMEs. This has certain reference value for SMEs to raise funds through SCF, obtain resources from suppliers and customers, promote R&D investment, and improve their innovation capability and enhance core competitiveness of enterprises.

2. Literature review

2.1. Enterprise innovation performance

Innovation involves enterprises leveraging knowledge and services to create new products, services, processes, or business models (Salavou and Avlonitis, 2008). It is the process of translating new discoveries and ideas into tangible outcomes, bridging the gap between the scientific and business ecosystems (Clarysse et al., 2014). Scientific discovery participants acquire commercialized knowledge and apply it in the market, while commercial development participants gain scientific insights to link discoveries with market needs, boosting economic benefits. The innovation intersection zone, essentially an innovation network, requires diverse participants to navigate between adjacent ecosystems, reorganize varied knowledge, and achieve innovation objectives (Dedehayir et al., 2018). However, knowledge flow within the network may face obstacles, even among spatially close participants, due to lack of direct contact or cognitive disparities. Network brokers play a crucial role in facilitating communication between disconnected actors, holding a structural position to bridge gaps and enhance knowledge exchange, ultimately boosting the innovation potential of the network (Kwon et al., 2020). After the end of the twentieth century,

due to the growing technological complexity, rapid changes in technology, and intensified market competition, individual enterprises, particularly SMEs, face challenges in achieving successful innovation independently (Bogers et al., 2018). As a result, SMEs have increasingly turned to the open innovation strategies to enhance their innovation performance through collaborations with external organizations (Lu et al., 2021). While there is limited research on how SMEs excel in innovation, both academic studies and management practices have shown a rising interest in enterprise performance evaluation systems. The performance of a commercial enterprise within a capitalist framework is typically assessed based on financial metrics such as return on investment and payback period, as well as operational efficiency metrics like productivity and cycle times (Kaplan and Norton, 1992). In the realm of innovation strategies for gaining competitive advantage, scholars have observed that value is not solely derived from tangible assets, but also from intangible assets within an enterprise. To gauge this dual value creation, scholars have developed a set of non-financial indicators that complement traditional financial metrics. These models include the performance measurement matrix (Keegan et al., 1989), the results and determinants framework (Fitzgerald et al., 1991), the performance pyramid (Lynch and Cross, 1991), the balanced scorecard (BSC) (Kaplan and Norton, 1992), and the performance prism (Neely et al., 2002). Dewangan and Godse (2014) argue that innovation consists of four stages based on the lifecycle perspective theory: lifecycle perspective, incubation of ideas, commercialization of ideas, and realization of innovation. They also proposed a process-based innovation performance evaluation scheme, emphasizing the importance of expanding evaluation dimensions, aligning with the innovation process, considering stakeholders' goals, establishing causal relationships between measures, and ensuring ease of implementation and usability. Edquist et al. (2018) argued that the Innovation Union Scoreboard lacks meaningful measures of innovation performance. They proposed a new approach using a simple index number and advanced nonparametric Data Envelopment Analysis techniques to redefine innovation input and output indicators. By employing bias-corrected efficiency scores, they ranked innovation across 28 EU countries and introduced the Summary Innovation Index as a more accurate reflection of innovation levels. This suggests that Data Envelopment Analysis techniques could also be applied to assess the innovation output performance of enterprises.

2.2. Supply chain finance

After the 2008 financial crisis, SCF has emerged as a key development strategy for logistics companies (Elliot et al., 2020). It has evolved into the primary financing method and a significant financing channel for addressing the financial challenges faced by SMEs. According to Lee et al. (2015), the lack of information transparency among SMEs can impact financing costs. This lack of transparency hinders financial institutions from effectively monitoring and overseeing the performance of these enterprises post-loan approval. Additionally, in cases of default by SMEs, financial institutions are often unable to impose strict penalties, leading to a reluctance in providing further loans to such enterprises. Consequently, financial institutions have tightened loan conditions and increased financing barriers for SMEs. The

advancement of SCF has brought about value-added effects, transmission effects, and optimization effects for the growth of SMEs. Walters (2004) emphasizes that SCF is a management service rooted in the value chain. It offers financial services to all stakeholders involved in the supply chain, fostering value creation and enabling stakeholders to realize value appreciation. Furthermore, Hofmann (2005) defines SCF as the comprehensive allocation of funds by two or more organizations (including external service providers) within the supply chain. It represents a fusion of logistics, management, strategic partnerships, and financial activities among enterprises within the supply chain. Supply chain cooperative enterprises establish a mutual commitment to share relationship resources, capabilities, information, and jointly bear risks through medium and long-term contracts. The aim of SCF is to reduce capital costs, enhance cash flow, and boost the credibility of the supply chain. Parties, like buyers, benefit from extended payment terms by leveraging loans from financial services providers to settle payments to suppliers. Suppliers have the option to receive payments early at a discounted price or at the original price during normal payment cycles. This collaborative financing approach fosters a more dependable supply base and alleviates financial burdens for suppliers. SCF prioritizes the collective interests of the entire supply chain over individual enterprises. The key participants in SCF include core enterprises, suppliers, buyers, and financial service providers, who come together to maintain product production and establish mutually beneficial partnerships. Söderberg and Bengtsson (2010) stated that among SMEs, there is a strong link between supply chain maturity and performance, among others. The relationship between supply chain maturity and financial performance. They further stated that SMEs can improve their performance if they use maturity indicators in reference areas of supply chain operations and can have an optimistic impact on supply chain performance and financial results.

2.3. Supply chain concentration

Research often indicates that the success of enterprises in technology-driven industries hinges on developing and commercializing innovative technologies in new products. Enterprises that excel in creating new technological knowledge are commended for blending internal knowledge with external sources (Berman and Hagan, 2006; Kirchberger and Pohl, 2016). In this regard, enterprises capable of creating new technological knowledge are praised for producing knowledge internally and combining it with external knowledge sources (Rosenkopf and Nerkar, 2001). However, in the process of identifying knowledge and integrating it into the enterprises' own knowledge base, enterprises need to deliberately seek out and access relevant cutting-edge knowledge. There are many sources of this knowledge. Businesses prefer to obtain the latest cutting-edge market knowledge from suppliers and customers. The degree of SCC determines the abundance of heterogeneous resources outside the enterprise, but the management and effective utilization of these heterogeneous resources are the key to generating innovative performance, which is inseparable from an efficient enterprise supply chain mechanism. Laursen and Salter (2006) pointed out that suppliers, customers, competitors and universities are the four main search sources for enterprises to conduct open knowledge search. Basole (2017)

proposed that knowledge flowing among supply chain partners can become a source of enterprise innovation. Lanier et al. (2010) divided SCC into two dimensions: suppliers and customers. In the upstream of the supply chain, suppliers play a crucial role. Wang and Hu (2020) discovered that collaborative innovation with suppliers can streamline the process of gathering information for innovation, reducing time and investment, and pave the way for identifying new innovation opportunities in the future. Narasimhan (2013) emphasized the significance of absorptive capacity theory in open innovation, highlighting the importance of leveraging the outputs of various suppliers. Enterprises can drive outside-in innovation by leveraging supplier networks, necessitating the establishment of knowledge exchange mechanisms within these networks. Moving downstream in the supply chain, customers become central. Köhler et al. (2012) noted that customers significantly contribute to product market-driven knowledge search, offering unique market insights that fuel innovation. Notably, innovation stemming from suppliers and customers may differ due to the distinct resources each group provides. Suppliers, situated upstream in the value chain, primarily offer technical knowledge related to product production, while customers, with their consumer-facing interactions, provide valuable market insights to enterprises (Haq et al., 2021).

3. Theoretical analysis and research hypothesis

3.1. Supply chain finance and Enterprise innovation performance

Innovation is a challenging long-term investment often limited by financial constraints (Hall, 2002). Major multinational companies like Walmart (Chen et al., 2019), Boeing (Tang et al., 2009), and Siemens (Abbasi et al., 2018) have established SCF platforms to support their smaller suppliers, boosting liquidity and improving cash flow. Analyzing the SCF Programs of these enterprises reveals two key benefits for financing SMEs. Firstly, SCF helps these enterprises generate internal funds, easing the financial ‘dilemma’ of daily operations, enhancing their business environment, improving operational capabilities, and reducing the risk of financial difficulties (Xu and Xuan, 2021). Secondly, engaging in SCF fosters close relationships with other supply chain partners, ensuring stability and reducing risks associated with innovation. By sharing information and resources, SMEs can access quality investment opportunities, reducing the inclination to invest in financial assets over physical investments (Yang et al., 2021).

Based on the aforementioned analysis, we propose the following hypothesis:

Hypothesis 1 (H1): Supply chain finance has a positive impact on enterprise innovation performance.

3.2. Supply chain finance and supply chain concentration

Knowledge and information play a crucial role in driving enterprise innovation. The sharing of knowledge and information between enterprises and suppliers has been identified as a key strategy for successful innovation (Jaca et al., 2016). In situations where SC is low, enterprises have the flexibility to engage with multiple upstream suppliers, reducing their reliance on a single supplier and minimizing the costs

associated with switching suppliers. This diversified supply model allows enterprises to access a broader spectrum of new knowledge and information, thereby enriching resources for innovation activities and ultimately enhancing the EIP. However, as SC increases, suppliers gain leverage in negotiating raw material prices. This may lead to suppliers prioritizing their own interests and raising raw material prices, consequently escalating corporate procurement costs. Moreover, highly concentrated suppliers may leverage their bargaining power in the supply chain to demand extended commercial credit terms from enterprises, placing strain on the enterprise's cash flow and potentially impeding the positive impact of SCF on innovation within the enterprise.

On the other hand, downstream customers play a crucial role in enterprise innovation strategies as they serve as the vital link between enterprises and consumers. While Pan et al. (2020) highlighted that excessive CC could potentially impede enterprises' technological advancements, Krolikowski et al. (2017) presented an alternative perspective. They suggested that strong relationships between enterprises and customers could lead to higher switching costs, thereby incentivizing companies to invest more in innovation. In scenarios with high CC, enterprise-customer relationships tend to be more robust, reducing maintenance costs and ensuring stable and continuous purchases of the enterprise's products. This, in turn, boosts the enterprise's inventory turnover rate and enhances profit margins, encouraging increased innovation investments. Technological innovation, as noted by Edler (2010), is driven by demand, and enterprises often draw inspiration for innovation from feedback provided by downstream customers. With high CC, demand information is communicated swiftly and accurately, making enterprises more receptive to novel ideas and further fueling innovation motivation (Hou et al., 2021). Such close customer relationships empower enterprises to develop new products that align better with market needs, thereby gaining a competitive edge.

Based on the aforementioned analysis, we propose the following hypothesis:

Hypothesis 2a (H2a): Supply chain finance has a negative impact on supplier concentration.

Hypothesis 2b (H2b): Supply chain finance has a positive impact on customer concentration.

3.3. Supply chain concentration and Enterprise innovation performance

Suppliers play a key role as stakeholders in close business relationships with enterprises. Effective communication and collaboration between suppliers and enterprises can enhance resource complementarity, facilitate information exchange, boost innovation enthusiasm, and improve innovation efficiency. Drawing from resource dependence theory, enterprises accumulate unique and valuable resources over time, which are difficult to replicate. Innovation theory posits that innovation involves reorganizing and combining various resources to enhance production efficiency. Thus, a lower SC and a greater number of suppliers expose enterprises to a wider range of heterogeneous resources, providing valuable materials for innovation and access to personnel for technical support. This exposure can stimulate innovative behavior and enhance EIP. Gronum et al. (2012) supported this perspective through their analysis of SMEs. Additionally, SCC impacts innovation performance by

influencing the bargaining power of transaction parties. According to Porter's five forces model, if the value of input factors provided by suppliers represents a significant portion of an enterprise's product costs, the supplier's bargaining power is strengthened, leading to potential price increases for raw materials and other tactics that may compromise the company's interests. Research findings by Dhaliwal et al. (2016) indicate that higher SC heightens the risks faced by a company from its partners, resulting in increased debt and equity costs. Moreover, as enterprise performance weakens and available cash diminishes, many enterprises tend to reduce their investments in innovation to maintain regular internal operations.

Customers play a crucial role not only as the focus of business activities and the foundation of business outcomes, but also as the driving force behind product and business design. The level of CC directly impacts the level of innovation input and the efficiency of innovation output. Customers, as direct market participants, possess valuable market demand information and have the ability to swiftly identify market trends, accurately estimate market demand, and adapt to market changes promptly. Chang and Taylor (2016) and Morgan et al. (2018) highlighted the significance of customer involvement in the development of new products. By engaging with diverse customers, enterprises can access a variety of resources such as market demand insights and technical expertise, enabling them to generate fresh ideas and identify opportunities for product development, ultimately fostering enterprise innovation. Moreover, when an enterprise sells a large volume of products to a limited number of customers, it indicates a high level of CC, a significant reliance on customers, and a strong customer bargaining power. Sarkar et al. (2023) highlighted that an increase in bargaining power could lead customers to negotiate for better quality products at reduced prices, prompting sellers to enhance product quality and lower prices. This, in turn, may result in enterprises limiting their innovative endeavors due to financial constraints, thereby weakening overall EIP. Additionally, downstream relationships within the supply chain denote enduring and cooperative ties between enterprises and customers. Zhao et al. (2023) suggested that heightened CC could exacerbate financial constraints for enterprises, potentially leading to extended payment terms and increased credit sales. When customers tie up an enterprise's funds, it inevitably shortens the turnover period and internal resources available to the enterprise. Given that sustained innovation efforts necessitate continuous investment in R&D over an extended period, customer control of corporate funds may hinder R&D activities by limiting resources and potentially reducing R&D investment.

Based on the aforementioned analysis, we propose the following hypothesis:

Hypothesis 3a (H3a): supplier concentration has a negative impact on enterprise innovation performance.

Hypothesis 3b (H3b): customer concentration has a negative impact on enterprise innovation performance.

3.4. Mediating role of supply chain concentration

The supply chain serves as a vital link connecting enterprises through logistics, capital flow, information flow, and technology flow, establishing a stable, long-term, and highly reliable partnership (Khan et al., 2015). Unlike the pursuit of personal gain,

supply chain partnerships prioritize teamwork over competition, ensuring fair and reasonable distribution of interests among collaborating enterprises to maximize overall benefits (Song et al., 2020). In the current era of open innovation, the complexity of innovation has risen, and the pace of product updates has quickened (Rubera et al., 2016). Innovation within enterprises now relies on collaborative efforts among supply chain members (Yang et al., 2020), rather than solely on individual investments. By enhancing integrated supply chain management, fostering collaborative and mutually beneficial partnerships, and leveraging the synergies of the supply chain system through knowledge sharing, information exchange, and technical collaboration, SMEs can optimize the allocation of innovative resources, adapt to market demands, reduce innovation costs and risks, and enhance their technological capabilities. Specifically, the positive impact of supply chain on the innovation performance of SMEs can be analyzed from three main aspects: input, process, and output. Firstly, enhancing supply chain integration allows these enterprises to effectively integrate and utilize R&D resources and capabilities from both upstream and downstream partners, fostering multi-party cooperation and innovation while reducing costs associated with acquiring innovative resources such as knowledge, information, and technology. Additionally, supply chain partnerships characterized by cooperation and competition effects can increase asset specificity between enterprises, improving operational collaboration stability, reducing transaction friction, and ultimately lowering transaction costs (Deng et al.,2021). Secondly, at a higher level of supply chain partnerships, strategic cooperation among partners facilitates the formation of a community of interests, reducing opportunistic behavior and ensuring stability in production and operation activities, thereby decreasing operational risks and optimizing the innovation environment. Lastly, in terms of innovation output, the supply chain enables enterprises to better understand their own resources and positioning, enhancing resource allocation capabilities and expediting innovation output. By maintaining a high level of CC, SMEs can promptly identify customer innovation needs and trends, develop targeted innovation plans, and enhance the efficiency and success rate of new product research and development. Furthermore, the establishment and growth of SCF systems facilitate deeper trade cooperation between organizations as major suppliers and customers become integrated into the supply chain network. SCF adds a strong chain to supply chain partnerships.

Based on the aforementioned analysis, we propose the following hypothesis:

Hypothesis 4 (H4): Supplier concentration mediates between supply chain finance and enterprise innovation performance.

Hypothesis 5 (H5): Customer concentration mediates between supply chain finance and enterprise innovation performance.

Based on the above assumptions, this study can establish the following conceptual model (**Figure 1**).

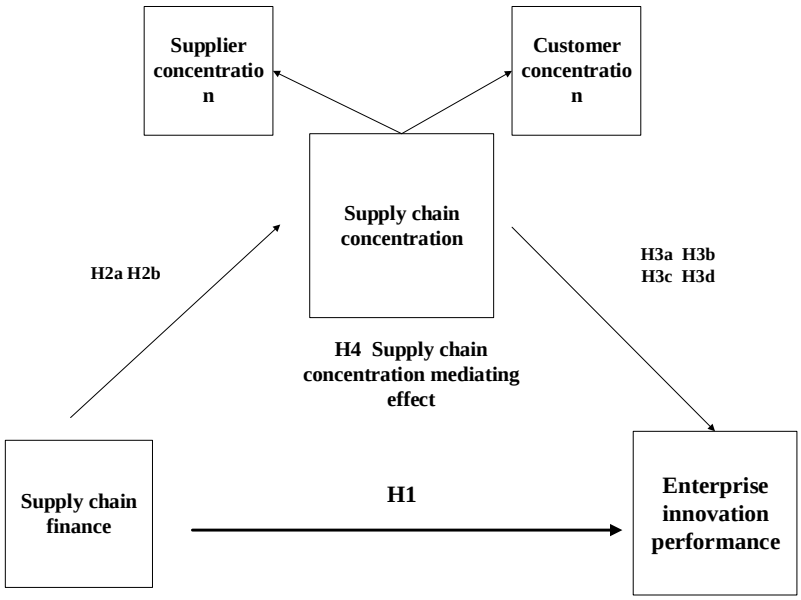

Figure 1. Conceptual model.

4. Methods

4.1. Sample source and data selection

This study meticulously selected listed companies in the SME Board and GEM Shenzhen, China, from 2011 to 2020 as the initial research sample. The choice of 2011 as the starting point of the sample period was informed by multiple considerations. Firstly, in December 2007, the China Securities Regulatory Commission issued the Content and Format Guidelines for Information Disclosure of Publicly Issued Securities Companies—No. 2 Annual Report Content and Format', explicitly requiring listed companies to disclose information on their major suppliers and customers, including the proportion of procurement amounts from the top five suppliers to the annual total procurement amount and the proportion of sales amounts from the top five customers to the enterprise's total sales. This regulation prompted listed companies to gradually disclose information on suppliers and customers, providing ample data sources for this study. Secondly, in 2005, Shenzhen Development Bank, as the first bank in China, introduced the country's first SCF solution. This solution replaced traditional real estate assets with receivables and payables as collateral for loan issuance (Li and Hu, 2017). Subsequently, more and more banks began to launch different types of SCF businesses, and listed companies gradually joined this financial system. Considering that the development of SCF business required a certain amount of time, this study assumes that the number of listed companies engaging in SCF business had significantly increased by 2011, five years later. Lastly, in December 2020, China experienced the outbreak of the COVID-19 pandemic. Subsequently, in 2021, the Chinese government implemented strict lockdown measures to contain the spread of the virus. These consecutive pandemic and policy measures had profound impacts on the operations of Chinese enterprises in 2021, with many enterprises experiencing severe operational disruptions. Therefore, to ensure the accuracy and reliability of the study, we chose 2020 data as the endpoint of our research. In summary, based on data from 2011 to 2020, this study delves into

the situation of EIP among A-share listed companies in the SME Board and GEM Shenzhen against the backdrop of SCF. It aims to provide valuable references for research and practice in the fields of SCF and EIP. This study excluded certain enterprises from the initial sample based on the following criteria. (1) Enterprises facing financial difficulties, special transfer (PT), or those classified as special treatment (ST or *ST) by the China Securities Regulatory Commission, with no signs of financial improvement in the year following ST classification. (2) Financial, insurance, securities, public utilities, and social service enterprises due to variations in accounting systems. (3) AB-share or AH-share cross-listed companies; (4) Samples with missing financial data. (5) Samples with missing or discontinuous disclosures of customer and supplier information. (6) To account for potential outliers, all continuous variables were winsorized at the top and bottom 1% levels. The final sample used in this study consisted of 15,275 firm-year observations from 1,656 enterprises (Huang and Sutunyarak ,2024).

4.2. Measurement of variables

SCF is the study's independent variable. De Rassenfosse et al. (2013) used the number of patents to measure enterprise innovation performance. So EIP which is determined by how many new patents are invented by enterprises is the dependent variable. Firm Size, profitability, firm nature and so on are the control variable. **Table 1** provides details on the measurement of these variables (Huang and Sutunyarak, 2024).

Table 1. Variables and definition.

Variable Types	Variable name	Variable symbol	Definition
Dependent variable	Enterprises innovation performance	Patent	Enterprises innovation performance mainly refers to the input and output results of enterprises in terms of new technology R&D investment Following Ren et al. (2015) that measures EIP, we use the value of in (design patents + utility model patents + invention patents + 1).
Independent variable	Supply chain finance	SCF	SCF is a collaborative and innovative business model that provides credit and services to businesses. It converts non-current assets into cash without incurring additional liabilities. Following Wu et al. (2022) that measures SCF, we use the value of in (account payables + notes payables + mortgage loan).
Intervening Variable	Supplier concentration	SS	Supplier concentration refers to the concentration of supplier s' supplying shares on the side of the enterprise. Following Yang (2017) that measures SC, we use the ratio of top five suppliers purchase amount to total purchase amount.
	Customer concentration	CC	Customer concentration refers to the concentration of customers' purchasing shares on the side of the enterprise. Following Yang (2017) that measures CC, we use the ratio of top five customers payment amount to total payment amount.
Control variables	Firm Size	Size	Total assets' natural logarithm at the conclusion of the time period.
	Firm nature	Soe	Firm nature represents who holds more enterprise shares. If the enterprise is state-owned enterprises, the value is 1, otherwise it is 0 (Ruiqi et al., 2017).

Table 1. (*Continued*).

Variable Types	Variable name	Variable symbol	Definition
Control variables	Return on total assets	Roa	Ratio of earnings before interest and tax to average total assets.
	Whether the chairman and the general manager are the same person	Dual	Dual indicates whether the chairman and the general manager are the same person. If the CEO concurrently serves in that year, the value is 1; otherwise, it is 0.
	Asset-liability ratio	Dta	Asset-liability ratio is used to measure the proportion between the assets and liabilities of a business or individual. Ratio of total debt to total assets.
	Stock market listing time	Age	The number of years since the firm went public's natural logarithm.
	To bin Q	To bin Q	Tobin's Q defined as the ratio of the market value of a firm to the replacement cost of its assets, is a good measure of a firm's longterm performance (Jose et al. 1996).
	Ownership concentration	Top l	Ratio of the number of first stockholder strands to total number of strands.
	Sales growth rate	Growth	Sales growth rate is the rate of increase in operating income this year over the previous year. Ratio of the current year's sales revenue to the total sales revenue of the previous year.
	Industry	Industry	It was used to control the effects of time.
	Year	Year	It was based on the 2012 China Securities Regulatory Commission (CSRC) industry classification codes (first digit).

Source: Author's Own.

4.3. Model specification

To explore the effect of SCC on SCF and EIP, we constructed models 1 to 7, of which models 2 to models 3 test H2a to H2b, and models 4 to models 5 test H3a to H3b (Huang and Sutunyarak, 2024).

$$Patent = \alpha_0 + \alpha_1 Scf_{i,\ t} + \alpha_2 Controls_{i,t} + Industry + Year\ + \varepsilon_{i,t} \quad (1)$$

$$SC = \beta_0 + \beta_1 Scf_{i,\ t} + \beta_2 Controls_{i,t} + Industry + Year\ + \varepsilon_{i,t} \quad (2)$$

$$CC = \beta_0 + \beta_1 Scf_{i,\ t} + \beta_2 Controls_{i,t} + Industry + Year\ + \varepsilon_{i,t} \quad (3)$$

$$Patent = c_0 + c_1 SC_{i,\ t} + c_2 Controls_{i,t} + Industry + Year\ + \varepsilon_{i,t} \quad (4)$$

$$Patent = c_0 + c_1 CC_{i,\ t} + c_2 Controls_{i,t} + Industry + Year + \varepsilon_{i,t} \quad (5)$$

$$Patent = \eta_0 + \eta_1 Scf_{i,\ t} + \eta_2 Sc_{i,t} + \eta_3 Controls_{i,t} + Industry\ + Year + \varepsilon_{i,t} \quad (6)$$

$$Patent = \eta_0 + \eta_1 Scf_{i,\ t} + \eta_2 Cc_{i,t} + \eta_3 Controls_{i,t} + Industry\ + Year + \varepsilon_{i,t} \quad (7)$$

All variables are described in Section 3.2, Controls represents control variables, year and industry are year fixed effects and industry fixed effects, $\alpha_0, \beta_0, c_0, \eta_0$ are constant terms, and $\varepsilon_{i,t}$ represents Errors (Huang and Sutunyarak ,2024).

4.4. Data analysis method

This study utilized Stata16.0 software to analyze the collected data. The data analysis involved descriptive statistical analysis, correlation analysis, regression equation path analysis, mediation effect test, and robustness test to verify the proposed hypotheses. Following the data analysis, the results are discussed (Huang and Sutunyarak, 2024).

5. Results

5.1. Descriptive statistics

Table 2 shows the number, mean, standard error, minimum and maximum of the variables in our models. The maximum VIF is 1.310, lower than the critical value of 10, indicating that the problem of multicollinearity has been ruled out (Huang and Sutunyarak, 2024).

Table 2. Descriptive statistics.

Variables	N	Mean	SD	Min	Max
Patent	15275	2.117	2.206	0.000	11.212
Scf	15275	0.264	0.173	0.000	1.146
SC	15275	0.352	0.198	0.004	1.000
CC	15275	0.3193	0.217	0.000	1.579
Size	15275	21.94	1.149	17.641	28.257
Soe	15275	0.229	0.420	0.000	1.000
Roa	15275	0.03115	0.109	–4.946	0.786
Cash	15275	0.04446	0.075	–0.714	0.664
Dual	15275	0.3313	0.471	0.000	1.000
Top1	15275	0.3233	0.141	0.029	0.900
Lev	15275	0.3951	0.207	0.008	3.919
Firm Age	15275	8.714	0.356	6.996	9.884
Growth	15275	0.2695	2.195	–1.116	130.696
To bin Q	15275	2.212	2.267	0.674	122.189

Source: Results on Stata 16 software.

5.2. Correlations analysis

The correlation analysis of the sample used in this study is presented in **Table 3**. It is observed that SCF shows a positive correlation with EIP, while SC exhibits a negative relationship with EIP. This suggests that companies with higher innovative performance tend to have a larger number of suppliers. Additionally, it is worth noting that CC demonstrates a positive relationship with EIP, which can be attributed to the fact that enterprises with innovative performance have a more concentrated customer base (Huang and Sutunyarak, 2024).

Table 3. Correlations analysis.

Variables	Patent	Scf	SC	CC	Size	Soe	Roa
Patent	1						
Scf	0.109***	1					
SC	–0.155***	–0.074***	1				
CC	0.047***	0.080***	0.241***	1			
Size	–0.00300	0.058***	–0.188***	–0.147***	1		
Soe	–0.108***	–0.046***	–0.0120	0.00800	0.302***	1	

Table 3. (*Continued*).

Variables	Patent	Scf	SC	CC	Size	Soe	Roa
Roa	0.064***	–0.182***	–0.030***	–0.045***	0.022***	–0.018**	1
Cash	0.054***	–0.256***	–0.036***	–0.063***	0.044***	0.00700	0.277***
Dual	0.052***	0.029***	0.014*	0	–0.137***	–0.256***	0.015*
Top1	–0.040***	–0.085***	0.00500	–0.00700	0.093***	0.139***	0.122***
Lev	–0.067***	0.487***	–0.086***	–0.040***	0.484***	0.227***	–0.356***
Firm Age	–0.058***	–0.033***	–0.00600	–0.016**	0.201***	0.219***	–0.068***
Growth	0	0	0.0120	0.0100	0.045***	–0.00300	0.050***
To bin Q	–0.023***	–0.088***	0.114***	0.066***	–0.298***	–0.074***	0.00900

Var name	Cash	Dual	Top1	Lev	Firm Age	Growth	To bin Q
Cash	1						
Dual	–0.00800	1					
Top1	0.077***	–0.00800	1				
Lev	–0.183***	–0.089***	0.022***	1			
Firm Age	0.024***	–0.102***	–0.061***	0.170***	1		
Growth	0.00100	0.00400	0.0120	0.034***	0.00400	1	
To bin Q	0.036***	0.046***	–0.062***	–0.114***	0.00500	–0.014*	1

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

5.3. Structural model regression

Since our dependent variable is a continuous variable, we used ordinary least squares (OLS) regression to analyze the impact of SCF on EIP and the mediating effects of SC and CC. **Table 4** presents the regression results for H1 to H5. In column (1), the coefficient of the first independent variable SCF is positive and significant (0.540, *t*-value = 0.128), indicating that enterprises' SCF has a substantial positive impact on EIP, thus supporting H1. In column (2), the coefficient of the independent variable SCF is negative and significant (–0.036, *t*-value = 0.012), suggesting that SCF decreases enterprises' CC, providing support for H2a. In column (3), the coefficient of SCF is positive and significant (0.061, *t*-value = 0.012), indicating that SCF has a positive impact on CC, hence supporting H2b. In column (4), the coefficient of SC is negative and significant (–1.028, *t*-value = 0.089), demonstrating that SC has an adverse effect on EIP, supporting H3a. In column (5), the coefficient of CC is negative and significant (–0.047, *t*-value = 0.084), revealing that CC also has a negative impact on EIP. Therefore, H3b was also accepted (Huang and Sutunyarak, 2024).

Table 4. Results of hypotheses 1–5.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Model 1	Model 2	Model 3	Model 4	Model 5
	Patent	SC	CC	Patent	Patent
Scf	0.540***	–0.036***	0.061***		
	(0.128)	(0.012)	(0.012)		
SC	0.166***			–1.028***	
	(0.019)			(0.089)	
CC	–0.102**				–0.047***
	(0.045)				(0.084)
Size	0.558***	–0.042***	–0.038***	0.110***	0.150***
	(0.169)	(0.002)	(0.002)	(0.019)	(0.019)
Soe	1.421***	–0.006	0.014***	–0.121***	–0.116***
	(0.235)	(0.004)	(0.004)	(0.044)	(0.044)
Roa	0.042	–0.026*	–0.008	0.613***	0.646***
	(0.035)	(0.015)	(0.016)	(0.168)	(0.168)
Cash	–0.112	–0.124***	–0.153***	1.111***	1.216***
	(0.119)	(0.021)	(0.023)	(0.229)	(0.230)
Dual	–0.569***	0.005*	–0.006*	0.048	0.043
	(0.124)	(0.003)	(0.003)	(0.035)	(0.035)
Top1	–0.358***	–0.003	0.038***	–0.136	–0.134
	(0.053)	(0.011)	(0.012)	(0.119)	(0.119)
Lev	0.007	–0.023**	–0.014	–0.318***	–0.273***
	(0.007)	(0.011)	(0.012)	(0.103)	(0.103)
Firm Age	–0.013*	–0.003	–0.010*	–0.368***	–0.366***
	(0.008)	(0.005)	(0.005)	(0.052)	(0.053)
Growth	1.117*	0.002***	0.002***	0.009	0.007
	(0.596)	(0.001)	(0.001)	(0.007)	(0.007)
To bin Q	15275.000	0.006***	0.003***	–0.010	–0.016**
	0.044	(0.001)	(0.001)	(0.008)	(0.008)
_cons	0.038	1.298***	1.174***	2.819***	1.568***
	0.540***	(0.054)	(0.058)	(0.597)	(0.597)
N	(0.128)	15275.000	15275.000	15275.000	15275.000
r2	0.166***	0.084	0.053	0.051	0.043
r2_a	(0.019)	0.078	0.047	0.045	0.037
industry	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

We introduced SC and CC into Model 1, resulting in Model 6 and Model 7. Our objective was to investigate the impact of SCF on EIP in supply chain relationships. The regression results for Hypothesis 6 and Hypothesis 7 are presented in **Table 5**. In

Column (1), we analyze the regression results for both SCF and SC on EIP. The coefficient for the independent variable SCF is positive and significant (0.503, *t*-value = 0.128). Moreover, when compared to Model 1 without considering SC, the coefficient for SCF (0.540) has decreased. This suggests the presence of an indirect transmission channel, whereby SCF influences EIP. Specifically, a portion of the effect of SCF is transmitted through SC, while another portion affects EIP. Moving on to Column (2), we examine the regression results when considering the impact of SCF and CC on EIP simultaneously. Once again, the coefficient for the independent variable SCF is positive and significant (0.543, *t*-value = 0.128), matching the coefficient for SCF (0.540) in Model 1 without considering CC. This indicates the existence of an indirect transmission channel through which SCF affects EIP via CC. Similar to the previous case, a portion of the effect of SCF is transmitted through CC, while another portion influences EIP (Huang and Sutunyarak, 2024).

Table 5. Results of hypotheses 6–7.

Variables	**(1)**	**(2)**
	Model 6	Model 7
	Patent	Patent
Scf	0.503***	0.543***
	(0.128)	(0.128)
SC	–1.019***	
	(0.089)	
CC		–0.061
		(0.084)
Size	0.123***	0.163***
	(0.019)	(0.019)
Soe	–0.108**	–0.101**
	(0.044)	(0.045)
Roa	0.532***	0.558***
	(0.169)	(0.169)
Cash	1.295***	1.412***
	(0.234)	(0.235)
Dual	0.047	0.041
	(0.035)	(0.035)
Top1	–0.114	–0.109
	(0.119)	(0.119)
Lev	–0.592***	–0.570***
	(0.124)	(0.124)
FirmAge	–0.360***	–0.358***
	(0.052)	(0.053)
Growth	0.009	0.007
	(0.007)	(0.007)

Table 5. (*Continued*).

Variables	(1)	(2)
TobinQ	–0.007	–0.013
	(0.008)	(0.008)
_cons	2.440***	1.188**
	(0.604)	(0.604)
N	15275.000	15275.000
r2	0.052	0.044
r2_a	0.046	0.038
industry	Yes	Yes
year	Yes	Yes

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

5.4. Intermediate effect test

The test analysis demonstrates that SCF enhances EIP by reducing SC and CC. To examine these mechanisms, two combinations were constructed based on previous research (Wen and Ye, 2014). The first combination includes model 1, model 2, and model 6, while the second combination consists of model 1, model 3, and model 7. The regression results can be found in **Tables 6** and **7** (Huang and Sutunyarak ,2024).

Table 6 demonstrates that SCF has a positive influence on EIP. Even with the inclusion of SC, SCF continues to have a positive impact on EIP regression. However, SC exhibits a negative effect (p = 0.001, β = –1.019). Notably, there exists a noteworthy negative correlation between SC's mediating effect on SCF and EIP. This finding supports the hypothesis H4, indicating that SC indeed acts as a significant mediator between SCF and EIP (Huang and Sutunyarak, 2024).

Table 6. Mediation effect tests-supplier concentration.

Variables	(1) Model 1	(2) Model 2	(3) Model 6
	Patent	SC	Patent
Scf	0.540***	–0.036***	0.503***
	(0.128)	(0.012)	(0.128)
SC			–1.019***
			(0.089)
Size	0.166***	–0.042***	0.123***
	(0.019)	(0.002)	(0.019)
Soe	–0.102**	–0.006	–0.108**
	(0.045)	(0.004)	(0.044)
Roa	0.558***	–0.026*	0.532***
	(0.169)	(0.015)	(0.169)
Cash	1.421***	–0.124***	1.295***
	(0.235)	(0.021)	(0.234)
Dual	0.042	0.005*	0.047
	(0.035)	(0.003)	(0.035)

Table 6. (*Continued*).

Variables	(1) Model 1	(2) Model 2	(3) Model 6
Top1	–0.112	–0.003	–0.114
	(0.119)	(0.011)	(0.119)
Lev	–0.569***	–0.023**	–0.592***
	(0.124)	(0.011)	(0.124)
Firm Age	–0.358***	–0.003	–0.360***
	(0.053)	(0.005)	(0.052)
Growth	0.007	0.002***	0.009
	(0.007)	(0.001)	(0.007)
To bin Q	–0.013*	0.006***	–0.007
	(0.008)	(0.001)	(0.008)
_cons	1.117*	1.298***	2.440***
	(0.596)	(0.054)	(0.604)
N	15275.000	15275.000	15275.000
r2	0.044	0.084	0.052
r2_a	0.038	0.078	0.046
industry	Yes	Yes	Yes
year	Yes	Yes	Yes

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

Table 7 demonstrates that SCF has a positive influence on EIP. Even when CC is introduced, SCF continues to have a positive impact on EIP regression. However, CC exhibits a negative relationship ($p < 0.001$, $\beta = -0.061$). Furthermore, CC displays a significant negative correlation in the mediating effect between SCF and EIP, indicating that the mediating effect of CC between SCF and EIP is indeed significant. Hence, H5 is accepted (Huang and Sutunyarak, 2024).

Table 7. Mediation effect tests-customer concentration.

Variables	(1) Model 1	(2) Model 3	(3) Model 7
	Patent	CC	Patent
Scf	0.540***	0.061***	0.543***
	(0.128)	(0.012)	(0.128)
CC			–0.061***
			(0.084)
Size	0.166***	–0.038***	0.163***
	(0.019)	(0.002)	(0.019)
Soe	–0.102**	0.014***	–0.101**
	(0.045)	(0.004)	(0.045)
Roa	0.558***	–0.008	0.558***
	(0.169)	(0.016)	(0.169)

Table 7. (*Continued*).

Variables	(1) Model 1	(2) Model 3	(3) Model 7
Cash	1.421***	–0.153***	1.412***
	(0.235)	(0.023)	(0.235)
Dual	0.042	–0.006*	0.041
	(0.035)	(0.003)	(0.035)
Top1	–0.112	0.038***	–0.109
	(0.119)	(0.012)	(0.119)
Lev	–0.569***	–0.014	–0.570***
	(0.124)	(0.012)	(0.124)
FirmAge	–0.358***	–0.010*	–0.358***
	(0.053)	(0.005)	(0.053)
Growth	0.007	0.002***	0.007
	(0.007)	(0.001)	(0.007)
TobinQ	–0.013*	0.003***	–0.013
	(0.008)	(0.001)	(0.008)
_cons	1.117*	1.174***	1.188**
	(0.596)	(0.058)	(0.604)
N	15275.000	15275.000	15275.000
r2	0.044	0.053	0.044
r2_a	0.038	0.047	0.038
industry	Yes	Yes	Yes
year	Yes	Yes	Yes

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

After conducting 500 iterations using the Bootstrap method, the results in **Table 8** indicate that both SC and CC have a statistically significant positive influence on EIP ($P < 0.001$, $\beta = 2.387$, $\beta = 2.466$). This suggests that in the context of this study, both SC and CC have a substantial positive impact on SCF and EIP. Furthermore, the findings also reveal a significant mediating effect on the relationship between SC and EIP. Therefore, the hypotheses H4 and H5 are once again accepted (Huang and Sutunyarak, 2024).

Table 8. Bootstrap mediating effect test results.

	Suppliers Concentration	Customers Concentration
	(1)	(2)
Indirect effect	0.144***	0.065***
	(0.020)	(0.013)
direct effect	2.387***	2.466***
	(0.124)	(0.122)
Gross effect	2.31	2.531
N	15275	15275

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

5.5. Robustness tests

The impact of SCF on the EIP can vary depending on the duration of participation. To address potential endogeneity issues that may affect the regression results, we employ the Heckman two-stage regression method (Sdiri et al., 2010) to examine the consistency between SCF and EIP, as hypothesized in H1. The regression results are presented in **Table 9**, indicating a positive regression coefficient for SCF on EIP, thus supporting the findings of this study (Huang and Sutunyarak, 2024).

Table 9. Heckman two-stage regression method test results.

Variables	**(1) The first Stage Probit regress**	**(2) The second Stage OLS regress**
	Patent 1	**Patent 1**
Scf		0.163***
		(0.029)
Mills		0.673***
		(0.106)
Size	–0.103***	–0.070***
	(0.013)	(0.008)
Soe	–0.036	–0.024**
	(0.031)	(0.010)
Roa	0.607***	0.445***
	(0.125)	(0.061)
Cash	0.466***	0.392***
	(0.166)	(0.061)
Dual	0.046*	0.032***
	(0.024)	(0.008)
Top1	–0.264***	–0.178***
	(0.084)	(0.032)
Lev	–0.362***	–0.352***
	(0.073)	(0.037)
FirmAge	–0.280***	–0.197***
	(0.037)	(0.020)
Growth	0.003	0.002
	(0.005)	(0.002)
TobinQ	–0.053***	–0.036***
	(0.008)	(0.005)
_cons	5.920***	4.054***
	(0.477)	(0.313)
N	15137.000	15137.000
r2		0.205
r2_a		0.201
industry	Yes	Yes
year	Yes	Yes

Note: ∗ Statistical significance at the 0.05 level. ∗∗ Statistical significance at the 0.01 level. ∗∗∗ Statistical significance at the 0.001 level. Source: Results on Stata 16 software.

6. Discussion

The purpose of this study is to explore the impact of SCF on the innovation performance of SMEs, and explore the mediating role of SCC.

This study suggests that SMEs can enhance their innovation performance by actively engaging in supply chain management and utilizing SCF tools. By strengthening their connections within the supply chain, enterprises can access valuable external knowledge, lower innovation costs, and ultimately improve their innovation performance. This finding aligns with previous research. Pan et al. (2021) argue that SCF serves as an innovative supplement to traditional bank financing, offering alternative financing options for SMEs. The expansion of SCF can mitigate information asymmetry and agency costs in financing, providing greater financial support to SMEs and easing their financing constraints, ultimately enhancing their innovation efficiency.

This study also discovered that SC and CC have a detrimental effect on EIP. This finding aligns with previous studies on supplier and customer leveraging and innovation performance (Medhi et al., 2019; Onofrei et al., 2020; Schoenherr, 2018; Wang et al., 2024; West and Bogers, 2014). Statsenko and Corral de Zubielqui (2020) further validated that service diversification and business diversification act as mediators between customer collaboration and creative performance. Service-oriented enterprises establish strong customer trust through information sharing and collaborative problem-solving. Qualitative interviews also supported these findings. METS companies actively utilize the knowledge and expertise acquired from customer interactions to expand their presence across various industries and develop diversified businesses. Service enterprises with diverse business portfolios can swiftly offer customers access to external resources for product innovation, thereby fostering customer-driven innovation. However, Manuela et al. (2021) demonstrated that supplier–customer relationships play a crucial role in knowledge acquisition and enterprise innovation. They categorized these relationships into behavioral and affective components, both of which have a positive impact on knowledge acquisition. Their findings emphasize the significance of interpersonal emotional connections between suppliers and customers for knowledge acquisition. To drive innovation, suppliers should invest in building strong relationships with key customers, fostering emotional bonds on a personal level. Apart from managing contractual obligations, enterprises should prioritize maintaining ongoing personal connections with key customers. It is essential for managers to comprehend and effectively handle the unique dynamics of interpersonal relationships with key customers. They should not only nurture commitment, loyalty, and trust among customers for long-term relationships, but also facilitate product and process innovation.

The final research findings indicate a significant correlation between SCF and SCC. Specifically, SCF and SC exhibit a clear negative correlation, while SCF and CC show a notable positive correlation. This highlights the beneficial impact of SCF on enterprises' access to diverse supplier and customer resources, ultimately enhancing the outcomes of enterprises' open innovation efforts. This novel finding contributes to existing literature by addressing a gap in the field. However, it is important to note that the adoption of SCF may reduce enterprise-specific assets,

potentially leading to increased innovation costs. Therefore, enterprises should carefully assess the impact of SCF on innovation costs to achieve a more balanced and comprehensive development strategy.

7. Conclusion

This study aims to investigate the correlation between SCF and EIP in SMEs, as well as the influence of SCC on this relationship. Our results indicate that the SMEs in our sample can utilize SCF to boost their innovation strategies, supporting the idea that different SME groups exhibit varied levels of innovation performance. SCC acts as a mediator in the link between SCF and EIP. Specifically, SMEs with higher SC show significantly lower innovation performance in terms of supplier resources, customer resources, innovation capital, and relationship capital. Similarly, SMEs with higher CC also exhibit lower innovation performance. Therefore, strong supplier resources and a diverse customer resources base appear to enhance SMEs' capacity to drive both radical and incremental innovations.

7.1. Theoretical and practical implications

In summary, the study's findings have significant implications for both enhancing and refining the theoretical understanding of the impact of EIP, as well as offering practical guidelines for management. This research contributes to the existing theories in the field of SCF and EIP by being the first to incorporate supply chain relationship factors within the context of SMEs. The results of this study align with prior research (Guo et al., 2023), indicating a positive influence of SCF on EIP, particularly within the SMEs sector. While literature on this topic is limited, studies focusing on specific contexts such as technology-based intelligent supply chain innovation services for commodity distribution enterprises (Liu et al., 2021), the impact of SCF on enterprise innovation in the realm of digital inclusive finance (Bai et al., 2024), and green SCF and green innovation (Fan and Zhou, 2023) have shown a positive correlation between SCF and EIP. While previous research has primarily focused on large listed companies, our study sheds light on SMEs, specifically exploring the relationship between suppliers, customers, and SMEs innovation performance. This highlights how SMEs can leverage their supply chain network to enhance their innovation capabilities.

This study introduces new research possibilities for SMEs in the context of a SCF system traditionally dominated by large enterprises. Scholars can utilize this information to further explore innovation in SMEs, which possess distinct characteristics compared to larger enterprises. As such, the unique dynamics surrounding innovation in SMEs present valuable avenues for study. Furthermore, considering SCC can be understood as a way to demonstrate supply chain partnerships, as it allows for a more realistic investigation of the impact of SCF on SMEs innovation performance.

By the same token, this study highlights important managerial implications for SMEs managers and entrepreneurs. It emphasizes the critical role of SCF in SMEs and suggests that investing in building and optimizing supply chain networks should be a priority. Additionally, focusing on supply chain governance is recommended. Enterprises can benefit from increasing their SCF borrowing quotas to secure external

funds for innovation investments. Moreover, developing multi-party supplier relationships, forming cooperative alliances, enhancing communication with suppliers, and maximizing resource sharing are key strategies for enterprises. Customer management is also crucial, with a recommendation to adopt a customer decentralization strategy, reduce reliance on large customers, and maintain a balanced power dynamic. Strengthening and maximizing the benefits of supply chain network investments is essential for businesses. Demonstrating the strength of SMEs supply chain networks to external stakeholders can help attract more funding for innovation investments, leading to significant improvements in innovation performance.

7.2. Limitations and future research

This study acknowledges several limitations that could be addressed in future research. The sample size is constrained by challenges in gathering primary data and focuses solely on firms' publicly available financial information. While this approach helps eliminate biases from artificial data collection methods, future studies should aim to collect data from a wider range of industries, firm sizes, and natures to enhance the generalizability of results. Another limitation is the use of one-sided measures for SCF, SCC, and EIP, which may not fully capture the complexity of these variables. Additionally, using an enterprise's patents as the sole indicator of innovation performance may not be entirely accurate, as some enterprises may not disclose all patents due to competitive reasons. Future research could explore alternative methods to assess enterprises' innovation engagement more comprehensively, considering the ongoing debate surrounding this topic. In addition, participation in the supply chain can provide SMEs with opportunities to manage orders, develop supply chain relationships, and foster innovation. This integration into the supply chain network reflects the enterprise's capability to handle such relationships effectively. Further analysis using theories such as the social network theory (Zhao and Wang, 2021) and the triple bottom line theory (Liang et al., 2018) could offer new insights. This suggests avenues for future research, highlighting the importance of exploring the link between supply chain participation and innovation performance in the context of SMEs.

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