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The Influence of Entrepreneurial Social Capital on the Innovation Performance of Biomedical Enterprises: Based on Dynamic Capabilities

ZHANG Qian

Doctor of Management

Supervisors:
PhD Renato Lopes da Costa, Assistant Professor,
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Southern Medical University

December, 2024

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iscte INSTITUTO UNIVERSITÁRIO DE LISBOA	**The Influence of Entrepreneur' social capital on the Innovation Performance of Biomedical Enterprises: Based on Dynamic Capabilities**	ZHANG Qian

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Abstract

Against the backdrop of the innovation performance of biopharmaceutical enterprises in China, this study aims to explore the relationship among entrepreneurs' social capital, corporate dynamic capabilities, and corporate innovation performance.

Grounded in the theories of social capital and dynamic capabilities, this study constructs a hypothetical model using bibliometrics and the Delphi expert consultation method. Adopting a longitudinal research design, this study selects 216 biopharmaceutical enterprises listed on the main board and GEM board of China's A-share market for panel data analysis based on their operational data from 2018 to 2022 (a total of 1,080 rows of observations), hoping to better reflect the causal relationship between variables under the time effect. A panel model is constructed using Stata to conduct mediation effect and path analysis on the data.

The findings reveal that entrepreneurs' social capital significantly enhances both corporate dynamic capabilities and innovation performance; dynamic capabilities play a critical role in the innovation process, significantly improving innovation performance and mediating the relationship between entrepreneurs' social capital and corporate innovation performance.

This study innovatively employs panel data for a longitudinal analysis, expands the theoretical understanding of social capital and dynamic capabilities, and uncovers their impact mechanisms on innovation performance. Additionally, through a multi-level analysis, it further deepens the resource-based view, emphasizes the central role of entrepreneurs in innovation, and provides insights for both business management practices and academic research.

Keywords: Biopharmaceutical enterprises, Social capital, Dynamic capabilities, Innovation performance

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Resumo

Com base no desempenho inovador das empresas biofarmacêuticas na China, este estudo visa explorar a relação entre o capital social dos empreendedores, as capacidades dinâmicas corporativas e o desempenho da inovação empresarial.

Fundamentado nas teorias do capital social e das capacidades dinâmicas, este estudo constrói um modelo hipotético utilizando bibliometria e o método de consulta a especialistas Delphi. Adotando um desenho de pesquisa longitudinal, a pesquisa seleciona 216 empresas biofarmacêuticas listadas na estrutura principal e estrutura GEM do mercado de ações A-share da China para análise de dados em painel, considerando os dados operacionais de 2018 a 2022 (totalizando 1,080 observações), procurando refletir sobre a relação causal entre as variáveis ao longo do tempo. Um modelo em painel é construído recorrendo ao Stata para conduzir os efeitos de mediação e "path analysis" dos dados.

Os resultados indicam que o capital social dos empreendedores melhora significativamente tanto as capacidades dinâmicas corporativas quanto o desempenho da inovação; as capacidades dinâmicas desempenham um papel essencial no processo de inovação, melhorando significativamente o desempenho da inovação e mediando a relação entre o capital social dos empreendedores e o desempenho da inovação corporativa.

Este estudo utiliza dados em painel para uma análise longitudinal, ampliando a compreensão teórica sobre capital social e capacidades dinâmicas, e revela os seus mecanismos de impacto no desempenho da inovação. Além disso, através de uma análise multinível, aprofunda a perspetiva baseada em recursos, enfatiza o papel central dos empreendedores na inovação, e providencia contributos tanto para a gestão empresarial quanto para o estado da arte em termos académicos..

Palavras-chave: Indústria biofarmacêutica, Capital social, Capacidades dinâmicas, Desempenho em inovação

JEL: O32, L26

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摘 要

在中国生物医药企业创新绩效不佳的背景下，本研究旨在探讨企业家社会资本、企业动态能力、企业创新绩效之间的关系。

本研究基于社会资本和动态能力理论，采用文献计量学、德尔菲专家法，构建了假设模型。采用纵向研究设计，选取中国 A 股主板和创业板 216 家生物医药上市企业 2018—2022 年经营数据（共 1080 行观察值）进行面板数据分析，以更好地反映时间效应下变量间因果关系，运用 Stata 软件构建了面板模型，并对数据进行了中介效应和路径模型分析。

研究结果表明，企业家社会资本对企业动态能力、企业创新绩效均具有显著促进作用，动态能力在企业创新过程中起到关键作用，能显著提升企业创新绩效，并在企业家社会资本与企业创新绩效之间起到中介作用。

本研究贡献在于采用面板数据进行纵向研究，拓展了企业家社会资本和动态能力理论，揭示其对创新绩效的作用机理，并通过多层次分析深化资源基础观，强调企业家在创新中的核心地位，为企业管理实践和理论研究提供参考。

□□□□生物医药企业，社会资本，动态能力，创新绩效

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Acknowledgements

Time flies, and in the blink of an eye, I have entered the fifth year of my doctoral research, a journey filled with immense growth and valuable experiences. From the initial feelings of confusion, helplessness, and despair, to gradually finding clarity through extensive reading, learning theories and research methods, accumulating knowledge, reflecting deeply, and achieving moments of epiphany—I have steadily defined my research direction, narrowed down my focus, identified variables, constructed theoretical models and hypotheses, mastered research techniques, resolved challenges, and ultimately completed my research and dissertation.

I extend my heartfelt gratitude to my supervisor, Professor Renato Lopes da Costa, for his invaluable guidance and unwavering support throughout my research. Your encouragement has given me the courage to persist and continually motivated me to move forward. Even during times of health challenges, your dedication to mentoring and assisting me has been a source of warmth and strength. I am also deeply thankful to my Chinese supervisor, Professor Wang Dong, for providing research guidance amidst his busy administrative, academic, and teaching responsibilities. My sincere thanks also go to Professors Virginia and Nelson for their valuable advice and assistance, as well as to Ms. Jia Lanlan and the project office team for their translations and multifaceted support during my studies and research.

I am equally grateful to my peers and alumni—Dr. Huang Sanhao, Dr. Zhang Manli, Dr. Wu Zijian, Dr. Wang Yufei, and Dr. Chen Jianping—for their enthusiasm in offering suggestions, sharing experiences, and patiently addressing my inquiries. They have generously sacrificed their personal time to meet with me for discussions or communicate online, providing numerous insights and guidance for my research. Special thanks also go to my employer, Professor Wang Yuqiang from Xique Pharmaceutical, and colleagues including Professors Zhang Zaijun and Zhang Gaoxiao, Associate Professor Dilip, Zhang Menghan, Chen Jixiang, Li Na, and Gao Kun, for their steadfast support and assistance.

Finally, I am profoundly grateful to my family—my husband, son, and parents—for their unwavering support during my doctoral journey, as well as to my cousin, Professor Li Peng, for his encouragement and help.

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致 谢

时光飞逝，转眼已进入博士研究的第五年，收获良多。从当初迷惘困惑，无助绝望，到不断阅读文献，学习理论和研究方法，不断积累、思考、顿悟，逐步明确研究方向，进一步锁定研究领域，确定研究变量，构建研究理论模型和研究假设，解锁一项项研究技术和方法，解决一个个难点和问题，最终完成研究和论文。

非常感谢我的导师 Renato Los Costa 教授对于我的研究给予的指导和支持，您的鼓励给我勇气，不断激励我前行，尤其是在教授健康欠佳的情况下，仍然坚持给予我指导和帮助，让我感到温暖和力量。同时感谢我的中方导师王冬教授，在繁忙的行政、科研和教学工作中给予我研究指导。还要感谢 Virginia 教授和 Nelson 教授给予我的建议和帮助，翻译贾兰兰老师以及项目办的各位老师，在我学习和研究的过程中给予我的各种帮助和支持。

还要感谢我的同学黄三浩博士、张漫莉博士，校友吴子健博士、王宇飞博士和陈建平博士，他们热心地给予我建议，分享经验，不厌其烦地接受我的咨询和求助，牺牲自己的休息时间与我见面讨论或是线上交流，对我的研究给予非常多的建议和帮助。以及我的老板喜鹊医药的王玉强教授，同事张在军教授、张高小副教授、迪里普、张梦晗、陈继祥、李娜、高坤等对我的支持和帮助。

同时，非常感谢我的家人，我的先生、儿子以及父母对我的博士学习的支持，还有我的表哥李鹏教授给予我的鼓励和帮助。

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List of Acronyms

CFA	Confirmatory Factor Analysis
CIP	Corporate innovation performance
CSC	Commercial social capital
DC	Dynamic capabilities
ESC	Entrepreneur' social capital
GEM	Growth Enterprise Market
NPL	New products launched
ORC	Organization reconfiguring capability
OSC	Overseas social capital
OSC	Opportunity sensing capability
PSC	Political social capital
PSSC	Professional skill social capital
RAC	Resource allocation capability

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Chapter 1: Introduction

1.1 Research background

The 21st century is an era of rapid development in high-tech technology. The rapid development of information technology and the digital economy has fundamentally changed the paradigm of enterprise competition in the traditional industrial era. Technological innovation has become a key variable in national, social, and economic development. This phenomenon has received unprecedented attention in recent years. Under the background of the global economic downturn and China's economic transformation, the implementation of an innovation-driven development strategy has become the key to the high-quality development of China's economy and the transformation and upgrading of its economic structure. Thus, improving their capabilities to effectively acquire and utilize various resources to achieve innovation has become a key issue in business and theoretical circles.

1.1.1 Practical background

Innovation is an inexhaustible driving force for the prosperity and development of a nation, a perpetual theme in economic and social development, and an effective way to promote the development of technology-based enterprises in China (J. Q. Fang, 2020). China has been deeply implementing the innovation-driven strategy at all levels and has undertaken a series of reforms in the capital markets to fully leverage the capital market's role in enhancing the nation's key core technological innovation capabilities (X. Q. Lin & Zhao, 2021). Internationally, the U.S. government has formulated a series of laws and policies to promote technological innovation, such as the "United States Innovation and Competition Act" (M. J. Pan & Yang, 2023); similarly, the Israeli government has developed a range of policies and plans to promote technological innovation. The Israeli government establishes innovation management agencies, universities are responsible for breakthroughs in innovative technologies, and enterprises ensure the transformation of outcomes, forming an efficient technological innovation system (Dong et al., 2020).

Currently, enterprises have become the main force in national innovation. With the wave of economic globalization and intensifying market competition, maintaining a competitive

advantage has become crucial for the survival and development of enterprises in an increasingly severe market environment (H. J. Ma et al., 2023; J. Wang, 2021). Against the backdrop of complex international situations and China's economic transformation, whether enterprises can obtain an advantageous position over competitors in the changing market often becomes the key for entrepreneurs to lead their companies toward strategic goals.

The innovation activities of an enterprise are undertaken by employees at all levels, with top management as the core talent being the main driver of management innovation (Yu et al., 2020). In the practice of corporate innovation, the social capital of entrepreneurs affects the choice between exploratory and exploitative innovation strategies. The cultivation of corporate innovation capabilities depends on the knowledge, ideas, and other resources obtained by entrepreneurs through social networks, enabling them to actively influence corporate innovation performance (Daspit & Long, 2014).

As the concept of social capital gradually moves from sociology to management, the entrepreneur is redefined as an embedded role. In the current context of rapidly changing external market environment and increasingly diversified consumer demands, entrepreneurs not only need to perceive and identify external opportunities through keen cognitive abilities, but also need to integrate the efficient information and high-quality resources obtained from embedded social networks, so as to transform these opportunities into innovative results of the enterprise (Baron & Markman, 2003). The breadth and depth of social networks, as well as the availability and quality of resources in the network, directly determine the scope and efficiency of resources that entrepreneurs can call upon in their innovation activities (Kemper et al., 2011).

Today, in the rapidly changing external environment of artificial intelligence and digital technology, corporate innovation activities have transcended static technological capabilities or mere product imitation, moving towards mastering one or several innovative fields and fully utilizing the dynamic resources of innovation networks. In fierce market competition, in addition to valuing the social capital of entrepreneurs, how they effectively apply their opportunity perception, resource integration, and organizational restructuring to corporate innovation to adapt to the rapidly changing market environment and enhance competitive advantages is crucial for enterprise development (Ai & Peng, 2021; J. Y. Wang et al., 2023). Dynamic capabilities, unlike general business capabilities, help enterprises acquire new resources, establish new core competencies, and assist in timely adjustments and updates of business directions (Teece & Pisano, 1994), profoundly impacting corporate innovation performance.

As people's standards of living continue to improve, so too do their demands for medical

health, with technological advancements greatly propelling the development of the pharmaceutical industry. The development of biopharmaceutical enterprises is inseparably linked to the nation, society, and individuals. Biopharmaceutical technology is an important area that will lead and support the future of China's technological innovation and development, and conducting research in this field can better promote the implementation of innovation-driven development and industrial transformation and upgrading (B. B. Cui, 2022).

In this context, Chinese biopharmaceutical enterprises must rely on innovation to address challenges stemming from global competition, technological advancements, and policy changes. Given the complexity and uncertainty of internal and external environments, internal resources alone are often insufficient to meet the demands of innovation. Entrepreneurs need to leverage their embedded social networks to access diverse external resources and capabilities, effectively integrating them with internal resources to enhance innovation performance.

However, while many studies have explored the relationship between social capital and innovation, research examining the impact of entrepreneurs' social capital from the perspective of dynamic capabilities remains relatively scarce. This study aims to fill this gap by investigating how entrepreneurs' social capital enhances the innovation performance of biopharmaceutical enterprises through the mediation of dynamic capabilities.

1.1.2 Theoretical background

In the context of the digital economy, where market changes and technology iterations are rapid, what enables companies to gain a competitive advantage and achieve success in business has always been a core question for management scholars. From Bain's analytical framework on organizational structure, behavior, and performance, to Porter and other scholars' attempts to explain differences in industrial competitive structures from an industrial perspective that influence a company's competitive position, to Barney's resource-based view, Prahalad's core competencies perspective, and Teece's dynamic capabilities view, all these are valuable explorations addressing this question.

(1) Related theoretical research has developed

The term "social capital" originated in 1916, proposed by Hanifan in his work on community studies and began to truly develop and be applied in theory and practice from the 1980s. The concept of "social capital" was first introduced by Hanifan in 1916 in the context of community studies. Since the 1980s, social capital theory has gradually evolved in academic and practical fields and has been widely applied. According to social capital theory (Putnam et

al., 1993), social capital refers to the social resources accumulated by individuals or organizations through trust, norms of cooperation, and network relationships. Entrepreneurs can leverage social capital to access opportunities for collaboration, information flow, financial support, and other resources, all of which facilitate innovation activities within enterprises. Structural hole theory further expanded the understanding of social capital, emphasizing that "gaps" in social network structures can provide firms with scarce resources necessary for innovation (Burt, 2000).

In the 1990s, China introduced new concepts of social capital theory. Building on existing research, scholars in related fields combined traditional entrepreneurial culture with contemporary social capital concepts, forming the notion of Entrepreneur' social capital. However, there is currently no final consensus on this concept, and further research is needed.

Corporate innovation levels can be explained through innovation performance, which mainly refers to the outcomes and benefits achieved by companies in their innovation activities. It is a long-term standard that fully demonstrates a company's capability to improve the importance, usefulness, and performance of its products and services (Hong et al., 2019). The research on corporate innovation performance has progressed amidst debates. Most scholars, both domestic and international, use innovation performance to measure the impact of a series of company activities on overall corporate performance (Yuan et al., 2024), reflect the company's competitive advantage in the market (D. F. Hu et al., 2021), and use it as an indicator to assess a company's potential for future development (K. Chang et al., 2024).

In the context of economic transformation, traditional theories such as the resource-based view are no longer effective in explaining how companies can achieve competitive advantages in dynamic environments. In 1997, Teece and other researchers introduced the concept of dynamic capabilities, defined as the process by which companies integrate, build, and reconfigure internal and external resources and capabilities to adapt to changing external environments. The dynamic capabilities theory provides a new logical explanation for this, hence attracting significant attention from scholars.

(2) The mechanism of entrepreneurs' social capital in corporate innovation performance lacks clear theoretical explanation

Since the 1980s, the concept of social capital has gradually become more defined, with theories becoming increasingly mature. It is widely defined as the resources individuals or groups acquire through social relationship networks (L. Zhou et al., 2020). Many scholars have explored the relationship between social capital and innovation, with most studies indicating that social capital significantly influences innovation, primarily by obtaining external

advantageous resources through social networks (Vu et al., 2023). Research has demonstrated that entrepreneurs' social capital serves as an essential pathway for acquiring societal resources, with social networks facilitating the acquisition of information and resources that drive technological innovation in firms (Fang, 2020). Numerous researchers have investigated the relationship between social capital and corporate innovation across various dimensions and industries. For instance, from the "network + resource" perspective, studies have shown that social capital positively influences the technological innovation of small and medium-sized technology enterprises (Fang, 2020). Other research explored vertical, horizontal, and social relationship networks, revealing significant effects on the performance of 100 emerging tertiary sector firms across seven industries (L. Y. Ma, 2010). Further studies examined entrepreneurs' professional skills, political connections, Business social capital, and overseas social capital (Chu et al., 2019; Qin et al., 2021). For example, professional skill capital was found to enhance the innovation performance of cultural and creative enterprises, while political and Business social capital showed no significant impact on innovation performance (Chu et al., 2019).

On one hand, the quantity and quality of social capital indicate whether a firm possesses a stronger foundation for achieving innovation, particularly through the social networks established or participated in by entrepreneurs. The personal characteristics of entrepreneurs (including senior executives) and their social capital (Lenart-Gansiniec, 2016), as well as relational social capital and entrepreneurship (S. L. Wang & Liu, 2016), can directly or indirectly promote corporate innovation. On the other hand, differences in the social networks embedded by entrepreneurs may lead to cognitive limitations, potentially influencing firm decision-making negatively and adversely impacting innovation in specific contexts (Adler & Kwon, 2002). Thus, while entrepreneurs' social capital can affect a firm's innovative capabilities, merely possessing resources does not guarantee innovation. The key lies in whether a firm has the ability to perceive, acquire, and transform internal and external resources, as well as to integrate them. This ability enables the firm to filter, allocate, and reorganize the associated social capital (Chu et al., 2019).

(3) The Mechanism of Dynamic Capabilities in the Relationship Between Entrepreneurs' Social Capital and Corporate Innovation Performance Remains Unclear

From the perspective of the relationship between social capital, dynamic capabilities, and innovation, dynamic capabilities, defined as a firm’s ability to recognize and integrate resources, have been widely acknowledged by scholars. Dynamic capabilities not only enhance a firm's ability to acquire and reconfigure external resources effectively but also drive the realization of innovation (Alarcón, 2014). Scholars have pointed out that dynamic capabilities are critical for

updating social networks and utilizing resources, thereby promoting innovation through resource acquisition and renewal from social networks (Smart et al., 2007).

However, existing research also suggests that the relationship between social capital and corporate innovation may not always be entirely positive. Greater quantity and higher quality of social capital enable firms to acquire the external information, knowledge, and other resources necessary for innovation. This external flow of information enhances a firm's internal cognitive and integrative capabilities, facilitating innovation (Dhanaraj et al., 2004). The relationship between corporate social networks and innovation performance can take an inverted U-shape. While enhancing absorptive capacity can positively influence innovation performance through diversified network technologies, excessive diversification may hinder innovation (S. H. Yu, 2013).

Some scholars have delved into the pathways through which entrepreneurs' social capital impacts corporate innovation performance, identifying mediating factors such as opportunity recognition, resource integration, and organizational restructuring. These mediating effects can be deeply conceptualized through the lens of dynamic capabilities, offering a valuable perspective for explaining such mechanisms (Ai & Peng, 2021; C. Peng et al., 2022; L. Yang et al., 2020). Studies on manufacturing firms have shown that listed companies leverage dynamic capabilities for learning, integrating, and restructuring internal and external resources, thereby acquiring and mastering external technologies to achieve competitive advantages (Ai & Peng, 2021). Research using dynamic capabilities as a bridge has yielded more valuable insights, demonstrating that improvements in dynamic capabilities can alter a firm's overall strategic or commercial level (C. Peng et al., 2022). Scholars widely recognize that dynamic capabilities are a vital force in promoting corporate growth, determining the dynamic variability of growth, and maintaining and renewing core competitive advantages (Chiappetta, 2018; Y. Qiu et al., 2022; Teece, 2018).

At present, existing research has not fully explained the mechanism through which entrepreneurs' embedded social networks and the social capital they acquire enhance dynamic capabilities to improve corporate innovation performance. Organizational integrative capabilities have been shown to promote innovation performance by increasing the efficiency of organizational transformation and value creation. Additionally, resource integration capabilities are positively correlated with corporate innovation performance (Pang et al., 2015). However, the process by which this occurs and the role of dynamic capabilities within this process remain inadequately explored.

Some scholars have suggested that external resources acquired through entrepreneurs'

embedded social networks can effectively compensate for a firm's internal resource deficiencies, increasing the supply of external complementary assets to enhance firm capabilities (Chesbrough & Rosenbloom, 2002). This mechanism helps firms address external environmental uncertainties through innovation. Nevertheless, whether corporate innovation performance can also be achieved through this mechanism requires further empirical investigation.

Moreover, there is limited research on listed biopharmaceutical firms, particularly concerning the relationship between entrepreneurs' social capital and innovation performance in this industry. Biopharmaceutical firms, as technology-intensive enterprises, rely heavily on innovation to achieve and maintain core competitive advantages.

This study focuses on Chinese A-share listed biopharmaceutical firms and employs empirical methods to deeply analyze the relational mechanisms among entrepreneurs' social capital, dynamic capabilities, and corporate innovation performance. By exploring how listed biopharmaceutical firms utilize entrepreneurs' social capital to enhance innovation performance, this research provides new perspectives and pathways for studying innovation in biopharmaceutical firms. It also offers significant theoretical support for the sustainable development of these firms.

1.2 Research problem and questions

1.2.1 Research problem

Entering the 21st century, China has experienced rapid economic growth, driven by the deepening of reform and opening-up policies. This economic transformation created opportunities for overseas Chinese scientists and technical talent to return, introducing new technologies and products. Over three decades of rapid economic development not only facilitated wealth accumulation but also fostered the rise of venture capital. Alongside these changes, reforms in China's regulatory framework and improvements in professional evaluation processes have positioned 2005 as a pivotal year for the development of China's biopharmaceutical industry, especially in the innovation of new drugs.

Despite significant growth and notable achievements in the past decade, Chinese biopharmaceutical enterprises still face limitations in their capacity for product innovation. These limitations fail to meet the country's substantial clinical demands. In particular, in the field of innovative drug research and development (R&D), the number of innovative drugs

approved annually in China remains significantly lower than in Western developed countries. Moreover, progress in innovative drug R&D is lagging. Currently, the majority of Chinese pharmaceutical companies' R&D outcomes are concentrated on generic drugs, with insufficient output of original innovative drugs. According to WHO statistics, over 50% of the new drugs launched globally in 2019 originated from the United States, while China contributed only 10%–12% of the global total. These challenges in new product R&D is the central issue that this study seeks to address.

Existing literature and practice suggest several potential reasons for the underperformance of Chinese biopharmaceutical enterprises in innovation: First, the rapid changes in external economic, policy, and market environments intensify the challenges faced by Chinese biopharmaceutical enterprises in keeping pace with global innovation. Second, limited or misallocated resources for innovation—such as inadequate R&D funding, shortages of skilled technical personnel, and constraints on international collaboration—hinder progress in developing original innovative drugs. Third, the lack of a comprehensive industrial ecosystem that integrates cognition, policy support, market readiness, and capital availability further constrain innovation performance.

1.2.2 Research questions

Main research question:

How does entrepreneur' social capital influence the dynamic capabilities and innovation performance of biopharmaceutical enterprises?

Sub-questions:

(1) What are the dimensions of entrepreneur' social capital, dynamic capabilities, and innovation performance in Chinese listed biopharmaceutical companies? How can these dimensions be effectively measured?

(2) How does entrepreneur' social capital affect innovation performance? How does Entrepreneur' social capital influence dynamic capabilities? What is the relationship between firm dynamic capabilities and corporate innovation performance?

(3) Does dynamic capability mediate the relationship between Entrepreneur' social capital and innovation performance? If so, to what extent does it act as a mediator?

(4) Do other control variables impact dynamic capabilities and corporate innovation performance?

(5) How to improve the innovation performance of biopharmaceutical enterprises?

1.3 Research objectives and significance

1.3.1 Research objectives

This study aims to explore the relationships among entrepreneurs' social capital, firm dynamic capabilities, and corporate innovation performance by combining theoretical analysis with empirical research. Specifically, from a cognitive perspective and based on the theory of heterogeneous resources, dynamic capabilities are categorized into three dimensions: opportunity sensing, resource integration, and organizational restructuring.

The study delves into how the four dimensions of entrepreneurs' social capital—professional skills, Political social capital, commercial capital, and overseas social capital—impact the three dimensions of dynamic capabilities. Furthermore, it investigates how each dimension of dynamic capabilities influences corporate innovation performance and analyzes how the different dimensions of entrepreneurs' social capital affect the three dimensions of corporate innovation performance.

By thoroughly uncovering the mechanism of the "entrepreneurs' social capital—dynamic capabilities—corporate innovation performance" relationship, this study seeks to enrich existing research from both theoretical and empirical perspectives. It aims to unveil the "black box" of the relationship among these three constructs.

Additionally, this research will contribute to corporate practices by providing insights into how firms can better acquire and allocate entrepreneurs' social capital as a resource. By effectively enhancing dynamic capabilities, firms can address the complexities of market environments in the context of the digital economy and maintain their competitive advantage through innovation.

1.3.2 Research significance

This study examines the impact of entrepreneurs' social capital on corporate innovation performance, focusing on biopharmaceutical companies listed on the Main Board and Growth Enterprise Market (GEM) of China's A-share market, against the backdrop of the complex and dynamic market environment in the digital economy. The significance of this study can be evaluated from both theoretical and practical perspectives.

(1) Theoretical significance

By introducing the mediating mechanism of dynamic capabilities, this research deepens and expands the theories of social capital, dynamic capabilities, and corporate innovation

performance from a new perspective.

First, this study enhances research on social capital. Drawing from existing literature, this study defines entrepreneurs' social capital as the relationships entrepreneurs establish with others through leveraging their skills, knowledge, and social networks to assist their businesses (Lu et al., 2022; Stypińska et al., 2019; G. H. Xie et al., 2021). While prior research, both domestic and international, often categorizes social capital into relational, structural, and cognitive dimensions, studies within the Chinese context have predominantly focused on the relational dimension. Research specifically addressing the impact of entrepreneurs' professional skill-based, political, commercial, and especially overseas social capital on corporate innovation performance remains limited.

This study builds on the classic three-dimensional framework of social capital while integrating the unique characteristics of biopharmaceutical firms as the research context. By employing empirical analysis, it investigates the relationship between the innovation performance of Chinese A-share listed biopharmaceutical firms and entrepreneurs' social capital. This contributes to a deeper understanding of the value and efficacy of entrepreneurs' social capital. The study clarifies how entrepreneurs embedded in social networks influence resource acquisition in terms of quantity and quality through the four dimensions of professional skills, political, commercial, and overseas social capital, as well as how these dimensions affect corporate innovation performance. This enhances and enriches the theoretical framework of entrepreneurs' social capital.

This study addresses these gaps by separately examining the relationships between different dimensions of entrepreneurs' social capital and various dimensions of corporate innovation performance. Additionally, it incorporates dynamic capabilities as a mediating variable, providing a novel theoretical perspective to explain the inconsistencies in prior findings. This approach not only fills gaps in the existing literature but also offers a more comprehensive understanding of the mechanisms underlying the relationship between social capital and innovation.

Second, this study divides firms' dynamic capabilities into three dimensions—opportunity recognition, resource integration, and organizational restructuring—from the perspective of managerial cognition. Drawing on existing research methodologies, these dimensions are measured, highlighting that cognitive differences can lead to variations in dynamic capabilities across firms. Most studies on the dimensions of dynamic capabilities emphasize their behavioral and functional aspects, such as adaptability to the environment, environmental insight, value chain configuration and integration, and resource allocation and integration.

However, they often overlook the impact of firms' cognitive processes on their competitive performance. Moreover, existing literature does not adequately identify the antecedent variables influencing the effectiveness of dynamic capabilities. Since the impact of dynamic capabilities on corporate innovation performance requires the accumulation of diverse resources, particularly heterogeneous ones, this study introduces entrepreneurs' social capital as an explanatory variable to address these gaps.

Third, this research enriches and extends the evaluation framework for corporate innovation performance. Current studies on corporate innovation performance primarily use patent counts as an indicator of a firm's innovation capacity, leading to a narrow evaluation scope. Previous studies have used new product launch speed as a mediating variable to examine its impact on firm performance, demonstrating a significant positive effect (Kong et al., 2013). Other research evaluates corporate innovation performance using new product counts (F. Cui & Song, 2022). Given the research focus on biopharmaceutical firms, where new products predominantly include drugs and medical devices, most listed biopharmaceutical firms consider the acquisition of clinical trial approvals as a pivotal point of capitalization (L. J. Liu, 2022). Accordingly, this study incorporates the number of production licenses obtained for drugs or medical devices into the innovation performance evaluation framework, further enriching corporate innovation theories by reflecting firms' innovation capabilities.

Finally, this research employs secondary panel data to empirically analyze the specific pathways and contingent factors through which entrepreneurs' social capital influences the innovation performance of listed biopharmaceutical firms in China's A-share market. A review of existing literature reveals that current studies primarily focus on the direct relationship between entrepreneurs' social capital and corporate innovation performance, such as the significant influence of social capital on innovation performance (Chu et al., 2019). However, there is limited research on internal organizational factors, such as how mediating effects contribute to this relationship (Geng et al., 2013; C. Peng et al., 2022), especially concerning biopharmaceutical firms.

Building on this, the study incorporates dynamic capabilities as a mediating variable to deeply analyze whether such an effect exists between entrepreneurs' social capital and innovation performance in listed biopharmaceutical firms. Furthermore, it examines whether dynamic capabilities mediate this relationship, thereby enriching the research framework on the interplay between dynamic capabilities and corporate innovation performance.

(2) Practical significance

This study considers entrepreneurs' social capital as a vital resource for firms and explores

its relationship with corporate innovation performance, revealing how entrepreneurs' social capital influences the innovation outcomes of biopharmaceutical firms. As knowledge-intensive enterprises, biopharmaceutical listed companies rely heavily on senior leadership as key talent and primary drivers of management innovation (C. P. Yu et al., 2020). By examining the impact of entrepreneurs' social capital on the innovation performance of biopharmaceutical firms listed on China's A-share Main Board and Growth Enterprise Market (GEM), this research elucidates the value and efficacy of entrepreneurs' social capital, providing empirical support for innovation management in biopharmaceutical firms. The findings offer strategic recommendations for the sustainable growth of biopharmaceutical firms and serve as an empirical reference for the long-term development of China's pharmaceutical industry.

By investigating the relationship between entrepreneurs' social capital and innovation performance through the mediating effect of dynamic capabilities, this study provides practical guidance for innovation strategy management in biopharmaceutical firms. Successful innovation involves multiple factors; in addition to cultivating and building entrepreneurs' social capital, firms must also consider the internal and external factors that influence innovation performance (Obianuju, 2022). This research, from the perspective of internal and external social capital of entrepreneurs, leverages the mediating role of dynamic capabilities to explore the specific pathways and influencing factors of how entrepreneurs' social capital impacts innovation performance. This helps improve firms' innovation capacity and capability, providing guidance for biopharmaceutical firms in navigating external turbulence and change.

The constructed model of entrepreneurs' social capital—dynamic capabilities—corporate innovation performance offers insights for biopharmaceutical firms to effectively acquire internal and external resources and enhance their independent innovation capabilities. In the highly innovation-driven biopharmaceutical sector, mastering core technologies is critical to securing the initiative for development (B. Cui, 2022). By conducting an in-depth analysis of the interconnections and mechanisms among entrepreneurs' social capital, dynamic capabilities, and innovation performance, this study provides valuable insights for biopharmaceutical firms to strengthen resource integration, optimize resource allocation, enhance innovation capabilities, and gain core competitive advantages. These findings are highly instructive for the innovative development of biopharmaceutical firms in China.

In summary, this study focuses on biopharmaceutical firms listed on China's A-share Main Board and GEM, investigating how these firms acquire and utilize innovation resources derived from entrepreneurs' social capital to enhance innovation performance. It not only offers managerial recommendations and practical strategies for biopharmaceutical firms but also

provides critical guidance for the innovative development of the biopharmaceutical industry.

1.4 Research methods

This study systematically reviews and critically evaluates existing literature to identify research gaps. Based on conceptual definitions and theoretical analysis, it proposes a theoretical model and research hypotheses. Using insights from prior studies, the study categorizes variables into dimensions and defines corresponding measurement indicators. Panel data are collected and test hypotheses empirically. The results are thoroughly discussed, and recommendations are provided to guide firms in enhancing innovation performance.

The specific research methods are as follows:

First, literature review. Once the research topic was established, this study systematically searched literature databases such as CNKI, Web of Science, and Scopus to collect, review, and organize extensive domestic and international research related to Entrepreneur' social capital, dynamic capabilities, and innovation performance. Through the systematic collation of these studies, the research progress on these variables was comprehensively reviewed, focusing on their definitions, structures, dimensions, and measurement methods. Additionally, the study thoroughly examined existing literature on the integrated relationship between Entrepreneur' social capital, enterprise dynamic capabilities, and innovation performance. This process clarified the concepts and dimensional frameworks of the three core constructs, analyzed the progress and limitations of previous studies, and identified future research directions.

Second, given that prior research on the variables in this study—Entrepreneur' social capital, enterprise dynamic capabilities, and innovation performance—originates from various disciplinary perspectives, differences in variable definitions have often led to divergent research outcomes. To address this issue, this study systematically defined the key variables based on a thorough literature review and prior to conducting empirical research.

These definitions were integrated with existing research findings to theoretically derive a framework describing the relationships among Entrepreneur' social capital, dynamic capabilities, and innovation performance. The framework served as the basis for developing the research hypotheses.

Upon completing empirical testing, the study engaged in a detailed discussion using existing research to further validate the theoretical mechanisms underpinning the hypotheses and their practical implications. Finally, actionable insights and recommendations were provided to inform enterprise management practices.

Third, quantitative empirical study. This study draws on the work of domestic and international scholars to develop its research model and hypotheses. Panel data were collected from databases such as Guotaian, focusing on A-share Main Board and Growth Enterprises Market (GEM)-listed companies in China. Using SPSS 23.0 for statistical analysis, the study conducted reliability and validity testing, factor analysis, correlation analysis, regression analysis, and model test.

1.5 Research innovations

This study demonstrates innovation in the following four key aspects:

The study delves into the essence of Entrepreneur' social capital and analyzes its multidimensional impact on the innovation performance of listed biopharmaceutical enterprises. Drawing from existing literature and acknowledging that biopharmaceutical firms are knowledge-intensive industries, the study categorizes Entrepreneur' social capital into four dimensions: professional skills, political, commercial, and international social capital.

This approach enriches entrepreneurial capital theory and resource-based theory. Given the limited research on the influence of Entrepreneur' social capital on the innovation performance of biopharmaceutical enterprises listed on China's Main Board and Growth Enterprises Market (GEM), this study addresses gaps in the existing literature and enhances the theoretical framework.

Prior studies on dynamic capabilities lack consensus regarding dimensional classification, often resulting in overlapping frameworks. This study refines the dimensions of dynamic capabilities to align with the characteristics of biopharmaceutical firms, following a logical evolutionary sequence: learning and absorbing, integrating internal and external resources, and innovating.

The study reclassifies dynamic capabilities into three dimensions: opportunity sensing, resource integration, and organizational restructuring. This clear and concise framework aligns with the unique attributes of biopharmaceutical enterprises and enhances the literature on dynamic capabilities.

Existing research often measures innovation performance in knowledge-intensive industries using patent counts, which is overly simplistic. This study proposes a novel framework for measuring innovation performance, tailored to the characteristics and business scope of biopharmaceutical enterprises.

The measurement framework includes three dimensions: the number of granted patents, the

number of approved clinical trial applications, and the number of newly launched products. This comprehensive approach captures the entire innovation lifecycle of biopharmaceutical firms, from preclinical research to clinical development and commercialization.

Importantly, this study is the first to introduce the number of approved clinical trial applications as an indicator, enriching the metrics for evaluating innovation performance in biopharmaceutical enterprises.

1.6 Thesis structure

This study investigates the relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance using biopharmaceutical companies listed on China's A-share Main Board and Growth Enterprise Market (GEM) as the research sample. First, the theoretical concepts of entrepreneurs' social capital, enterprise dynamic capabilities, and innovation performance are reviewed and summarized through literature analysis. Combined with the characteristics of the research sample, the dimensions of these constructs are defined. Second, based on the theoretical review, a research framework and hypotheses are proposed. Panel data required for the study are collected from the CSMAR database according to the defined dimensions. Third, correlation analysis, and regression analysis are performed on the panel data to validate the proposed hypotheses. Last, the results are analyzed and discussed in depth, and conclusions are summarized. The study identifies its limitations and provides directions for future research.

Chapter 1: Introduction. This chapter introduces the practical background and theoretical foundation of the study. It examines the challenges of maintaining competitive advantages in corporate management practices and identifies gaps in existing theoretical research. The objectives and significance of the study are clarified. Additionally, this chapter provides preliminary definitions of key terms, explains the research methodology and technical approach, and outlines the potential innovations of the study.

Chapter 2: Related Theories and Literature Review. This chapter uses bibliometric methods to explore the theoretical foundation and systematically review related studies by domestic and international scholars. It provides an overview of research on entrepreneurs' social capital, enterprise dynamic capabilities, and innovation performance, offering a basis for the development of the study’s theoretical model and hypotheses. It also identifies progress and limitations in existing research, providing insights for this study.

Chapter 3: Theoretical Model and Research Hypotheses. Based on existing literature, this

chapter integrates theories of social capital, dynamic capabilities, and innovation theory to define key concepts comprehensively and categorize research dimensions. Through systematic logical reasoning, a conceptual model is proposed. The study employs Delphi expert consultation method to validate and refine the theoretical model and hypotheses. The relevant measurements are supplemented and improved to form a measurement indicator system.

Chapter 4: Research Design and Methods. This chapter provides an in-depth exploration of the theoretical framework discussed earlier. It first identifies the specific research objects for this study and, in conjunction with a substantial body of existing literature, determines the data collection methods. Additionally, it outlines the procedures for data collection, organization, cleaning, and analysis employed in this research. The study utilizes web scraping techniques to gather relevant data, calculates the weights of various indicators using the coefficient of variation method, and conducts an initial analysis of the significance differences in the data through variance testing. Furthermore, correlation analysis is applied to explore the underlying relationships between variables, and panel data models are employed to examine the dynamic impacts of time and individual differences.

Chapter 5: Empirical Test. This chapter provides a statistical description of the sample and employs Stata 15 software to test the model type using the Hausman test. Fixed Effects Model (FEM) and Random Effects Model (REM) are applied for regression analysis of the research model, examining the relationship between entrepreneurial social capital and firm innovation performance, as well as the mediating effect of dynamic capabilities. In addition, this study introduces mediation models and path models to further explore the complex causal relationships among the variables.

Chapter 6: Discussion, Conclusion, and Outlook. This chapter provides a detailed discussion based on the regression results. It focuses on exploring the specific mechanisms and processes through which the two core dimensions of dynamic capabilities influence the relationship between entrepreneurial social capital and firm innovation performance. Additionally, the chapter summarizes the conclusions drawn from the previous empirical research and in-depth analysis, highlighting the implications of these findings for both business management practices and theoretical advancements. The discussion also addresses how biomedical companies can achieve innovation performance. Finally, the chapter outlines the contributions and innovations of this study, discusses its limitations, and proposes directions for future research.

Chapter 2: Literature Review

2.1 Bibliometric research

2.1.1 Data collection

For the collection of data, the Elsevier Scopus database was utilized, which is currently the largest abstract and citation database globally. The search was conducted using keywords related to Entrepreneur' social capital, dynamic capabilities, and innovation performance.

The search parameters were as follows:

Paper title, abstract, keywords = ("social capital" or "entrepreneurial capital" or "Entrepreneur' social capital" or "social network" or "entrepreneurial network" or "innovation capability" or "dynamic capability" or "innovation performance" or "dynamic performance") and ("entrepreneur" or "business owner" or "business leader" or "entrepreneurial firm" or "startup" or "business innovator") and ("organization" or "enterprise" or "corporation" or "company")

Timeframe: 1945-2024.

In this research, keywords such as "Entrepreneur' social capital," "dynamic capabilities," and "innovation performance" were used in the Elsevier Scopus database. The quality of the retrieved literature was assessed according to the 27 items of the PRISMA statement checklist. Out of 2825 initially retrieved documents, after excluding conference abstracts, editorial material, errata, unpublished papers, book chapters, retracted and conference papers, a total of 2812 documents were included for evaluation (see Figure 2.1).

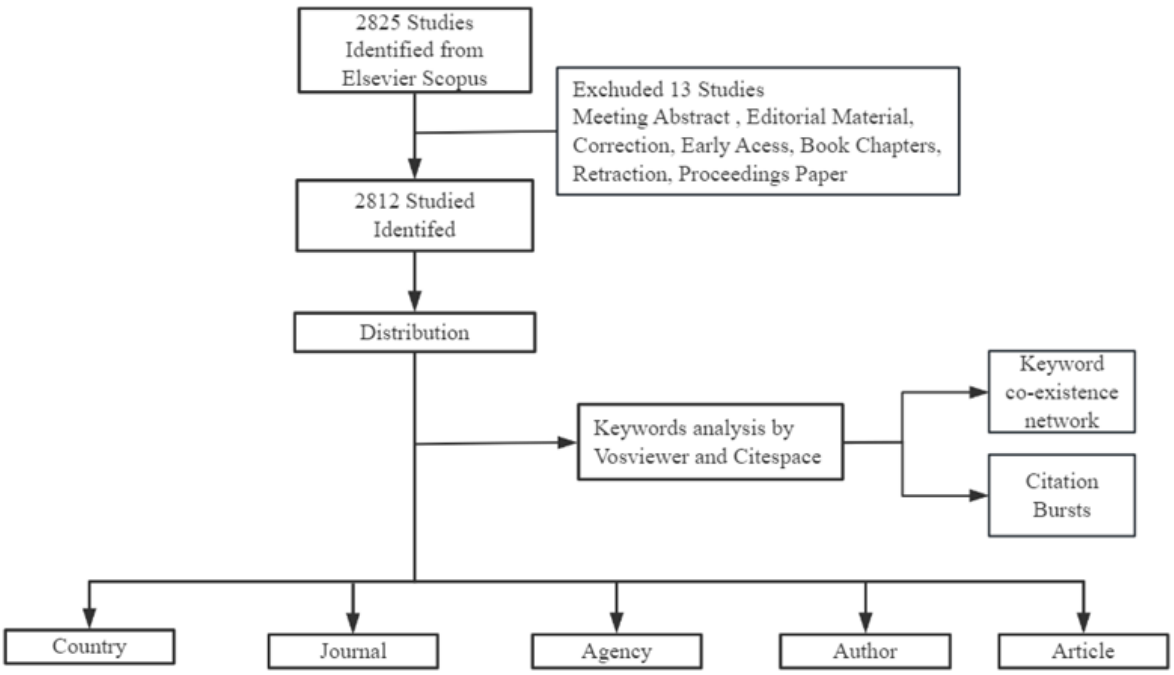

Figure 2.1 Screening process

According to the PRISMA statement checklist scoring criteria, each item fully reported scores 1 point, partially reported scores 0.5 points, and not reported scores 0 points, with a total possible score of 27 points (Y. Gao et al., 2021). The distribution of scores in the research reports is as follows:

Scores ≤15 points: Indicate that the research report has relatively serious information flaws.

Scores between 15-21 points: Indicate that the research report has certain deficiencies.

Scores between 21-27 points: Indicate that the research report is relatively complete.

These metrics and evaluation standards provide a comprehensive overview of the robustness and completeness of the studies included in this research, allowing for a more structured and systematic review of the existing literature in the fields of Entrepreneur' social capital, dynamic capabilities, and innovation performance.

(1) Annual publication volume

Figure 2.2 illustrates the annual volume of publications that study the relationship between Entrepreneur' social capital, dynamic capabilities, and innovation performance. The publication volume has generally increased year over year, with temporary declines observed in 2012, 2014, and 2016, and a decrease in 2024 (note: data collection for 2024 is not yet complete). Overall, this trend indicates a growing academic interest in these topics, suggesting a rising awareness and emphasis on these themes over time.

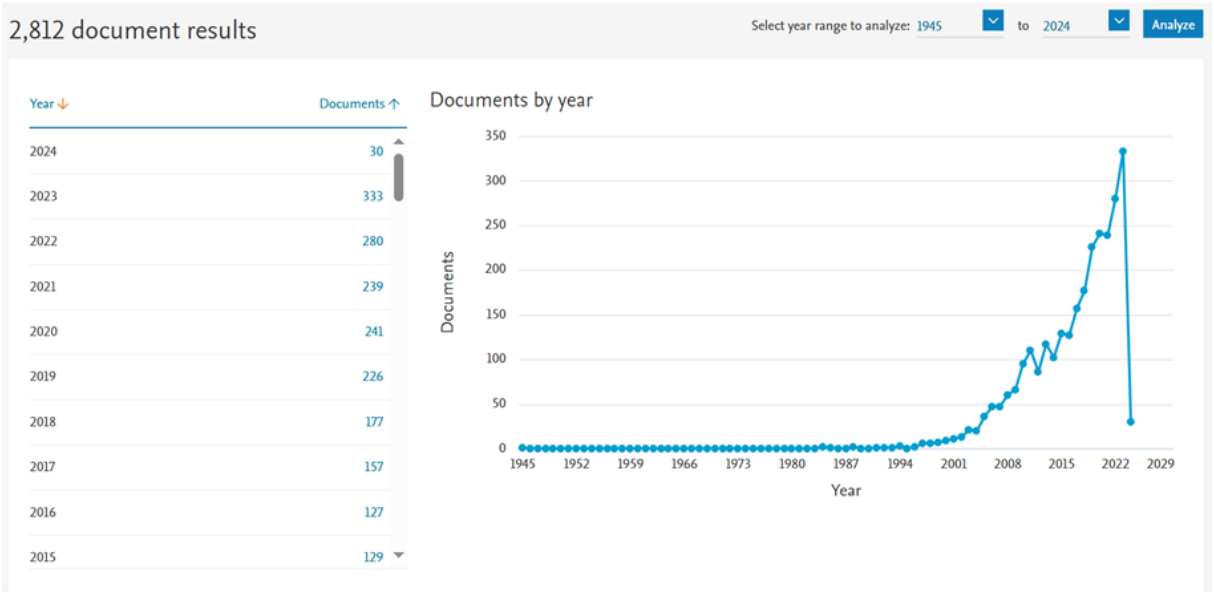

Figure 2.2 Overall publications per year

(2) Main sources of publications

Figure 2.3 indicates that the journal "Sustainability Switzerland" is the leading source of publications on these topics, suggesting a concentration of articles in the environmental science domain. The significant number of articles published in "Sustainability Switzerland" may indicate the journal's high reputation and influence in the areas of Entrepreneur' social capital, dynamic capabilities, and innovation performance. It also implies that this journal may be one of the key academic journals in the field, with a high preference for publishing related research. This may also reflect the journal's specialization and academic contributions to these topics.

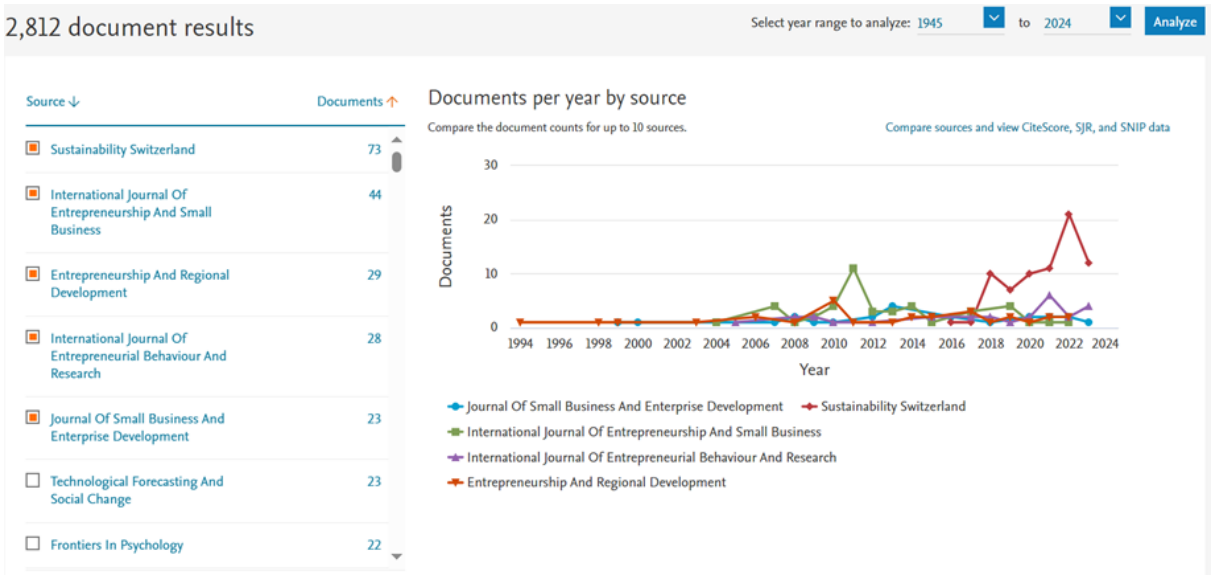

Figure 2.3 The main source of publication

(3) Publication volume by academic discipline

As shown in Figure 2.4, of the 2812 papers retrieved, 34.9% originated from the fields of

business, management, and accounting, which is approximately twice the volume of papers from the social sciences (16.5%). This distribution indicates that a significant portion of the research on the relationship between Entrepreneur' social capital, dynamic capabilities, and innovation performance originates from the fields of business, management, and accounting. This suggests that these topics receive broad attention and emphasis within these fields. It also highlights the importance and contributions of these disciplines to research on Entrepreneur' social capital, dynamic capabilities, and innovation performance. Conversely, the relatively lower volume of publications from the social sciences suggests a need for more interdisciplinary collaboration and research to enrich the knowledge and exploration in related areas.

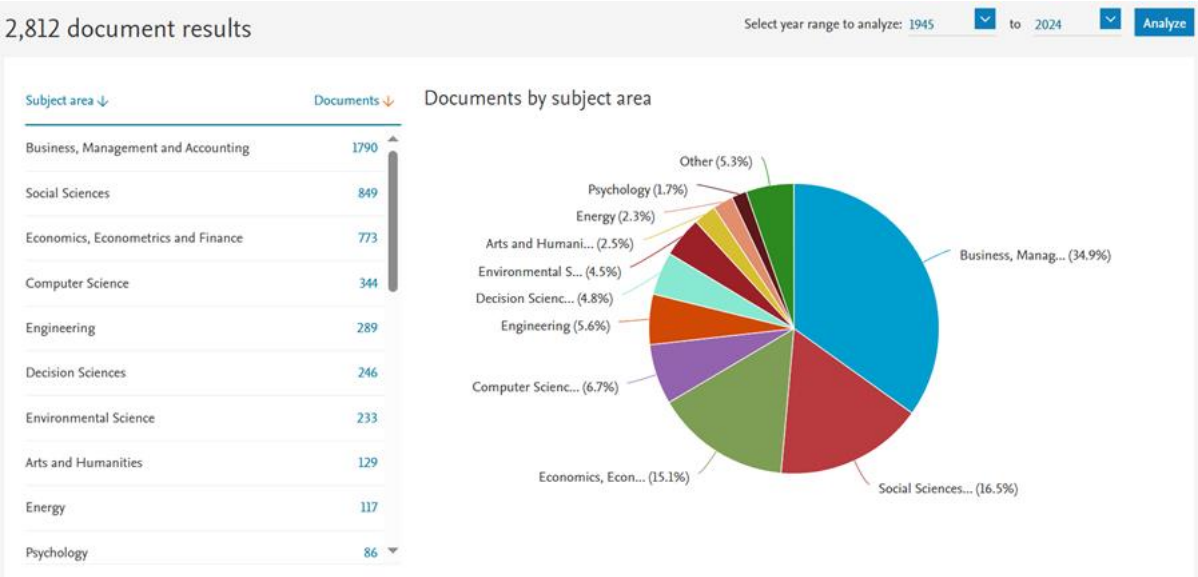

Figure 2.4 Total number of publications by subject area

(4) Geographic distribution of publications

As shown in Figure 2.5, the majority of these publications are predominantly from the United States, United Kingdom, China, and Spain, with the United States leading in publication volume. This indicates that the U.S. holds a leading position in research and publication on Entrepreneur' social capital, dynamic capabilities, and innovation performance. The high volume of publications from the U.S. suggests active research activities and significant academic output, with considerable international influence. The considerable volume of publications from the UK, China, and Spain also indicates these countries' influence and importance in this research field.

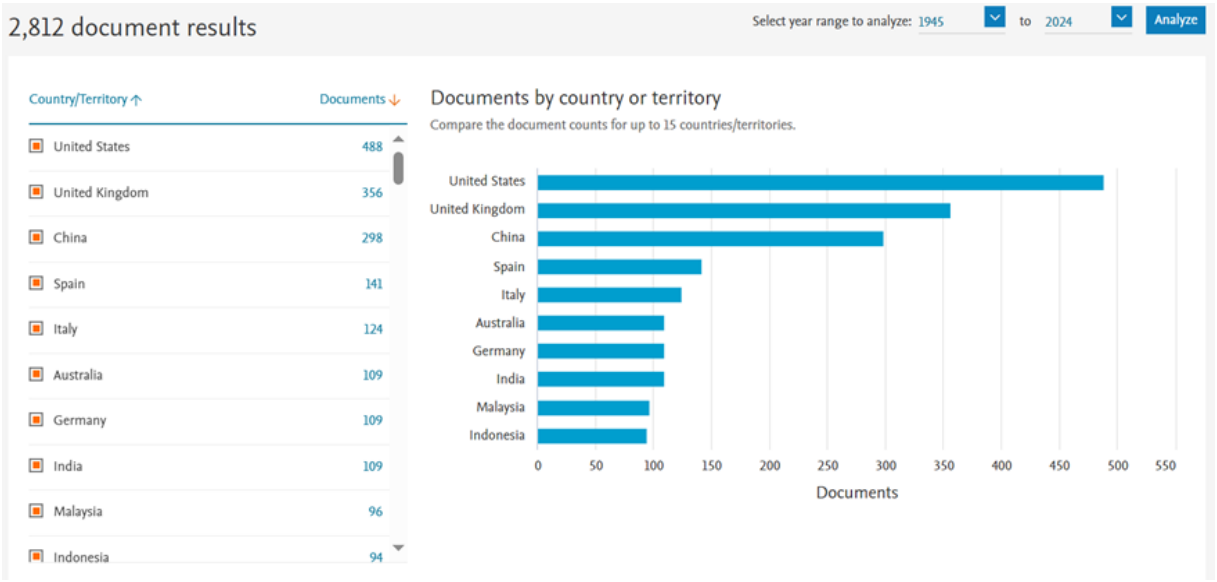

Figure 2.5 Geographical distribution

(5) Types of publications in the field

As illustrated in Figure 2.6, 73.5% of the published articles are data-based Articles. This indicates a reliance on empirical data, case analysis, and practical experiences among researchers to support their findings and hypotheses. This preference underscores the importance placed on empirical validation and analysis within the fields of Entrepreneur' social capital, dynamic capabilities, and innovation performance. Hence, data-based articles hold a significant position in the research of these areas, providing solid evidence and detailed examinations of theories and practices.

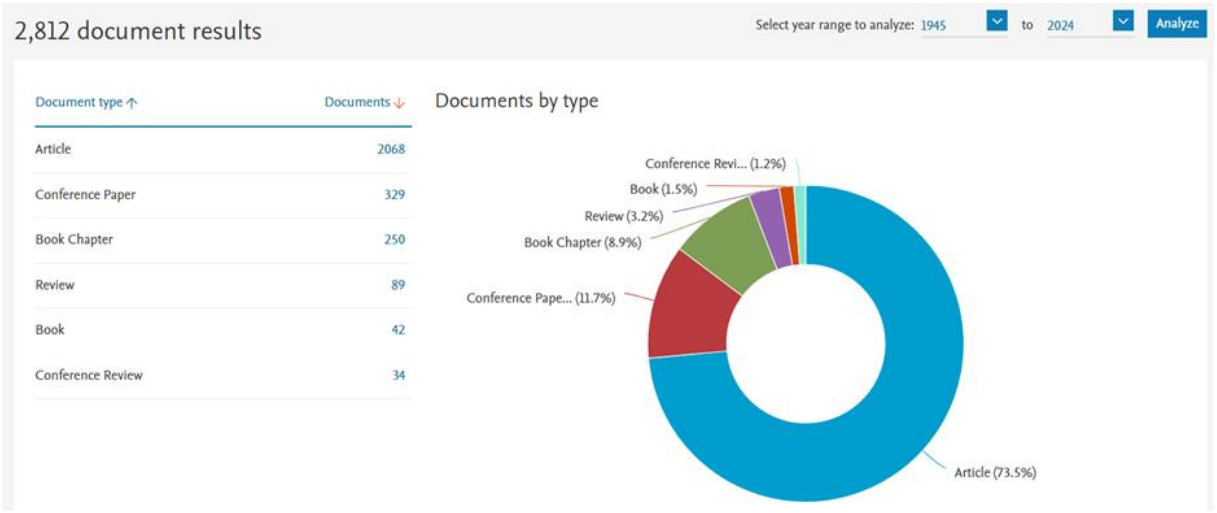

Figure 2.6 Types of publications

(6) Key concepts, structures, and research outcomes in the field

The analysis begins with exporting the 2812 identified articles from the Elsevier Scopus search into a CSV format. Using VOSviewer for a keyword co-occurrence analysis, a network visualization of popular keywords is generated, categorizing them into different groups as

shown in Figure 2.7. This visualization demonstrates the frequency and relationship of keywords within the entire database of 8766 keywords.

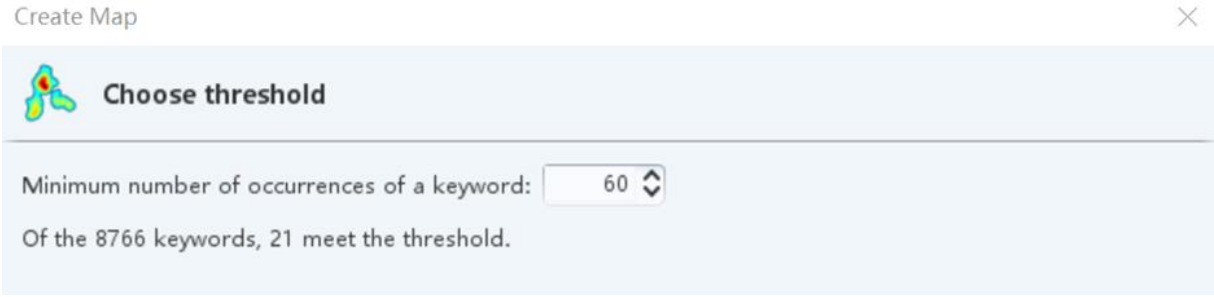

Figure 2.7 Keyword selection

Figure 2.8 illustrates the distance between keywords in a bibliometric analysis, where proximity often suggests strong associations. This proximity implies that these keywords frequently co-occur in academic literature, suggesting tight interconnections within specific research topics or fields. Scholars tend to study and analyze these keywords collectively, which leads to frequent co-occurrences in multiple documents, indicating popular research directions or themes.

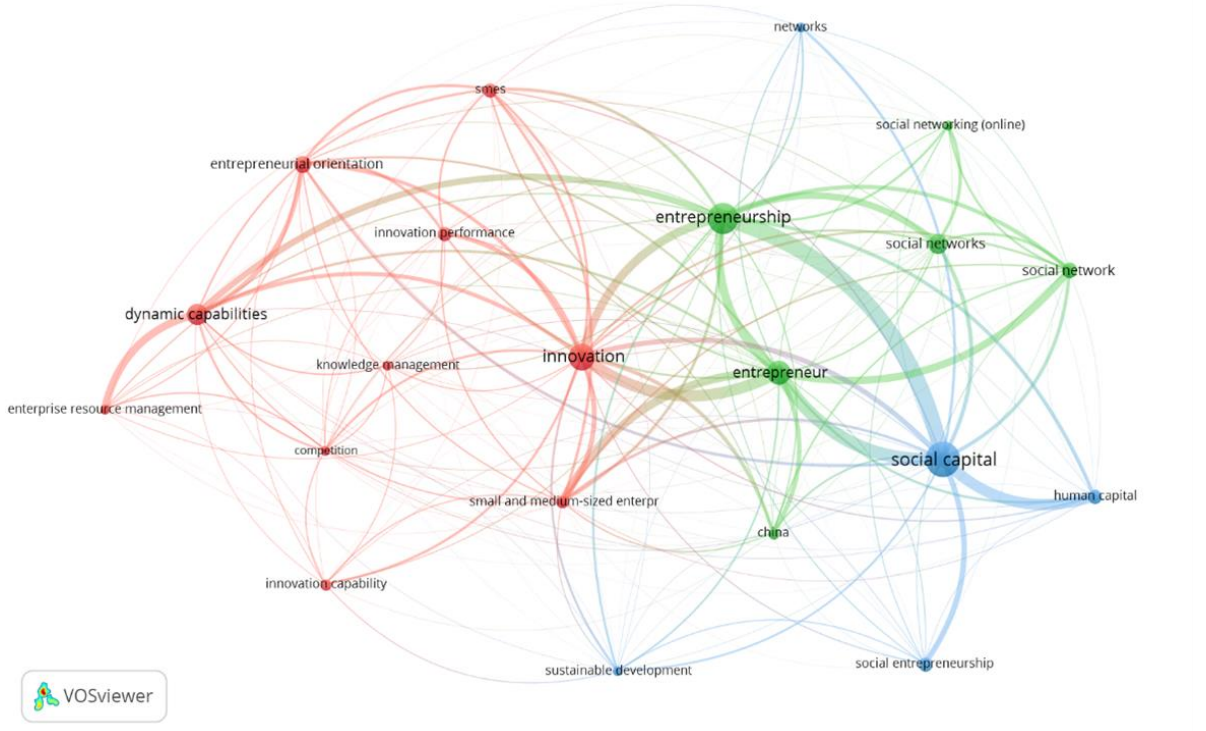

Figure 2.8 Network visualization of keywords and co-occurrences

After analyzing Figure 2.8, three main clusters are identified: Dynamic capabilities, innovation capability, and social capital, as listed in Table 2.1.

Table 2.1 Cluster analysis

Dynamic capabilities	
Competition, enterprise resource management, entrepreneurial orientation, innovation, innovation performance, knowledge management, small and medium-sized enterprise, SMES	
Innovation capability	Social capital
China, entrepreneur, social network, social networking (online), social networks, entrepreneurship	human capital, networks, social entrepreneurship

7) Data clustering analysis

To further understand the internal connections and significance of each research theme, a detailed analysis of each cluster is conducted. This process focuses on closely linked keywords, often indicating the hotspots and core issues of the research field. By quantitatively analyzing the co-occurrence frequency and the strength of associations between keywords, the top 21 influential papers are successfully identified (see Table A.1). These papers are not only highly aggregated in terms of keyword usage but also have a wide-reaching impact in the academic community.

The selected papers are included in the collection of highly cited papers due to their exceptional research quality and influence. Highly cited papers are those frequently referenced by other researchers within a specific field or over a certain period, typically representing the cutting edge and significant advancements within the field. These top 21 papers play a pivotal role within their clusters and hold an iconic status across the research landscape, profoundly influencing subsequent research activities. Through an in-depth analysis of these highly cited papers, a better understanding of current research trends is achieved, future research directions can be predicted, and valuable research materials and inspiration are provided for researchers.

1. Entrepreneur’ social capital cluster analysis

Using VOSviewer, a tool designed for visualizing scientific landscapes, has benefits for researchers analyzing literature data, identifying research trends, and pinpointing hot topics, employing VOSviewer for search and analysis facilitates a better understanding and mastery of the knowledge structure and dynamics within a research field, guiding researchers' work.

The final step involves visualizing the selected papers from Elsevier Scopus. During this process, certain terms were excluded to narrow down the scope of results for Entrepreneur’ social capital, dynamic capabilities, and innovation performance. Excluded terms include ambiguous and unrelated words such as "author", "role", "MCS", "degree", and "use". This enables clustering of other terms to understand their interrelations.

As shown in Figure 2.9, the analysis of Entrepreneur’ social capital can be segmented into four dimensions: professional skills capital, Political social capital, Business social capital, and

overseas social capital. Each dimension reflects different aspects of an entrepreneur's social resources and capabilities, and their combined analysis can help assess an entrepreneur's accumulation and application of social capital in multiple areas.

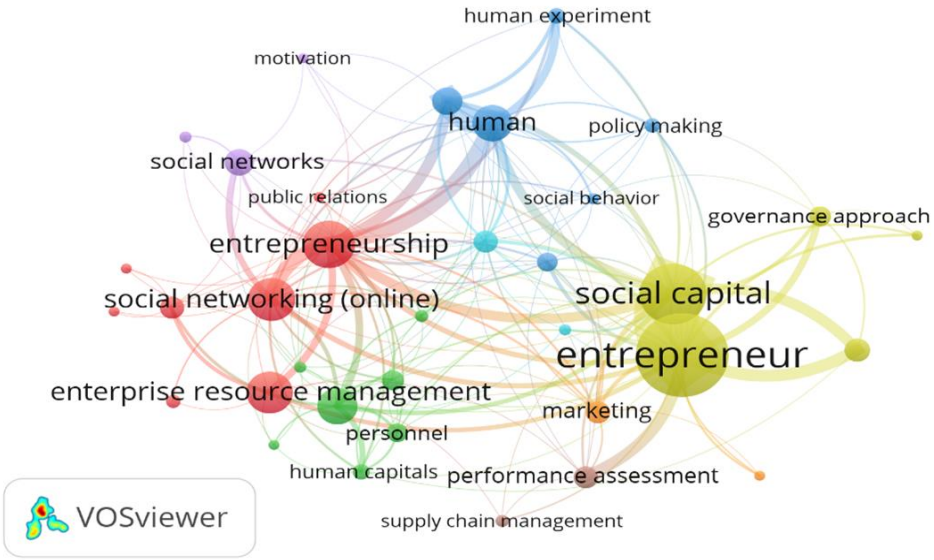

Figure 2.9 Cluster analysis of entrepreneurs' social capital

2. Cluster analysis of dynamic capabilities

As revealed by Figure 2.10, through systematic cluster analysis of the terminologies in the dynamic capabilities field, this study has categorized the main dimensions into three key areas: Opportunity Sensing, Resource Integration, and Organizational Reconfiguration. This finding significantly enhances the understanding of the components and deeper implications of the concept of dynamic capabilities.

Specifically, opportunity sensing capability refers to an organization's sensitivity and capability to recognize potential opportunities and threats in the external environment. This capability enables organizations to proactively capture market changes, technological advancements, or shifts in consumer demands, thereby allowing timely strategic adjustments and seizing development opportunities. Resource integration capability focuses on how organizations efficiently integrate and utilize their internal resources, including capital, human resources, and technology. This capability demands that organizations demonstrate high flexibility and innovativeness in resource allocation to maximize the efficiency of resource usage, thereby maintaining an advantage in a competitive market. Organizational reconfiguration capability refers to an organization's capability to make timely adjustments in structure and mechanisms in response to external environmental changes or internal development needs. This capability reflects the organization's flexibility and adaptability,

enabling it to swiftly reconfigure its operational models and management processes when facing significant challenges or transformations, ensuring continuous and stable development.

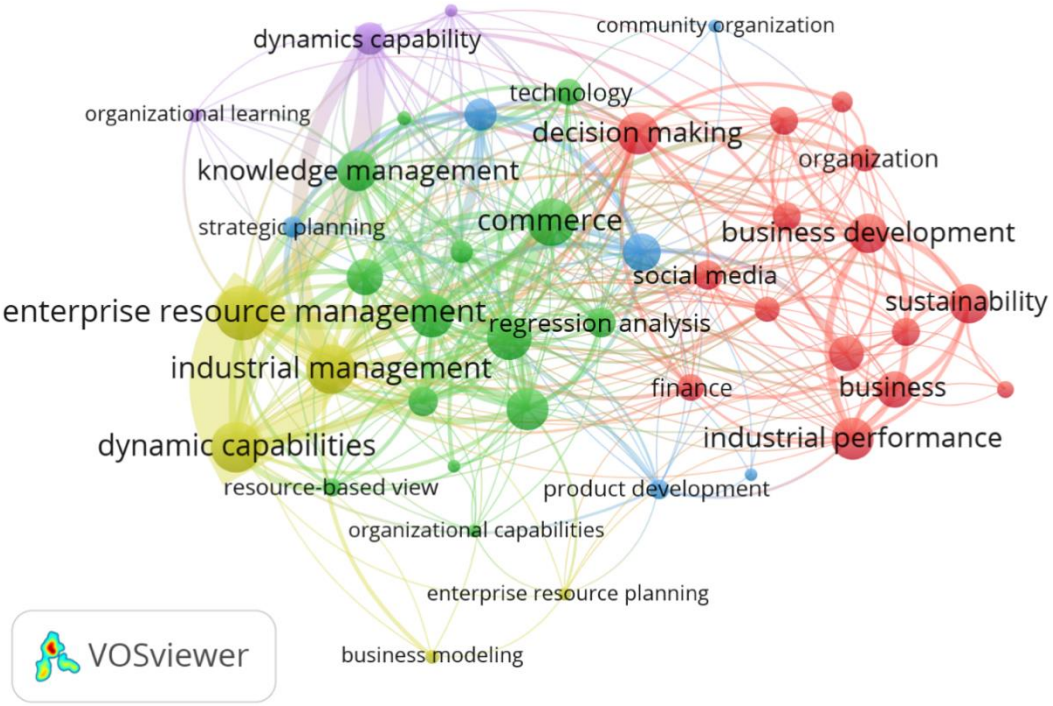

Figure 2.10 Clustering analysis of dynamic capabilities

Exploring these three dimensions not only aids in theoretical refinement but also provides guidance for practical application. Organizations can enhance their dynamic capabilities by focusing research and practice on these dimensions, enabling them to more effectively respond to changes and challenges in the external environment, enhance competitiveness, and maintain long-term vitality and adaptability. This comprehensive enhancement of capabilities is crucial for organizations' survival and development in an increasingly complex and volatile business environment.

3. Cluster analysis of corporate innovation performance

As demonstrated in Figure 2.11, a detailed cluster analysis of the terminologies related to corporate innovation performance identifies three key dimensions as core components: the number of patent applications, the number of authorized clinical trial approvals, and the number of new products launched. This analysis significantly deepens the understanding of the components of corporate innovation performance and its influencing factors.

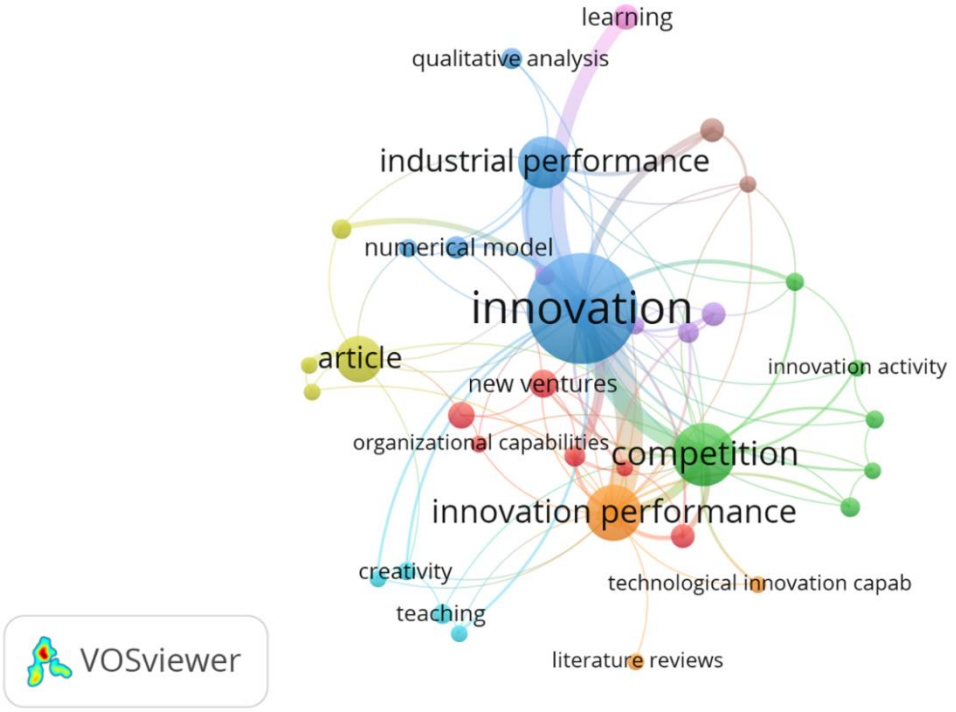

Figure 2.11 Cluster analysis of firms' innovation performance

First, number of patent applications is a crucial indicator of a company's innovation capacity and outcomes. It reflects not only the company's commitment and results in R&D investment but also its activity and leading position at the technological forefront. The number of patents directly represents the level of technological innovation and competitive strength and technological reserves within the industry. Second, number of authorized clinical trial approvals measures a company's R&D strength in the pharmaceutical field. In highly regulated industries like biopharmaceuticals, obtaining clinical trial approvals is a critical step for innovative drugs or treatments to move from the laboratory to the market. The count of these approvals not only represents the company's investment and progress in new drug development but also indicates potential future commercial success and market potential. Third, number of new product launches directly reflects a company's market impact and competitiveness. The successful launch of new products means that the company can translate innovation outcomes into actual market revenue. This is an indication of the company's technological innovation capabilities as well as its market strategy and business operation skills.

The in-depth study and analysis of these dimensions provide a comprehensive evaluation system for assessing corporate innovation performance. This not only helps companies understand their strengths and weaknesses in innovation but, more importantly, provides scientific and quantified references and guidance for formulating future innovation strategies.

Through these analyses, companies can optimize resource allocation, enhance R&D investments, improve the quality of patents, and accelerate the market introduction of new products. This strategic approach enables them to maintain a leading position in the fierce market competition and achieve sustainable development.

2.2 Literature review

This section systematically decodes and analyzes the key variables of Entrepreneur' social capital, enterprise dynamic capabilities, and innovation performance within bio-pharmaceutical companies listed on China's Main Board and GEM Board. This provides a solid foundation for constructing a theoretical framework aimed at revealing the intrinsic mechanisms by which Entrepreneur' social capital influences the dynamic capabilities and innovation performance of pharmaceutical companies.

2.2.1 Definition of the research subject

(1) Defining bio-pharmaceutical enterprises

Bio-pharmaceutical enterprises refer to companies engaged in the research, development, production, operation, and service of pharmaceutical products. This group includes pharmaceutical companies, pharmaceutical production enterprises, pharmaceutical trading companies, pharmaceutical logistics companies, Contract Research Organizations (CROs), and pharmaceutical sales companies. These enterprises play a key role in the pharmaceutical industry chain, from R&D to production, circulation, and sales, adhering strictly to regulations to ensure the quality and safety of pharmaceutical products.

China's A-Share Main Board and GEM listed bio-pharmaceutical companies

The A-Share Main Board, also known as the markets of the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE), is an integral part of China's capital market. It serves as a financing channel and trading venue for mature, large enterprises and is one of the primary ways investors participate in the Chinese stock market, characterized by high listing standards and regulatory requirements.

In contrast, the GEM Board, listed companies refer to those listed on the GEM market of the Shenzhen Stock Exchange. The GEM market supports innovative, growth-oriented small and medium-sized enterprises, focusing more on the growth potential and innovation capabilities of companies, typically characterized by high growth potential, strong technical innovation capabilities, and significant market potential. Overall, GEM pharmaceutical

companies refer to those SMEs listed on the GEM market that focus on the pharmaceutical industry, utilizing this platform to further drive their business development and industry innovation.

(2) Concept of the entrepreneur

The concept of the "entrepreneur" was first introduced by the French economist Richard Cantillon in his economic treatise "Essay on the Nature of Commerce in General." Since then, the term "entrepreneur" has gradually become a focal point in both theoretical and practical realms, with the theory of entrepreneurship being progressively developed and refined through long-term scholarly research and practical activities. Cantillon (1755) enriched the concept of the entrepreneur, attributing to them the role of a "bearer of uncertainty."

Smith (1776) in The Wealth of Nations noted that all the capital of a business comes from the entrepreneur, equating entrepreneurs with capitalists. However, he did not distinguish between investors in a business and those who make final decisions—the entrepreneurs. Marshall (1962) saw the entrepreneur not only as a producer of goods but also as the marketer, acting as a "middleman" between laborers and consumers. Knight (1921) defined entrepreneurs as adventurers and confident individuals. Penrose (1959) focused more on entrepreneurs' receptivity to innovation and change. Cooter (1982) argued that the basic condition for the formation of a company is that the cost of production factors is lower than the cost of market transactions, with entrepreneurs acting as substitutes for market price mechanisms, playing a role in keeping company costs below the market average. Drucker (1985) defined entrepreneurs as those engaged in market management and making judgmental decisions regarding the allocation of scarce resources for businesses.

In summary, entrepreneurs are primarily associated with roles related to managing and operating businesses, coordinating and allocating scarce resources, bearing management risks, and making strategic decisions in uncertain environments. Based on this understanding, for the purposes of this study, entrepreneurs are defined as individuals who can discern and seize business development opportunities, make accurate decisions, mobilize internal and external innovative resources, and possess a certain capacity to bear risks. They embody the functions of leaders, coordinators, and decision-makers, occupy a central position within the business, and are key figures in the enterprise. In this research, the term "entrepreneur" generally refers to high-level management personnel in biopharmaceutical companies, such as chairpersons, presidents, general managers, vice-chairpersons, vice-presidents, and deputy general managers.

(3) Social Capital

Social Capital is a broad term defined as the resources acquired by individuals and groups

through social relationships (Reyes et al., 2019). The term was first introduced by Hanifan in 1916 in his study of communities and has since evolved both theoretically and practically from the 1980s. French sociologist, Bourdieu (1980) was one of the first to systematically study social capital, viewing it as a collection of actual or potential resources accessible through group networks. While Bourdieu's pioneering work based on the social network perspective enriched the understanding of social capital, his focus was primarily on the reproduction and transformation of social capital, somewhat neglecting a clear definition of its essence and the impacts it generates.

American sociologist Coleman (1988) systematically elaborated on the concept, characteristics, and development process of social capital, defining it functionally not as a single entity but as a variety of entities with different forms. He argued that social capital, like other forms of capital, is productive but distinct in that it does not exist within the material production process but within the structures of interpersonal relationships. However, Coleman's (1988) research on social capital was criticized for its vague conceptual boundaries, confusion between cause and effect, and lack of attention to its negative impacts.

Following Coleman (1988), Burt (1992) defined social capital as the opportunity to use the financial and human capital of friends, colleagues, and more general contacts. Unlike Coleman, Burt interpreted social capital from a structuralist perspective, emphasizing that an individual's or collective's social network structure constitutes their social capital. Burt's theory introduced social network analysis into social capital studies, providing a robust framework for examining how social network structures influence the formation of social capital. However, Burt's focus on "structural holes" between individual actors created conditions for social capital formation but did not analyze the types of resources obtained or the types of social connections involved.

Putnam (1993) saw social capital as including networks, trust, and norms that facilitate coordination and cooperation for mutual benefit, thereby enhancing social efficiency. Arrow (2000) considered social capital as networks of social relationships that could affect individual actions and economic growth. Woolcock (1998) regarded social capital as norms of information, reciprocity, and trust existing within members of a social structure.

Bian and Qiu (2000) viewed social capital as a capability, the capability to acquire scarce resources through mutual interactions between individuals and society. Later, Chinese-American scholar N. Lin (2001) described social capital from the perspective of social network resources as investments in social relations with expected returns, noting that social capital is rooted in social institutions and interpersonal relationships.

In summary, social capital encompasses various elements including tolerance, trust, honesty,

unity, cooperation, and reciprocity, contributing to social and economic efficiency, reducing societal conflicts, and enhancing social harmony. These comprehensive definitions provide a nuanced understanding of social capital as a conceptual resource that is instrumental in bridging the gap between the theoretical exploration and practical application in diverse fields including economics, sociology, and business management.

(4) Entrepreneur' social capital

Entrepreneur' social capital is an emerging branch of social resource theory. Although many studies on social capital involve Entrepreneur' social capital or entrepreneurial social networks, few directly propose and deeply explore the concept of Entrepreneur' social capital. Batjargal and Lin (2004) view entrepreneur' social capital as a product embedded in local culture and traditions, comprising various institutions, networks, and partnerships. However, there is currently no final consensus on this concept, and scholars continue to debate the definition of social capital, leading to a diversity and ubiquity of the concept of Entrepreneur' social capital. Summarizing broadly, it can be divided into four representative perspectives: capabilities, resources, networks, and multi-perspective.

From the capability perspective, Hmieleski and Baron (2008) see entrepreneur' social capital as the entrepreneur's capability to access resources. W. J. Zhang and Chen (2009) describe it as the capability of entrepreneurs to mobilize internal and external resources. P. P. Yang et al. (2005). J. Lin (2018) argues that entrepreneurs can develop personal reputation and geosocial capital through personal capabilities, bringing various resources to the enterprise, representing the entrepreneur's capability to acquire resources. This perspective views Entrepreneur' social capital as a form of capability, where stronger personal abilities lead to richer social capital.

From the resource perspective, Leenders (1999) regards Entrepreneur' social capital as a special, scarce resource that can be used to achieve strategic business goals. Acquaah et al. (2007) define it as the resources obtained by corporate executives (e.g., chairpersons or general managers) through personal social networks with external entities (including government, community organizations, suppliers, customers, competitors, associations). Similar to this concept is H. Yu's (2005) definition, who considers Entrepreneur' social capital as an actual or potential resource collection embedded within an entrepreneur's existing stable social relationship network and social structure, based on trust, norms, and networks.

From the network perspective, Stam et al. (2014) define entrepreneur' social capital as the connections an entrepreneur has with external stakeholders (including government, community organizations, suppliers, customers, competitors, associations) or internal members of the

company. L. L. Li (1995), one of the earliest Chinese scholars to study Entrepreneur' social capital, believed that the most important social capital an entrepreneur has is their social relationship network. G. Wang et al. (2004) view the social network that entrepreneurs possess as bringing benefits or potential benefits to the business, representing the strength of the business's social reputation.

From the multi-perspective view, this perspective includes two or more of the above viewpoints. Baron and Markman (2003), for instance, from the perspectives of network and capability, view Entrepreneur' social capital as comprising the social networks, reputation, and social activity skills owned by the entrepreneur. Similarly, Chinese scholars C. M. Chen and Zhou (2001) believe that social networks based on reputation and norms are capabilities that enable entrepreneurs to mobilize various resources.

Overall, despite different perspectives on the definition of Entrepreneur' social capital, it is commonly believed to be a product of relationships between entrepreneurs and governments, associations, business partners, internal employees, and various institutions. It represents both internal and external organizational networks or relationship networks, as well as the personal support networks of the entrepreneur, based on trust and norms, essentially constituting a unique social resource. The comparison and summary are shown in Table 2.2.

Table 2.2 Concepts of social capital of entrepreneur

Researcher (year)	Concepts of social capital of entrepreneurs
X. Y. Shi (1998)	Entrepreneurs need to provide all kinds of resources necessary for the growth of enterprises, involving production management, political and legal affairs, as well as spiritual and cultural aspects. They play a crucial role as a link and hub between the enterprise and the external environment.
Bian and Qiu (2000)	Resources exist in the social network relationships established between social actors. However, individual social actors are only the carriers of resources and do not have the capability to use resources. These resources can be developed, accumulated and effectively used only when the whole social network works together.
X. H. Zhou (2002)	Social capital of entrepreneurs constitutes a network system with the individual at its core, which extends around them and covers aspects such as trust, expectations, and social reputation, in other words, it reflects the entrepreneur's capability to mobilize internal and external resources.
G. Wang et al. (2004)	Social capital of entrepreneurs is essentially a network of relationships, which involves the connections established between external and internal organizations of the business.
J. H. Sun and Chen (2009)	Whether an entrepreneur can successfully obtain all kinds of scarce resources depends mainly on two important conditions: the quality of the social network he integrates into, and the strength of his capability to activate and utilize the resources in the network.
W. J. Zhang and Chen (2009)	The resources raised by entrepreneurs through interpersonal networks, the so-called personal social capital, will eventually be converted into corporate social capital.

J. J. Wu and Dai (2013)	Entrepreneurs' social capital is essentially a series of internal and external relationship networks between specific groups, which provide various resources for the growth of enterprises, including creating innovation opportunities for entrepreneurs, providing information and services for enterprise management, and providing support in public opinion.
H. Wei and Chen (2014)	Social capital of entrepreneurs is embedded in his social network, which can be activated and utilized. These relations have a positive effect on the production and management activities of the enterprise.
L. Liu (2015)	Social capital of entrepreneurs refers to the social resources that entrepreneurs can obtain through their social network, which can bring benefits or potential benefits to enterprises.
Dias et al. (2022)	Entrepreneurs' social capital, through their extensive network connections, can facilitate the acquisition of critical information and knowledge. This information and knowledge, in turn, stimulate and enhance the firm's innovation activities.

In summary, the concept of social capital has not been uniformly defined across academic disciplines, but it typically revolves around four core aspects: resources, network relationships, capabilities, and trust norms. Thus, this thesis conceptualizes Entrepreneur' social capital from a "network + resources" perspective, defining it as the accumulation of resources and social connections through an entrepreneur's personal relationship network, including information, capital, partners, customers, and reputation. These resources are used to interact with and mobilize or access various resources within the network.

As for the dimensions of Entrepreneur' social capital, dividing Entrepreneur' social capital into different dimensions allows for a deeper understanding of an entrepreneur's advantages and characteristics in terms of social capital. Specifically, this can be analyzed through four dimensions: professional skills, political, business, and overseas social capital. These dimensions offer a comprehensive view of an entrepreneur's strengths and characteristics, providing robust support for business development. Additionally, these dimensions are not entirely independent but are interrelated and mutually influential.

(1) Professional skills social capital dimension

Daellenbach et al. (1999) studied the executive teams of 52 metallurgical and semiconductor companies, finding that companies with strong R&D innovation capabilities tend to have more team members with technical professional backgrounds. A higher proportion of executives with technical backgrounds can stimulate a company's R&D innovation. S. L. Yu and Wang (2014) used empirical analysis to study the impact of members with technical professional backgrounds on R&D investment in companies listed on China's GEM board from 2009 to 2011, showing a positive correlation between these factors.

However, some scholars argue that executives with general management skills may be more inclined to engage in R&D innovation. Custódio et al. (2013) found that executives with general management skills, due to their higher tolerance for failure and capability to apply their

management skills across different areas, often lead to more patents and invest more funds to stimulate innovation. They suggested that executive teams should have diverse professional backgrounds. His research indicated that teams with diverse work experiences or professional backgrounds bring different perspectives to problem analysis, which can lead to innovative solutions and support corporate transformation, upgrading, and R&D innovation.

Entrepreneurial Professional skills social capital encompasses not only professional identities, backgrounds, and experiences in universities or research institutes but also covers various aspects (Chu et al., 2019). Professional identity refers to certifications, qualifications, and achievements obtained in specific fields, which attest to an individual's expertise and knowledge base in those areas (J. Zhao et al., 2022). Professional background includes work experiences, project involvements, and innovative outcomes in specific fields, which not only enrich their knowledge but also provide valuable practical experience and resource accumulation for entrepreneurship (Drennan et al., 2007). Additionally, experiences in universities or research institutions bring in-depth academic research and comprehensive knowledge in specialized fields, giving entrepreneurs a competitive edge in innovation and development. The accumulation of these professional skills equips entrepreneurs to better respond to market changes, drive innovation, and achieve greater success in specific industries (C. Huang et al., 2022).

Entrepreneurs leverage their Professional skills social capital through technological innovation, interdisciplinary integration, industry insight, strategic collaboration, brand building, team training, intellectual property protection, and practicing social responsibility. They create new market opportunities and business models by using their professional knowledge to drive technological advancements, combining industry understanding with market trend predictions to innovate products and services, enhancing efficiency and customer experiences. Furthermore, by establishing collaborative relationships, strengthening brand image, enhancing team competitiveness, protecting intellectual property, and actively taking on social responsibilities, they not only boost their market competitiveness but also lay a solid foundation for the long-term development of their enterprises.

This process emphasizes utilizing professional advantages, keeping up with market dynamics, and daring to innovate to foster continuous business growth. This analysis divides an entrepreneur's professional skills into three dimensions—professional identity, professional background, and experience in academia or research institutes—reflecting their level of expertise and skills in specific areas. Analyzing Professional skills social capital in these three dimensions offers comprehensiveness, targeting, practicality, and guidance, allowing for a more

precise and scientific assessment of their contribution and potential value to business development.

(2) Dimension of Political social capital in entrepreneurship

The Political social capital of an entrepreneur refers to their relationships with government officials and institutions. These relationships can assist entrepreneurs in gaining government support and resources such as policy incentives, financial subsidies, and land use rights (Chu et al., 2019; Y. Wu, 2023). Current research on Political social capital primarily analyzes whether entrepreneurs have political connections, such as political affiliations or identities. Influenced by China's political environment and traditional culture, an entrepreneur's political connections can provide a favorable R&D innovation environment, such as broadening financing channels, fiscal resources, and increasing opportunities for innovative talent resources (Z. H. Li et al., 2017; R. Wang, 2017). Although many entrepreneurs do not hold positions in government departments, efforts to attain positions like People's Congress delegates or members of the Chinese People's Political Consultative Conference (CPPCC) can also accumulate relationship resources through government interactions, providing certain conveniences for their businesses (J. K. Liu & He, 2020).

An entrepreneur’s political appearance reflects their political beliefs and values, mainly indicating whether they are members of the Communist Party of China or other democratic parties. This dimension showcases the entrepreneur's political beliefs, values, and worldview. In China, Communist Party members typically have strong beliefs in communism and socialist values, which may influence their business management and decision-making. An entrepreneur's political identity is primarily defined by whether they are delegates of the People’s Congress or members of the CPPCC. This dimension reflects their status and influence within the political system. As important components of China's political structure, these delegates and members can participate in the discussion and decision-making of national and social affairs, make suggestions and proposals, and influence policy-making. An entrepreneur’s political appearance and identity together constitute their Political social capital. Political appearance determines their political beliefs and values, while political identity illustrates their position and influence within the political system. These two dimensions jointly affect the entrepreneur’s performance and role in the political realm.

The pharmaceutical industry is highly regulated, where government policies and regulations significantly impact business development. By studying the Political social capital of entrepreneurs, this study can analyze how Political social capital affects the performance of pharmaceutical companies in terms of policy-making, regulatory environments, and market

competition, as well as how companies use Political social capital to address industry challenges and opportunities. Understanding the Political social capital of entrepreneurs not only aids in making appropriate strategic decisions—companies can adjust their market positioning, resource allocation, and partner selection strategies based on the Political social capital of entrepreneurs to achieve development goals—but also helps us comprehend the interactions between the government and businesses. The government can adjust policy support and regulatory measures based on the Political social capital of entrepreneurs to promote business development and social progress.

In conclusion, dividing the Political social capital of entrepreneurs into the dimensions of political appearance and political identity helps us more comprehensively study pharmaceutical companies listed on China's A-share main board and GEM, providing important bases for corporate strategic decision-making and government policy formulation.

(3) Dimension of Business social capital in entrepreneurship

Entrepreneurial Business social capital refers to the wealth, skills, knowledge, and interpersonal resources accumulated by entrepreneurs in the business sphere. These resources can provide entrepreneurs with a competitive edge in the market, driving business development and growth (M. W. Peng & Luo, 2000). Business social capital includes the social networks established by entrepreneurs with others and various enterprises (Omar et al., 2022), the funding and investments they have acquired (X. Huang et al., 2023; Onginjo et al., 2021), intellectual property rights such as patents, trademarks, and copyrights they hold (Allem et al., 2019), and the brand recognition and reputation they have built (J. Wang et al., 2022).

When researching an entrepreneur's business social capital, dividing it into three horizontal dimensions—corporate management experience, experience in financial institutions, and roles in industry associations—allows for a more comprehensive and in-depth understanding of the commercial resources accumulated by entrepreneurs in different fields and their impact on business development. Corporate management experience reflects an entrepreneur's management capabilities and their deep understanding of business operations. Experience in other enterprises implies that the entrepreneur may possess diverse management skills, strategic planning abilities, and experience in handling complex business issues. Working in banks, securities companies, or investment funds provides entrepreneurs with insights into the mechanisms of financial markets and avenues for capital raising. Such experiences are crucial for the company's financing, investment decisions, and optimization of capital structure. Entrepreneurs can use these resources and knowledge to raise capital for the company, conduct effective capital operations, and reduce financial risks.

Entrepreneurs who have held positions in industry associations usually possess significant industry influence and extensive industry contacts. Industry associations serve as platforms for internal communication and cooperation within the industry, and through these roles, entrepreneurs can stay informed about industry trends and build industry networks. This experience helps entrepreneurs leverage their advantages in brand promotion, market expansion, and industry collaboration. It also enables them to influence industry policy-making and standard-setting, bringing potential business opportunities to the company.

By studying these three dimensions, a comprehensive assessment of an entrepreneur's business background and resources can be made, providing a multidimensional perspective for analyzing their business success and potential risks. This approach allows for an examination of the interrelationships and interactions between an entrepreneur's experiences in different fields and how these factors collectively influence business development. It can serve as a reference for other entrepreneurs, helping them understand how to enhance their Business social capital through diverse professional experiences, thereby increasing their company’s competitiveness and viability.

In the highly knowledge-intensive pharmaceutical industry, where managers' professional knowledge and experience are crucial, understanding an entrepreneur's corporate management experience, particularly whether they have held positions in other pharmaceutical companies, helps assess their management capabilities and industry understanding. This is vital for the operation and development of the business. The pharmaceutical industry requires substantial R&D investments and faces a strict regulatory environment. Therefore, an entrepreneur's experience in financial institutions can assist in fundraising, effective capital operations, and reducing financial risks. The highly competitive market of the pharmaceutical industry necessitates maintaining good relationships with governments, medical institutions, and industry associations. Understanding whether an entrepreneur has held positions in industry associations can evaluate their industry influence and networking, which is significant for market expansion and brand promotion.

(4) Dimension of overseas social capital

With the rapid development of China's economy and the gradual implementation of the talent-strong nation policy, an increasing number of overseas talents are entering domestic enterprises, playing a significant role in the management of Chinese businesses. Filatotchev et al. (2011) conducted research on the relationship between Chinese high-tech enterprises and returnee entrepreneurs. Their findings suggest that returnee entrepreneurs bring a knowledge spillover effect, not only fostering R&D innovation within their own companies but also

stimulating innovation awareness among other enterprises in the industry. R. Yuan and Wen (2018) found that senior managers with overseas backgrounds tend to possess superior risk mitigation capabilities due to their experiences studying and working abroad. Y. H. Ge and Shen (2011) argue that the skills and experience accumulated by senior managers in handling transnational affairs can bring cutting-edge market information and unique management practices to the company. Additionally, the diversity in managers' nationalities and linguistic backgrounds can play a complementary role, aiding teams in capturing risks and opportunities in the environment.

However, some scholars have different views. X. T. Zhang and Li (2017) studied the relationship between executive team characteristics and the performance of companies on China's Growth Enterprise Board and found that managers' overseas backgrounds did not significantly impact business performance. This may be because enterprises on the Growth Enterprise Board are typically rooted in Chinese local contexts, and executives with overseas backgrounds might experience a "maladaptation" when working in domestic enterprises.

The 2017 Report on the Condition of the Younger Generation of Chinese Family Enterprises indicates that the next generation of private enterprise successors generally possesses extensive international experience (X. Wang & Chen, 2022), which gives them an advantage in understanding more advanced international systems of social responsibility and their operational practices. This enables them to more effectively integrate these concepts and practices into the management of Chinese enterprises (Jiang & Lai, 2019). H. Li and Wu (2015) further refined the definition of social capital, specifically introducing the concept of "overseas social capital," referring to the social capital existing in the host countries of overseas markets. He pointed out that multinational corporations, when forming competitive advantages, need to rely not only on their resources but also on relationships established with customers, suppliers, investors, and government agencies in overseas markets.

Entrepreneurial overseas social capital facilitates easier market entry, expands sales channels, establishes stable customer relationships, and enhances product visibility and competitiveness in international markets (Ban et al., 2019). Furthermore, it promotes exchanges and cooperation with international advanced technologies, management expertise, and talents, improving the enterprise's technological innovation capabilities and management levels, and strengthening international competitiveness. In summary, entrepreneurial overseas social capital plays a crucial role and holds advantages in the globalization process, aiding enterprises in adapting better to international market environments, enhancing international competitiveness, and achieving sustainable development.

Discussing the overseas capital of entrepreneurs is particularly beneficial for understanding the A-share mainboard and GEM listed pharmaceutical companies in China. Firstly, overseas capital typically implies that entrepreneurs have extensive contacts and resources in international markets, which assists pharmaceutical companies in acquiring advanced technologies, knowledge, and talents. Secondly, the overseas activities of entrepreneurs reflect their insights into global industry trends, crucial for maintaining technological leadership and competitiveness in pharmaceutical enterprises. Additionally, investment decisions related to overseas capital indicate the strategic intent and risk management capabilities of entrepreneurs, essential for large pharmaceutical companies engaged in high-risk, high-investment R&D activities. Lastly, studying overseas capital helps reveal how entrepreneurs integrate international resources and promote transnational cooperation, which is significant for pharmaceutical enterprises to innovate and grow in the global market.

(5) Concept of dynamic capabilities

When Teece and Pisano (1994) first introduced the concept of dynamic capabilities in 1994, it was primarily to explain how enterprises maintain competitiveness in industries characterized by rapid technological changes. Subsequently, Teece et al. (1997) published a paper titled Dynamic Capabilities and Strategic Management, marking the formal establishment of the dynamic capabilities theory. This study described dynamic capabilities as the process through which enterprises integrate, build, and reconfigure internal and external resources and capabilities to adapt to continuously changing external environments. Since then, the introduction and development of the dynamic capabilities theory have provided a new perspective for strategic management. This thesis systematically reviews the theories related to firm dynamic capabilities from scholars both domestically and internationally, with details provided in Table 2.3.

Table 2.3 Concepts of firm dynamic capabilities

Categorization	Author	Concepts of Firm dynamic capabilities
Competency theory	Teece et al. (1997)	The capability to improve a company's operational capability through a series of processes such as integrating, structuring and reorganizing to better respond to changes in the environment
	Cavusgil et al. (2007)	Dynamic capability refers to an organization's ability to purposefully create, extend, or modify its resource base.
	D. Li and Liu (2014)	Enterprises sense opportunities and risks in the external environment, make instant decisions, implement strategic plans, and then develop potential systematic problem-solving capability.
Competency theory	Tan (2016)	Ability to quickly recognize and capture opportunities, to integrate existing information resources, and to protect its own alternative technologies and resources in order to

		adapt to changing external environments, with a view to gaining a first-mover advantage
Competency theory	D. D. Chen (2017)	An capability to complete organizational and management processes by reconfiguring and integrating corporate resources and capabilities through market perception, which is a higher-order capability.
Process theory	Vanpoucke et al. (2014)	The process by which firms respond to changes in the marketplace by utilizing their own resources
	T. L. Liu (2018)	The unique and customary process by which an enterprise identifies information about market opportunities and threats, integrates existing internal and external resources, and responds to changes in the environment.
Behavioral tendency theory	Wang and Ahmed (2007)	Behavioral tendencies that enterprises must have to integrate and reset their resources and capabilities in order to achieve lasting competitiveness in a rapidly changing environment.
The settlement mechanism theory	Lang (2015)	A potential problem-solving mechanism in an organization that adapts to changes in the environment by sensing opportunities and threats, making timely, market-oriented decisions, and transforming the organization's resources.
	Patrício et al. (2022)	By facilitating knowledge integration, learning capabilities, and resource reconfiguration, dynamic capabilities enable firms to adapt to changes in the external environment.

In the international academic arena, Teece et al. (1997) defined dynamic capabilities as the capacity to integrate, build, and reconfigure internal and external resources to increase operational efficiency and respond to environmental changes. C. L. Wang and Ahmed (2007) viewed dynamic capabilities as an organizational behavior tendency necessary for sustained competitiveness in rapidly changing market environments, involving the integration, resetting, renewal, and recreation of resources. Barreto (2010) described dynamic capabilities as an internal, latent mechanism that improves problem-solving by perceiving opportunities and threats, making timely market-oriented decisions, and making transformative adjustments to resources. Vanpoucke et al. (2014) suggested that dynamic capabilities depict how organizations optimally leverage existing resources to flexibly adapt to the market. D. Li and Liu (2014) asserted that dynamic capabilities are reflected in an organization's capacity to perceive external opportunities and risks, followed by rapid decision-making and strategic implementation, culminating in systemic problem-solving potential.

Domestically, Tan (2016) viewed dynamic capabilities as the capability to quickly seize opportunities, integrate informational resources, and protect the uniqueness of technology and resources, aimed at adapting to rapid environmental changes and securing a first-mover advantage. D. D. Chen (2017) considered dynamic capabilities as a higher-order capability that reconstructs and integrates enterprise resources and capabilities through market perception to

facilitate organizational and managerial processes. T. L. Liu (2018) interpreted it as a unique habitual process, involving the identification of market opportunities and threats, the integration of information, and responses to environmental changes.

Based on this, the study defines firm dynamic capabilities as the capability of an enterprise to identify internal and external potential opportunities and threats through opportunity perception capability, effectively combine internal and external resources using resource integration capability, and innovatively transform and timely adjust the enterprise's resources, operations, and organizational processes through organizational restructuring capability. This capability covers everything from new resource configurations to the evolution of operational practices, ensuring enterprises can seize opportunities, adapt to external environmental complexities, and ultimately achieve sustained competitive advantage. Dynamic capabilities are seen as the core element for enterprises to gain and maintain competitive advantages and include three complementary dimensions: opportunity perception, resource integration, and organizational restructuring (H. J. Xia, 2017).

The selection of measurement dimensions for dynamic capabilities varies based on scholars' research perspectives, resulting in a diversified classification. This study has compiled classifications of dynamic capabilities dimensions by scholars domestically and internationally, as presented in Table 2.4.

Table 2.4 Dimension of firm dynamic capabilities

Categorization	Author	Dimensional classification
Bi-dimensional	Teece et al. (1997)	Integration, Reconfiguration
	T. T. Gao (2015)	External coordination, Internal integration
Three-dimensional	Teece (2007)	Sensing opportunities, Seizing opportunities, Reconfiguring resources
	C. L. Wang and Ahmed (2007)	Adaptive capacity, Absorptive capacity, Innovative capacity
Three-dimensional	D. Li and Liu (2014)	Strategy-aware decision-making capability, Prompt resolution capability, Change implementation capability
	D. D. Chen (2017)	Environmental awareness, Resource reconfiguration, Resource integration
Five-dimensional	Cao et al. (2009)	Flexibility in mobilizing information, Coordinating with the external environment, Reorganizing internal resources, Acquiring resources, Releasing resources
	F. H. Zhang (2013)	Environmental insight capacity, Environmental responsiveness capacity, Organizational tolerance capacity,

Six-dimensional	Lang (2015)	Learning capacity, Innovation capacity Resilience capacity, Knowledge management capacity, Resource mobilization capacity, Learning and assimilation capacity, Environmental awareness capacity, Innovation capacity

In the international academic field, early studies by Teece et al. (1997) mainly focused on the core functions of integration and reconfiguration of dynamic capabilities. Building on this, Teece (2007) further refined the understanding of dynamic capabilities, specifying them as the abilities to sense market opportunities, seize business opportunities, and reconfigure enterprise resources. C. L. Wang and Ahmed (2007), based on their research findings, categorized dynamic capabilities into three main types: adaptability to change, absorption of new knowledge, and innovation capacity. D. Li and Liu (2014) expounded on dynamic capabilities from three dimensions: strategic sense-making, immediate decision-making, and transformative execution.

In domestic research, Cao et al. (2009) and others detailed the components of dynamic capabilities into five aspects, covering the abilities to flexibly mobilize information, coordinate external environments, reorganize internal resources, acquire new resources, and release surplus resources. F. H. Zhang (2013) discussed dynamic capabilities from four dimensions: environmental sensing capacity, adaptability to environmental changes, organizational tolerance, learning capacity, and innovation capacity. T. T. Gao (2015) focused on the capability to coordinate and integrate internal and external resources. Lang (2015) proposed six dimensions in the same year, including elastic management capacity, knowledge operation capacity, resource mobilization capacity, learning and absorption capacity, environmental identification capacity, and innovation capacity. D. D. Chen (2017) summarized dynamic capabilities into three main dimensions: environmental perception, resource reconfiguration, and resource integration.

Combining the research findings of scholars both domestically and internationally, it is evident that the theory of dynamic capabilities is widely recognized in the academic community. Although there is an emphasis on different dimensions of dynamic capabilities, there are common elements such as integration, reconfiguration, coordination, absorption, and perception. These elements together form a multidimensional framework of firm dynamic capabilities, interdependent and mutually reinforcing, helping enterprises maintain a competitive edge in the constantly changing market environment. To further explore this concept, this article, aligned with the research objectives, conducts a detailed study of dynamic capabilities, subdividing them into three key dimensions: opportunity sensing capability,

resource integration capability, and organizational restructuring capability, as detailed in Table 2.5.

Table 2.5 Dynamic capabilities dimension segmentation of enterprise

Dimension	Literature sources
Opportunity Perception Resource integration capacity Organizational reconfiguration capacity	Teece et al. (2014, 1997, 1994), Xin (2015), Long (2016), F. H. Zhang (2013)

Opportunity Sensing Capability:

Opportunity sensing capability refers to an enterprise's capacity to identify and discover market opportunities, constituting a vital component of a company's dynamic capabilities (Han et al., 2023). Enterprises can cultivate and enhance this capability by adopting the following methods: on one hand, businesses need to learn and master new knowledge to heighten sensitivity to market opportunities (Tarka, 2019). On the other hand, enterprises should encourage innovation, creating new products and services to identify and seize emerging market opportunities (Buil-Fabregà et al., 2017). The development of opportunity sensing capability means that enterprises need to continually search for relevant technologies and information to adapt to changes in the market environment. This includes discerning customer needs and technological possibilities, structural changes in the industry and market, and potential reactions from suppliers and stakeholders.

For listed pharmaceutical companies, which require capabilities in R&D, production, quality assurance, innovation, and enterprise management, there is a high demand for talented individuals. The talent within a company significantly impacts its sustained development, enhancing the perception of crucial opportunities and junctures. Academic qualifications to some extent reflect the capability of talent in terms of knowledge reserves (X. L. Wang & Li, 2015). Additionally, some studies have used the financial investment in R&D to reflect the degree of a company's knowledge and technological innovation, indicating the enterprise's capacity to perceive market needs (J. C. Zhang & Long, 2022).

The dimension of opportunity sensing capability in dynamic capabilities is reflected in an enterprise's sharp observation and profound understanding of the market environment. This includes quickly identifying and responding to changes in industry policies, advancements in technology, shifts in market demand, and competitor dynamics. Through this capability, companies can anticipate industry trends, identify innovative opportunities, and adjust their strategies accordingly to gain a competitive edge.

For enterprises listed on the main and startup boards of China's A-shares in the biopharmaceutical sector, they operate in a highly innovation-dependent and rapidly changing

industry. The strength of their opportunity sensing capability directly impacts their capacity to timely leverage policy benefits, capture new market demands, lead technological developments, and make swift strategic adjustments in response to industry changes. Thus, this capability enables them to stand out in fierce market competition and achieve sustainable development.

Resource Integration Capability:

To achieve sustained competitive advantage, enterprises must possess the capability to allocate resources effectively (Qiu et al., 2022). Resource allocation serves as the foundation and prerequisite for resource integration, which represents a deepening and optimization of resource allocation. Resource allocation focuses on how resources are distributed among various user units, whereas resource integration concerns how dispersed resources can be organically combined into a cohesive whole, optimizing resource allocation and enhancing efficiency. Resource integration adopts a system thinking approach, emphasizing organization and coordination to integrate related but separate elements, thereby achieving optimized resource allocation and enhancing overall effectiveness. This mindset is applicable not only to business management but also to personal growth and societal development (J. L. Zhang et al., 2024).

In studying biopharmaceutical companies and enterprises listed on the main and startup boards of China's A-shares, dynamic resource integration capability is crucial for these businesses to continue thriving in the complex and volatile industry environment. This capability enables them to fully leverage policy support, capital markets, and industry resources to forge a distinct competitive edge. It facilitates the rapid transformation and application of new products and technologies, strengthens research and development capabilities, expands market share, and enhances the overall resilience of the enterprise, thereby securing a favorable position in the competitive biopharmaceutical sector.

Organizational restructuring capability:

Organizational restructuring is the process of adjusting and optimizing internal organizational structures and operational methods in response to changes in the market environment. It represents a continuous effort by enterprises to reconfigure their business operations to gain a competitive advantage. As publicly listed companies grow, they can enhance their adaptability to market fluctuations by continuously learning and mastering new knowledge; encouraging innovation to create new products and services; and establishing effective communication mechanisms to promptly identify and solve problems. Establishing a market-oriented organization that stays attuned to market dynamics and adjusts its organizational structure based on market demands is crucial (Wajcman & Martin, 2001).

Organizational restructuring capability is a critical concept in operational management. Current literature suggests that reconfiguration capabilities involve reorganizing and reinventing existing operational abilities to cope with the turbulent external market environment (Chi et al., 2020). It is identified as a key factor influencing the transformation of new technologies and production and operational methods, and is pivotal for disruptive innovation (M. W. Zhang, 2023). Feng and Wei (2011) noted that in the dimensionality of dynamic capabilities, restructuring capability is a relatively mature construct widely recognized by the academic community globally. Past research has often demonstrated organizational restructuring capability through flexible adjustments to organizational structures, workflow, and function redesign, discarding outdated resources and knowledge (Meng, 2016). Some studies have also inferred organizational restructuring capability indirectly through financial data metrics.

In the rapidly evolving biopharmaceutical industry, effective organizational restructuring enables companies to adapt efficiently to external environmental changes. It assists businesses in improving and adjusting organizational processes and practices that are misaligned with environmental shifts, thereby enhancing the innovation performance of biopharmaceutical companies.

(6) Innovation performance of enterprises

Innovation performance of enterprises refers to the performance and outcomes achieved in innovation activities (Lee Mendoza, 2023). Evaluation metrics for corporate innovation performance include innovation outputs (such as new products, services, processes, and technologies), innovation processes (organization, management, and implementation of innovation activities), and innovation effectiveness (the contribution of innovation activities to enterprise performance) (Gan et al., 2023; Su et al., 2023). Biopharmaceutical companies, as knowledge-intensive entities with typically short product lifecycles, rapid technological updates, and high R&D costs, must continuously innovate to maintain market position and profitability.

Literature on innovation performance is extensive, with most domestic and international studies considering innovation a crucial metric for competitiveness in high-tech industries. Given the broad scope of innovation performance, scholars have various conceptual understandings of it. This thesis compiles international and domestic scholarly discussions on the concept of corporate innovation performance, detailed in Table 2.6.

Table 2.6 Concepts of corporate innovation performance

Categorization	Author	Concepts of corporate innovation performance
Narrowly defined	Ahuja and Katila (2001)	Increased performance as a result of bringing new ideas or technologies to market
	Gregor and Hevner (2014)	Comprehensive benefits generated, focusing on new products developed
	Jantunen (2005)	Efficiency gains through process or product innovation
Broadly defined	X. Y. Liu (2013)	Changes in operational efficiency and effectiveness as a result of trying out new management methods, developing new technologies and products, and developing new market segments.
	X. Y. Zhou and Wang (2014)	It refers to the satisfaction of the parties involved in collaborative innovation, which is defined from the perspective of collaborative innovation of enterprises, and includes the strategic synergy and organizational communication of the parties in the process of innovation.
	R. Wang (2017)	Innovation performance is a holographic description of the state of innovation within a system from a holistic perspective

Internationally, Ahuja and Katila (2001) defined innovation performance as the quantifiable performance growth achieved after introducing novel ideas or technologies to the market. Gregor and Hevner (2014) viewed it from the comprehensive benefits of corporate innovation activities, primarily reflected in the development of new products. Jantunen (2005) expanded the scope of innovation performance to include the benefits brought by process innovations or product innovations.

Domestically, X. Y. Liu (2013) proposed that innovation performance is the significant change in operational efficiency and effectiveness following efforts in implementing new management methods, developing new technological products, and exploring new market areas. R. Wang (2017) argued that innovation performance should not be evaluated from a single dimension but rather from a comprehensive perspective that assesses the system's state of innovation holistically. This perspective emphasizes the complexity and multidimensionality of evaluating innovation performance, providing a richer theoretical framework for understanding the effectiveness of innovation activities.

Combining existing research findings, this thesis notes that discussions on the connotation of innovation performance are rich, with domestic and international scholars emphasizing different aspects, and no unified consensus has been formed yet. Upon in-depth analysis, this thesis proposes that the connotation of innovation performance can be broadly divided into two levels: narrowly, it focuses on the outcomes of new technology and product development, which dominates current research; broadly, it encompasses not only the benefits triggered by product

and technological innovations but also the comprehensive effects generated by a series of innovative behaviors and activities.

Dimensions of corporate innovation performance:

Extensive academic literature recognizes innovation performance as a crucial metric for assessing innovation activities at the national, regional, and corporate levels. Scholars have introduced various classification methods to measure innovation performance, offering diverse perspectives and theoretical frameworks for a comprehensive understanding and assessment of innovation activities. This thesis compiles the dimensions of corporate innovation performance as categorized by scholars both domestically and internationally, as shown in Table 2.7.

Table 2.7 Dimension of corporate innovation performance

Categorization	Author	Dimensional classification
Bi-dimensional	D. H. Pan and Sun (2013)	Innovation processes and innovation capability outputs
	Arias and Molina (2002)	R&D expenditures and number of original patents Process and output performance Product and process innovation
Four-dimensional	D. R. Shen and Wang (2012)	Growth performance, technological innovation, economic benefits, social benefits
	S. X. Gao et al. (2015)	Improvements in the company's production technology, innovations in products or services, number of patents, company's R&D costs
	H. Li and Zhang (2007)	New product development, process flow, market situation, cooperation with technical organizations
	Hagedoom and Cloodt (2003)	Investment of R&D funds, number of patents, professional papers, new product disclosure

From the international perspectives, Arias and Molina (2002) expanded the quantitative analysis of innovation performance to include the outputs of innovation capabilities and the processes involved. Hagedoom and Cloodt (2003), based on a detailed survey of nearly 1200 firms in four high-tech industries, used multiple indicators including R&D spending, patent applications, academic publications, and new product launches to study innovation performance comprehensively. H. Li and Zhang (2007) proposed that innovation performance evaluation should encompass the development of new products, improvements in production processes, market performance, and collaborations with technological institutions.

From the domestic perspectives, D. R. Shen and Wang (2012), based on empirical research, suggested that innovation performance includes growth performance, technological innovation, economic benefits, and social benefits as key dimensions. D. H. Pan and Sun (2013) further divided innovation performance into process performance and output performance, where technological innovation represents output performance, and management level and innovation capability represent process performance. S. X. Gao et al. (2015), building on H. Li and Zhang

(2007), noted that innovation performance evaluation should also cover improvements in production technology, innovativeness of products or services, patent ownership, and company R&D investment.

The academic standards for measuring innovation performance are diverse. Most scholars domestically and internationally tend to use direct metrics such as patent applications, new product revenues, and R&D innovation rates. However, innovation performance is not limited to these overt indicators; its objective assessment should also include the latent performance formed through the implementation of management innovations, which are crucial for supporting and ensuring the effectiveness of output innovations.

2.2.2 The relationship between entrepreneur' social capital, dynamic capabilities, and innovation performance

(1) The relationship between entrepreneur' social capital and dynamic capabilities

International scholars, such as Blyler and Coff (2003) that social capital plays a crucial role in an organization's dynamic capabilities. They argued that without valuable personal social connections, businesses would struggle to adapt to external environmental volatility and instability through the acquisition, integration, and optimal configuration of resources. This perspective highlights the central role of social capital in organizational adaptability and strategic flexibility, underscoring the critical function of personal social networks in building corporate dynamic capabilities. Based on this, a firm's social capital becomes a decisive factor in effectively adapting and seizing opportunities in a competitive market.

Researchers Adner and Helfat (2003) analyzed various resource elements in their studies and proposed that dynamic capabilities are influenced by three key factors: human resources, social capital, and management cognition. They pointed out that these factors can operate independently or interact with each other, jointly shaping the strategic and operational management decisions of a company, thus profoundly impacting its dynamic capabilities.

Building on this foundation, L. Y. Wu (2007) conducted empirical research that further elucidated the mediating role of dynamic capabilities between Entrepreneur' social capital and corporate performance. Wu's findings indicated that the richer the social capital possessed by entrepreneurs, the stronger their firms' dynamic capabilities, which in turn become a significant driving force for enhancing corporate performance. This viewpoint emphasizes the role of dynamic capabilities as a bridge linking Entrepreneur' social capital and corporate performance, revealing its central position in the implementation of business strategies and the construction

of competitive market advantages. Dias et al. (2021b) explored the relationship among entrepreneurs' social capital, dynamic capabilities, and innovation performance by proposing an integrated model. Their findings support the notion that entrepreneurs with abundant social capital are more likely to build strong dynamic capabilities, which in turn drive innovation activities and enhance innovation performance.

Domestically, scholars like F. L. Wei (2019) believe that there is a mutually reinforcing relationship between Entrepreneur' social capital and dynamic capabilities, which plays a crucial role in the growth and development of companies. First, Entrepreneur' social capital serves as the foundation for acquiring key resources, information, partners, and support, significantly enriching the entrepreneurs' social networks and enhancing their influence and credibility in the business environment. The accumulation of such social capital enables entrepreneurs to keenly capture market changes and quickly integrate various resources, thereby nurturing and enhancing their firms' dynamic capabilities. These capabilities manifest in the company's agile response to market opportunities, active embrace of technological innovations, flexible adjustment of organizational structures, and continuous innovation in strategic planning.

On the other hand, the dynamic capabilities of a company further enhance the value and efficacy of its entrepreneur' social capital. By continuously adapting to and leading market changes, the company gains a competitive edge, which not only boosts the personal reputation and brand image of the entrepreneur but also brings more social contacts and resource exchange opportunities. The display of these dynamic capabilities, such as the successful launch of innovative products, disruptive changes in business models, and effective execution of market expansion, further broadens the entrepreneur's social capital network, creating a positive cycle that maintains competitive advantages and achieves sustainable development in a constantly changing environment (T. L. Liu, 2018).

A higher level of social capital facilitates the development of dynamic capabilities within organizations. Social capital provides resources and information that promote collaboration and knowledge sharing both within and outside the organization, thereby aiding organizations in rapidly adapting to environmental changes, enhancing innovation capabilities, exploring new market opportunities, and effectively responding to competitive pressures. Additionally, social capital offers opportunities for organizational learning, promotes teamwork, and fosters innovative thinking, all of which contribute to the cultivation and development of dynamic capabilities. Through the social contacts and resources provided by social capital, organizations can more effectively gather information and technology, collectively address challenges, and

enhance their innovative abilities, thereby strengthening their competitive advantages (H. Li & Wang, 2016). Therefore, social capital and dynamic capabilities complement each other, with social capital helping to foster the development of dynamic capabilities, which in turn rely on social capital to support their function. Thus, in developing organizational strategies, consideration should be given to how to fully utilize and enhance social capital to promote the development of dynamic capabilities.

In summary, the majority of both domestic and international scholarly research on the relationship between corporate social capital and dynamic capabilities indicates that a firm's social capital has a positive effect on its dynamic capabilities.

Internationally, research in Malaysia on small and medium enterprises reveals that social capital significantly impacts corporate innovation culture and indirectly affects innovation performance (Hanifah et al., 2020). Another study in Ghana looking at recycling innovation enterprises demonstrated that an entrepreneur's personal traits such as age, tenure, and educational level are linked to innovation, influencing the development of the company's innovative capabilities (Dangui et al., 2021). When exploring the impact of entrepreneurs' personal and social relationships on innovation performance from the perspectives of industrial institutional mitigation and survival pressure, it was found that entrepreneurs' social relationships directly influence innovation activities. In specific contexts, business and political relationships positively impact innovation performance. Entrepreneurs with different subjective perceptions can trigger various effects between social capital and innovation performance (L. Chen, 2021). A survey of 654 enterprises in Vietnam found significant relationships between personal and business networks of social capital and innovation, suggesting that managers can enhance company performance by effectively utilizing social networks to access information (Vu et al., 2023). Dias et al. (2022) investigated the recovery strategies of lifestyle entrepreneurs in the context of the COVID-19 pandemic. Their study revealed that during times of crisis, entrepreneurs' social capital, through resources obtained via their network relationships, plays a crucial role in enabling firms to survive and thrive in turbulent market environments.

Domestically, an analysis of 192 Chinese SMEs found that entrepreneurs' business and political social capital positively influences business model innovation (W. Li et al., 2018). Exploring the relationship between Entrepreneur' social capital and technological innovation performance, a survey of 154 Chinese private companies found that different components of Entrepreneur' social capital have varying impacts on technological innovation, with business and skills social capital significantly boosting innovation performance (S. D. Shen & Fang, 2018). Research on cultural and creative enterprises listed in Shanghai and Shenzhen from

2010-2016 showed that entrepreneurs' social capital in professional skills can release more information about innovative projects, reducing internal and external information asymmetry and thus improving innovation performance. Political and commercial social capital can impact enterprises through trust and reputation mechanisms, though they require higher maintenance costs and have heterogeneous effects (Chu et al., 2019). A study on 212 listed high-tech companies found that entrepreneurs' social capital positively affects the quality of innovation in high-tech enterprises, demonstrating that entrepreneurs with business, institutional, and technical social capital can leverage their social networks to introduce external resources, thereby enhancing the quality of corporate innovation (He, 2020).

Entrepreneur' social capital plays a significant role in enhancing innovation performance. Social capital, representing resources from social networks, trust, and cooperative relationships, aids individuals and organizations in collaborating more effectively, sharing information and resources, and fostering innovation. Studies indicate that a high level of social capital facilitates innovative activities and improves innovation performance. Through social networks and trust, individuals and organizations can more easily access external information, share knowledge, and gain support from partners. This cooperation and exchange of information stimulate innovation and the creation of new products, services, or business models. Moreover, social capital supports cross-sector collaboration and inter-organizational learning, promoting an increase in innovation performance.

Thus, social capital is considered a vital resource for innovation, and higher levels of social capital are likely to have a positive impact on innovation performance. This relationship underscores the increasing focus in research and practice on enhancing and utilizing social capital to boost innovation activities and improve innovation outcomes, as evidenced by recent research trends.

In the field of international research, studies such as the one on four North European book publishing and distribution companies found that dynamic capabilities affect innovation performance differently among companies, particularly in the areas of opportunity identification, capture, and reconfiguration (Jantunen, 2005). Further, Makkonen et al. (2014) analyzed 301 local American businesses and deduced that dynamic capabilities facilitate organizational transformation, thereby enhancing competitive advantages and ultimately improving innovation performance. Ferreira and Coelho (2020), in an empirical study of 387 Portuguese businesses, defined dynamic capabilities from a strategic process perspective as the potential to systematically solve problems, with a tendency to perceive opportunities and threats, make timely decisions, and effectively implement strategic decisions and transformations,

ensuring the correct direction. The findings indicated a significant positive impact of dynamic capabilities on performance. Gonzalez (2022), through survey data from 262 respondents in 65 Brazilian industrial companies, discussed how knowledge-based dynamic capabilities and organizational structures within Brazilian industry influence team innovation performance, finding that innovation-oriented dynamic capabilities play a mediating role between centralization and integration. Gonzalez (2022), through an online survey of 83 logistics service providers and 30 internal logistics departments during the COVID-19 pandemic, used a theoretical framework to explore the relationship between different innovation orientations of dynamic capabilities, dynamic resilience, and business performance in LSPs and internal logistics departments of industrial enterprises. The results showed that innovation-oriented dynamic capabilities positively affect company performance. Pundziene and Geryba's (2023) empirical research on 268 fully viable SMEs from the USA, Sweden, and Lithuania aimed to explore the effect of dynamic capabilities on the performance of native digital SMEs when collaborative innovation mediates, showing that the impact of dynamic capabilities on native digital SMEs' performance is more significant when collaborative innovation mediates. Dias et al. (2022) emphasized the role of dynamic capabilities in sustainable business models, highlighting that firms with strong dynamic capabilities can effectively leverage their resources and transform them into the inputs required for innovation, thereby enhancing their innovation performance.

Domestically, Fu et al. (2016) through research on emerging businesses in Shanghai, Jiangsu, and Zhejiang, found that dynamic capabilities significantly foster innovation performance in new enterprises through capabilities like perception, integration, and absorption. M. Y. Chen (2017) studied 150 randomly selected companies in Henan Province and found that elements of dynamic capabilities such as resource acquisition, integration, reconfiguration, opportunity perception, and learning and creation abilities positively influence corporate innovation performance. H. Sun and Zhang (2018), in discussing the relationship between dynamic capabilities and innovation performance in the context of internationalization, chose high-tech enterprises as the research subjects and demonstrated that dynamic capabilities play a critical role in enhancing their own innovation benefits. Jian et al. (2014), combining the cognitive perspective and the service ecosystem viewpoint, systematically explored how businesses construct dynamic capabilities to support a series of service innovation activities in the internet environment, finding that in the internet context, dynamic capabilities are essentially a combination of abilities that exist in the process from organizational cognitive updating to leading business responses to dynamic integrations in the service ecosystem. M. Li

and Xia (2022), selecting companies engaged in R&D internationalization in China's knowledge-intensive industries as samples, explored the specific impact mechanisms of R&D internationalization on corporate innovation performance from a dynamic capabilities perspective, showing that R&D internationalization enhances innovation performance by boosting corporate dynamic capabilities. C. F. Wang et al. (2023), using samples from intelligent manufacturing enterprises listed in Shanghai and Shenzhen stock markets from 2012 to 2021, analyzed the impact of four dimensions of dynamic capabilities (digital perception capability, digital capture capability, resource integration and reconfiguration capability, and organizational transformation capability) on the quality of digital innovation in intelligent manufacturing enterprises, finding that all four dimensions significantly promote the quality of digital innovation in these enterprises.

Dynamic capabilities have a close relationship with innovation performance. As capabilities that help enterprises respond to environmental changes, integrate resources, and seize opportunities, dynamic capabilities significantly impact a company's innovation performance. Specifically, dynamic capabilities can enhance innovation efficiency, reduce innovation costs, and strengthen market competitiveness, thereby improving innovation performance. Therefore, cultivating and enhancing an enterprise's dynamic capabilities is a crucial approach to boosting innovation performance.

2.3 Chapter summary

This chapter started with an overview of concepts such as entrepreneurs, social capital, Entrepreneur' social capital, dynamic capabilities, innovation, and corporate innovation performance. It systematically reviewed and compared the evolution of these concepts and explicitly defined the key variables for this research: Entrepreneur' social capital, dynamic capabilities, and innovation performance, providing a solid theoretical foundation for the empirical study conducted in this dissertation. Additionally, this chapter systematically organized the existing literature on the dimensions of Entrepreneur' social capital, dynamic capabilities, and innovation performance. It also analyzed the progress in research on the relationships between Entrepreneur' social capital and innovation performance, Entrepreneur' social capital and dynamic capabilities, and dynamic capabilities and corporate innovation performance, as well as the relationship between enterprise social capital, dynamic capabilities, and corporate innovation performance. The chapter critiqued existing research findings,

pointing out deficiencies and areas that require further in-depth study, thus setting the direction for this dissertation.

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Chapter 3: Research Model and Research Hypotheses

This chapter introduces dynamic capabilities from a heterogeneity perspective, positioning them as a mediating variable. Using the Delphi expert consultation method, it draws on previous literature analysis and theoretical research to explore the relationships between Entrepreneur' social capital, dynamic capabilities, and corporate innovation performance. Based on expert consultation, the study constructs a measurement index system and a theoretical model for each dimension of these variables. Through an in-depth analysis of the relationships among these variables, relevant research hypotheses are proposed.

3.1 Construction of the theoretical research model

Innovation serves as the soul of a nation and its people, acting as a constant driver of modern social development. Against the backdrop of rapid advancements in high technology in the 21st century, the biopharmaceutical industry has been explicitly recognized as a core sector concerning national security and strategic development within China's 14th Five-Year Plan and 2035 Vision. Additionally, in a keynote address at the Central Economic Work Conference, President Xi Jinping underscored the importance of consolidating efforts to overcome critical technological barriers, particularly in the domains of pharmaceuticals and medical devices, highlighting the significance of innovation (T. Zhang & Chen et al., 2023). Currently, innovation-led, technology-driven productivity represents the new trajectory of high-quality growth (Yin et al., 2024). At the same time, as the microeconomic agents within a society, the strength of enterprises directly influences the prosperity of industries and, by extension, the nation. Cultivating an enterprise's core competencies, particularly dynamic capabilities, serves as a foundation for enhancing industrial technological innovation and is essential to building national scientific leadership and driving the advancement of new productive forces (Yin et al., 2024; X. W. Zhang & Qin et al., 2023). Consequently, promoting innovation within enterprises, particularly in biopharmaceutical firms, holds tremendous value for socio-economic development and the enhancement of national scientific prowess.

The driving factors behind corporate innovation performance are multifaceted and complex. In recent years, Entrepreneur' social capital has emerged as a key element, drawing extensive attention from scholars. In a study on Ghana's waste recycling industry, Dorcas et al.

constructed a theoretical model illustrating the direct impact of Entrepreneur' social capital on innovation performance. Their research revealed how the personal traits of entrepreneurs influence corporate innovation capabilities through their social capital (Dangui et al., 2021), providing substantive evidence for understanding the direct relationship between Entrepreneur' social capital and innovation performance. Similarly, W. Li et al. (2018), by constructing a model where Entrepreneur' social capital indirectly influences innovation performance through moderating variables, analyzed 192 Chinese SMEs, further distinguishing the differential impacts of various dimensions of Entrepreneur' social capital on technological innovation.

Meanwhile, in the field of strategic management, dynamic capabilities have been emphasized as essential for enterprises to cope with technological advancements and globalization while continuously enhancing their competitive advantage (Teece et al., 1997). Jantunen et al. (2012) constructed a theoretical model on how different dimensions of dynamic capabilities directly impact innovation performance and, through case studies of four Nordic publishing companies, demonstrated that the details of dynamic capabilities across dimensions affect innovation performance differently within the same industry. Focusing on high-tech industries, a theoretical model was developed wherein Entrepreneur' social capital affects technological innovation capabilities through dynamic capabilities as a mediating variable, highlighting that Entrepreneur' social capital can enhance innovation performance by strengthening an enterprise's dynamic capabilities (S. Chen, 2016).

In summary, based on the extensive research findings above, this study integrates dynamic capabilities theory and social capital theory, focusing on the high-tech biopharmaceutical sector. Using a sample of biopharmaceutical companies listed on the A-shares main board and Growth Enterprise Market (GEM) in China from 2018 to 2022, this study aims to examine the intrinsic relationships among Entrepreneur' social capital, dynamic capabilities, and corporate innovation performance. Specifically, it seeks to verify whether Entrepreneur' social capital indirectly influences the innovation performance of biopharmaceutical firms through the mediating role of dynamic capabilities, as well as to explore potential contingency factors. To this end, a theoretical framework has been constructed (as shown in Figure 3.1) in this study, providing new insights and guidance for both theory and practice in this field.

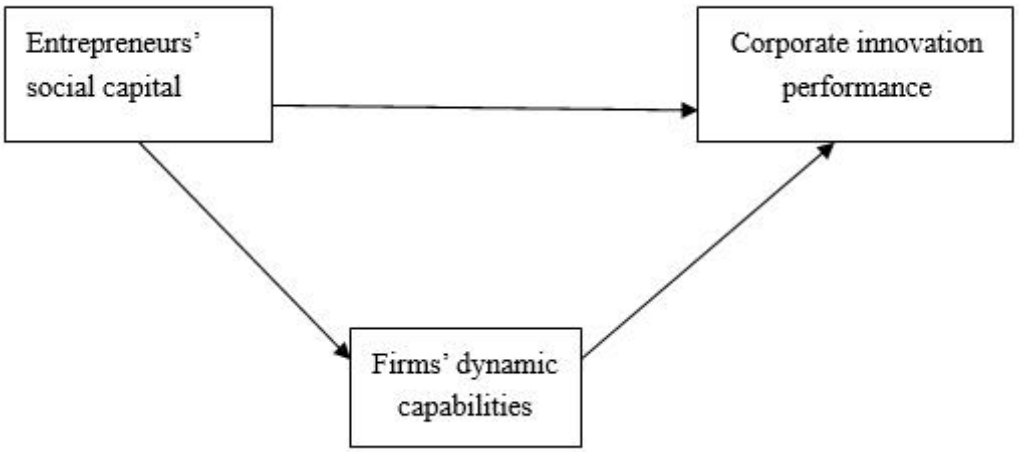

Figure 3.1 Theoretical research model

3.2 Development of basic research hypotheses

3.2.1 Entrepreneur' social capital and innovation performance

Innovation serves as the source of value creation and is the core driving force behind the rapid growth of modern high-tech industries, particularly in the biopharmaceutical field, where progress relies on continual breakthroughs in process innovation and patented technologies. Schumpeter's theory of innovation emphasizes that new combinations of resources and the services they provide form the foundation for developing new products and methods, establishing that an enterprise must possess resources to lay the material groundwork for innovation. Within this framework, the "entrepreneur" functions as a key concept, responsible for realizing these new combinations. Thus, in Schumpeter's model of innovation, entrepreneurs and the recombination of resources are closely interconnected, jointly forming the core concept of innovation. For an enterprise to progress steadily in innovation, it must possess a foundation of resource combinations (Schumpeter, 2019).

Entrepreneur' social capital serves as a vital pathway to accessing resources, as entrepreneurs can leverage their capabilities and social networks to acquire resources that bring both direct and potential benefits to the enterprise. Studies have indicated that entrepreneurs, through their social capital, can convert resources from the external environment into accessible assets, further internalizing these as corporate resources to address internal shortages, thereby enhancing innovation capacity. Entrepreneur' social capital achieves this improvement in innovation capacity through a "resource acquisition" intermediary effect (2014). Meanwhile,

Hanifah et al. (2020), in their analysis of Malaysian SMEs, found that social capital significantly influences corporate innovation culture, which indirectly affects innovation performance. In exploring how entrepreneurs' personal and social relationships impact corporate innovation performance, L. Chen (2021) discovered that social relationships of entrepreneurs directly promote innovation activities.

Based on the above, this study proposes the following hypothesis:

H1: Entrepreneur' social capital has a positive impact on corporate innovation performance.

3.2.2 Entrepreneur' social capital and dynamic capabilities

The value of Entrepreneur' social capital primarily lies in providing firms with access to external information, knowledge, and resources essential for overcoming external complexities and the uncertainty of constantly changing environments (Acquaah, 2007). Resources and information obtained through Entrepreneur' social capital play a significant role in supporting a firm's current and future development and help it secure a competitive edge. Moreover, resources sourced from personal, business, and technological social capital positively influence the identification, integration, reorganization, and reconfiguration of dynamic capabilities (Geng & Zhang, 2010).

Adner and Helfat (2003), through an integrated analysis of various resource elements, argued that dynamic capabilities are influenced by three key factors: human resources, social capital, and management cognition. They found that these factors could act independently or interactively to shape strategic and operational decisions, ultimately impacting a firm's dynamic capabilities. Building on this, L. Y. Wu (2007) further explained through empirical research the mediating role of dynamic capabilities in the relationship between Entrepreneur' social capital and firm performance. This study indicated that as entrepreneurs' social capital becomes richer, their firm's dynamic capabilities are correspondingly stronger, positioning dynamic capabilities as a critical driver of improved firm performance. This view highlights dynamic capabilities as a bridge linking Entrepreneur' social capital with firm performance, underscoring their essential role in strategy implementation and competitive advantage.

Therefore, this study proposes the following hypothesis:

H2: Entrepreneur' social capital has a positive impact on a firm's dynamic capabilities.

3.2.3 Dynamic capabilities and innovation performance

A strong relationship exists between dynamic capabilities and corporate innovation

performance, as the strength of dynamic capabilities affects resource utilization, ultimately influencing innovation performance. When facing complex, ever-changing environments, companies must perceive and identify potential internal and external opportunities and risks. Effective integration of internal and external resources and appropriate adjustments in organizational structure and operations are crucial to gaining a competitive advantage.

In international research, Makkonen et al. (2014) studied 301 local firms in the United States and concluded through surveys that dynamic capabilities can drive organizational change, which in turn strengthens competitive advantage and improves innovation performance. Domestic studies further underscore that companies with stronger dynamic capabilities are more likely to achieve significant gains in innovation performance, emphasizing the need to enhance the capability to transform resources into innovation outputs (M. Li et al., 2022).

In the biopharmaceutical industry specifically, where R&D cycles are long, costs are high, and product lifecycles are short, firms need to maintain high market sensitivity and rapid response capabilities. By accurately grasping market dynamics and adjusting strategic directions promptly, biopharmaceutical firms can ensure sustained competitive advantage in a highly competitive market (R. X. Zhou, 2012). Hence, for biopharmaceutical companies, strengthening dynamic capabilities—particularly the capability to efficiently convert resources into innovation outputs—is of paramount importance.

Accordingly, this study proposes the following hypothesis:

H3: Dynamic capabilities have a positive impact on corporate innovation performance.

3.2.4 The mediating effect of dynamic capabilities

The above analysis has established the relationships between Entrepreneur' social capital and dynamic capabilities, Entrepreneur' social capital and innovation performance, as well as dynamic capabilities and innovation performance. In the high-tech context of the 21st century, Entrepreneur' social capital facilitates access to resources critical for innovation, making it an effective means of building dynamic capabilities, which are essential for enhancing corporate innovation capacity.

On one hand, an entrepreneur's capabilities and social network provide biopharmaceutical firms with a diversified resource base, establishing foundational conditions for innovation and thereby influencing corporate innovation performance. Strong dynamic capabilities allow firms to effectively identify opportunities or threats, adjust based on available resources, and make appropriate organizational changes, thereby supporting innovation performance and providing

a safeguard for its enhancement. On the other hand, through Entrepreneur' social capital, publicly listed biopharmaceutical firms can access cutting-edge information, funding, and opportunities related to biopharmaceutical innovation. This helps them seize external opportunities and make rapid strategic adjustments in response to changes, thus improving innovation performance.

Consequently, dynamic capabilities act as a crucial bridge between entrepreneur' social capital and innovation performance, with Entrepreneur' social capital impacting innovation performance through dynamic capabilities. S. Chen (2016), in her study of how entrepreneur' social capital enhances technological innovation, found that entrepreneur' social capital can improve technological innovation performance by elevating a firm's level of dynamic capabilities. Similarly, P. Liu and Wu (2022) examined the influence of executive teams on corporate growth, finding that executive teams enhance adaptability, absorptive capacity, and financial flexibility—key aspects of dynamic capabilities—thereby supporting corporate growth, demonstrating dynamic capabilities as a vital mediator between executive teams and corporate growth.

Based on the above analysis and combining hypotheses H2 and H3, this study proposes the following hypothesis regarding the mediating role of dynamic capabilities:

H4: Dynamic capabilities mediate the relationship between entrepreneur' social capital and innovation performance.

3.3 Variable measurement indicator system

The resource-based view holds that an enterprise is a collection of heterogeneous resources, and the value, rarity, inimitability and non-substitutability of resources are the source of sustained competitive advantage for an enterprise. Due to the limited internal resources of an enterprise, in the context of a constantly changing external environment, it is difficult for an enterprise to rely solely on its own resources to adapt to the requirements of the market development for sustained corporate innovation and maintenance of competitive advantage. In this case, how to more effectively obtain heterogeneous resources outside the enterprise is very crucial for the corporate innovation, especially its innovation performance. Therefore, through the Delphi expert consultation method, we invite relevant experts to rate the variable measurement indicators of entrepreneurs' social capital, dynamic capabilities and innovation performance, and, on this basis, establish a more scientific and reasonable variable measurement indicator system.

3.3.1 Delphi expert consultation

The Delphi expert consultation (Delphi) method is a consultation-based decision-making technique that can be applied in any field summarized and proposed by the American Rand Corporation in 1964, and it is a prescribed-procedure expert consultation method named after the ancient Greek city of Delphi. The Delphi method is a qualitative assessment method of group decision-making featuring anonymity, feedback and statistical analysis. In essence, it is analysis and prediction based on the knowledge, practical experience and subjective judgment ability of many experts, mainly in the form of a series of questionnaires distributed to the experts in relevant fields to ask for their opinions. Based on the answers of the experts to the original questionnaire, the researchers will formulate a new version of questionnaire to solicit opinions from various experts once again, and the conclusion is not obtained until the majority of the experts reach a consensus (W. T. Liu et al., 2011). The Delphi method generally requires two to three rounds of consultation and is an important step in constructing the evaluation system. The specific process is shown as per Figure 3.2.

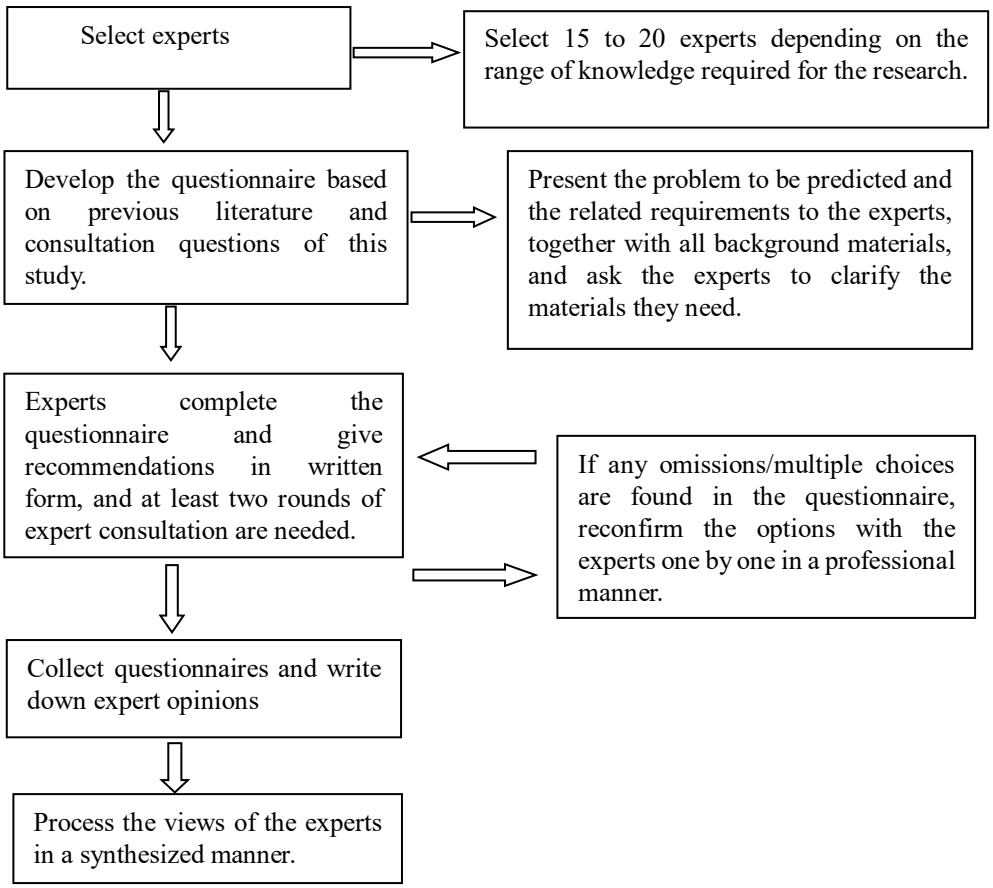

Figure 3.2 Delphi method flowchart

This study adopts the Delphi expert consultation method to establish a variable measurement index system. When performing data analysis, the following indicators are considered:

1. Expert Enthusiasm Coefficient: The level of expert enthusiasm reflects the extent of experts' concern for this study, which can be evaluated by the proportion of experts participating in the index system evaluation relative to the total number of experts, i.e., the questionnaire return rate. Research has shown that a questionnaire return rate of over 70% indicates a high level of expert enthusiasm (Y. X. Hu, 2022).

2. Expert Opinion Authority Coefficient: The authority level of expert opinions reflects the recognition and influence of the consulted experts in this field. The higher the authority, the more reliable the results. Authority is determined by two factors: the basis for the expert's judgment on the questionnaire and the expert's familiarity with the issues, represented by the expert judgment basis coefficient (Ca) and expert familiarity coefficient (Cs), respectively. The familiarity level is divided into five grades—very familiar, familiar, somewhat familiar, unfamiliar, and very unfamiliar—with specific values shown in Table A.2. The authority level of experts is calculated using the equation 3.1 (Y. X. Hu, 2022).

$$\mathbf{Cf = (Ca + Cs)/2} \tag{3.1}$$

3. Degree of Expert Opinion Concentration: The degree of expert opinion concentration reflects the consistency in experts' ratings of the importance of each indicator. It is typically measured using the arithmetic mean, full-score frequency, and coefficient of variation (C. Z. Wang & Si, 2011). The arithmetic mean represents the sum of scores divided by the number of experts participating in the evaluation, while full-score frequency refers to the proportion of experts who rated the indicator with a full score of 5 out of the total number of experts. Higher values for the arithmetic mean and full-score frequency indicate greater concentration of expert opinions. The coefficient of variation, calculated as standard deviation divided by the mean, represents the variation in experts' ratings of indicator importance. A smaller coefficient of variation indicates less fluctuation in expert opinions, meaning a higher concentration of expert consensus on the indicator. The standard deviation is the average distance of each importance rating from the mean.

4. Degree of Expert Opinion Coordination: The degree of expert opinion coordination reflects the consistency of experts' judgments on the consultation content, generally represented by the Kendall's coefficient of concordance. This coefficient indicates the level of agreement among experts on all evaluation content (J. L. Zhang et al., 2024) and is based on the concept of variance from probability theory, where variance indicates the degree of deviation of a

random variable from its mean (Qi, 1985). A higher Kendall's coefficient signifies better coordination of expert opinions, with values ranging from 0 to 1. A chi-square test (χ^2) is performed with a significance level of $\alpha = 0.05$, and results are considered reliable if $P < 0.05$ (H. Zhang, 2015).

5. Boundary Screening Criteria: The boundary method is used to establish inclusion criteria for indicator screening. The boundary values are set as follows (B. B. Liu et al., 2023): the boundary value for the arithmetic mean of indicator importance is defined as the arithmetic mean of importance ratings minus the standard deviation; the boundary value for full-score frequency is the arithmetic mean of full-score frequency minus the standard deviation of full-score frequency. Indicators scoring below these boundary values are eliminated. The boundary value for the coefficient of variation is the arithmetic mean of the coefficient of variation plus the standard deviation of the coefficient of variation, with indicators scoring above this boundary value being removed. Indicators meeting all three elimination criteria are removed, while those meeting only one or two criteria are further reviewed by the expert panel. The research team then discusses the scientific and practical validity of the indicators to decide on their inclusion or exclusion.

3.3.2 Constructing the variable measurement index system

From existing research literature, it is evident that while there are numerous studies on Entrepreneur' social capital and dynamic capabilities, scholars approach the conceptual definitions of these terms from various perspectives. This diversity in viewpoints has led to different dimensional compositions, resulting in a lack of a unified definition or dimension classification for quantification. Additionally, most literature on corporate innovation performance primarily considers patents. In this study, this study incorporates the characteristics of the biopharmaceutical industry by adding indicators such as the number of clinical trial approvals and the number of new products launched to comprehensively reflect the innovation performance of biopharmaceutical companies.

However, there is currently no relevant literature that includes the number of clinical trial approvals in the evaluation system for innovation performance in biopharmaceutical enterprises. Therefore, this study employs the Delphi expert consultation method to thoroughly gather opinions from experts engaged in research or management within the biopharmaceutical field. By leveraging the extensive expertise and practical experience of numerous specialists, this study will evaluate the measurement indicators for Entrepreneur' social capital, dynamic

capabilities, and innovation performance in biopharmaceutical companies, ultimately determining the final measurement index system for this research.

Based on literature research and theoretical analysis, this study initially identified alternative measurement indicators for the variables. Using keywords such as "Entrepreneur' social capital," "dynamic capabilities," and "innovation performance of biopharmaceutical companies," this study conducted literature searches in databases such as Web of Science, China National Knowledge Infrastructure (CNKI), and Wanfang Data. This process helped us understand the fundamental theories surrounding Entrepreneur' social capital, dynamic capabilities, and corporate innovation performance, as well as the evaluation methods and measurement indicators related to these concepts in the context of biopharmaceutical companies. This study summarized and synthesized the indicators for all three aspects.

Taking into account the characteristics of biopharmaceutical enterprises, which are talent, technology, and knowledge-intensive, this study aimed to ensure that the measurement indicators are as comprehensive, objective, representative, and contributory as possible. This approach also supports horizontal comparisons within the evaluation system for the three variables across their respective dimensions.

This study classified entrepreneur' social capital into four dimensions as primary indicators: professional skill social capital, political social capital, commercial social capital , and overseas social capital. For each primary indicator, this study set up ten secondary indicators. Dynamic capabilities were divided into three dimensions as primary indicators: opportunity sensing capability, resource integration capability, and organizational restructuring capability, with six secondary indicators established for each.

Considering the characteristics of the biopharmaceutical industry and the corporate social responsibilities undertaken by these firms, this study classified the innovation performance of biopharmaceutical companies into four dimensions as primary indicators: the number of patent applications, the number of granted patents, the number of clinical trial approvals obtained, and the number of new products launched. Subsequently, this study designed a Delphi expert consultation questionnaire based on the aforementioned alternative indicators through discussions in a thematic group.

3.3.3 Questionnaire design philosophy and structure

The design of the expert consultation questionnaire in this study is based on the analysis and organization of relevant literature. Since the related scales already exist in the current literature,

the initial draft of the scale was designed and compiled directly in conjunction with the objectives of this study. After completing the initial draft of the questionnaire, it was submitted to relevant experts for evaluation and analysis to correct any biases, ambiguities, and content that was less relevant to this research. Upon completion of the revisions, the questionnaire underwent testing and preliminary research within a specific group of experts. Based on the preliminary testing outcomes and the results of interviews with related entrepreneurs, comprehensive modifications and improvements were made to the questionnaire content, ultimately leading to the creation of the formal consultation questionnaire.

The structure of the survey questionnaire primarily revolves around themes related to Entrepreneur' social capital, dynamic capabilities, innovation performance, and associated mechanisms. This approach aims to provide authentic, reliable, and effective foundational data for this study, on which statistical methods such as factor analysis, correlation analysis, and regression analysis will be applied to the relevant variables. The key variables to be measured in this study include dimensions of Entrepreneur' social capital, dimensions of dynamic capabilities, and internal dimensions of innovation performance.

To objectively measure the relevant concepts of this research, a substantial amount of literature was referenced in the development of the scales. The specific design includes the following quality assurance measures. First, scales directly related to this study were selected from literature that has a direct connection to the research topics of entrepreneur' social capital, dynamic capabilities, and innovation performance. Second, the selection process began with scales from literature within the same field as this research. Third, efforts were made to choose scales that have been continually validated and widely used by scholars. Fourth, scales with high reliability and validity from existing literature were prioritized in the selection process. Fifth, whenever possible, direct scales from the literature were selected; indirect scales were only cautiously chosen in the absence of direct options. All measurements in this study were conducted using direct scales. Last, existing scales in the literature were carefully revised, strictly adhering to scale design standards.

It is evident that the relevant scales developed in existing research literature serve as the foundation for the design philosophy and structural framework of this questionnaire. Additionally, methods such as group discussions, a certain range of questionnaire testing, and preliminary research were employed to ensure that the scales are reasonable, objective, and applicable.

3.3.3.1 Selection of experts

Expert Qualifications: The selection of experts is a critical aspect of the Delphi expert consultation method. The selection is not random but requires individuals with specialized knowledge and experience in the field. The qualifications of consulting experts can be assessed based on criteria such as familiarity with specific issues, depth of research, and innovativeness, ensuring their representativeness and authority (W. T. Liu et al., 2011). This study focuses on selecting professors/scholars, entrepreneurs, and heads of industry associations primarily engaged in biomedical research and development, health administration, and enterprise management.

Number of Experts: The number of experts significantly affects the reliability of consultation results. If the number of consulting experts is too few, there may not be sufficient evidence to address the predictive issues. Conversely, having too many experts increases the workload for data statistics (C. Z. Wang & Si, 2011). Research indicates that credibility increases less significantly once the number of experts exceeds 15, with a general recommendation of 10 to 50 experts being optimal (Owens et al., 2008).

3.3.3.2 Design and distribution of the expert consultation questionnaire

The main content of the Delphi expert consultation questionnaire includes a) Background and purpose; b) Source of evaluation indicators: This aims to help experts better understand and familiarize themselves with the content of the consultation; c) Basic information of experts: This includes the expert's name, gender, age, highest educational qualification, technical title, nature of the workplace, primary professional field, and years of work experience; d). Importance rating of variables: Experts are asked to score the importance of various indicators; e). Judgment basis for familiarity and importance ratings: A scoring table for the importance of primary and secondary indicators within the measurement indicator system for Entrepreneur' social capital, dynamic capabilities, innovation performance, and control variables; f). Additional feedback sections: There are sections for modification suggestions, recommendations for new indicators, and other suggestions, allowing experts to provide open-ended responses regarding each indicator.

The expert consultation questionnaires are sent to selected experts via email. In the first round of expert consultation, the questionnaires are collected, and the results are organized and analyzed. Based on the experts' feedback, adjustments are made to some indicators. In the second round of expert consultation, the results from the first round are published, and a second-round questionnaire is designed. Experts are invited to rate the importance of the measurement

indicators again, and the results are collected and analyzed. If any questionnaires are found to have multiple selections or missing responses during data collection and summarization, the research team communicates individually with the experts to confirm the selections, ensuring the completeness and authenticity of the questionnaire information. This study conducts two rounds of Delphi expert consultation, with both questionnaires available in the appendix.

3.3.3.3 Measurement of variables

The variable items are constructed using the Likert scale method. While the Likert 7-point scale offers better differentiation between variables, it also has drawbacks, such as increasing the time cost for respondents and potentially causing difficulty in distinguishing between too many options, which may affect the accuracy of the responses. After reviewing relevant literature, incorporating suggestions from scholars and experts, and considering the preference of some respondents, this study ultimately adopts the more mature and reliable Likert 5-point scale. Respondents are asked to rate the importance of each item on a 5-point scale, with the levels of importance assigned the following values: very important (5 points), important (4 points), moderately important (3 points), unimportant (2 points), very unimportant (1 point).

3.3.4 Results analysis

After collecting the expert consultation questionnaires, data were organized and statistically analyzed based on the experts' background, their level of engagement (expert engagement coefficient), their authority (expert authority coefficient), and the degree of consensus among their opinions (expert consensus coefficient). These analyses led to the identification of the variables to be included in the measurement indicator system.

3.3.4.1 Basic information of experts

In this study, 20 experts who have been engaged in biopharmaceutical enterprise management or biopharmaceutical research and development for an extended period were selected. These experts work in various fields, including biopharmaceutical companies, universities/research institutions, and industry associations. When analyzing the experts' background, it was found that some experts had experience in two or more professional fields, and their years of work experience varied. Therefore, the study grouped professional experience into three categories: entrepreneurs, professors/scholars, and association leaders, using the maximum years of experience reported for each.

The gender ratio of the experts was 3:1, with 95.0% holding a master's degree or higher,

70.0% holding a senior or higher professional title, and 100.0% having more than 10 years of work experience in their respective fields. The detailed breakdown is provided in Table A.4.

3.3.4.2 Expert engagement coefficient

In the first round of expert consultation, 22 questionnaires were distributed with a one-week deadline for submission. A total of 20 valid questionnaires were returned within the deadline, resulting in an expert engagement coefficient of 90.9%. In the second round, 20 questionnaires were distributed, and all 20 were returned within the deadline, resulting in an expert engagement coefficient of 100.0%. Both rounds of consultation had engagement coefficients far exceeding 70%, indicating a high level of engagement from the experts, demonstrating their strong interest in this research.

3.3.4.3 Expert authority coefficient

In selecting experts, the study fully considered the experts' representativeness in their fields and ensured that the selected experts possessed a well-rounded knowledge base and extensive practical experience. The experts had substantial professional backgrounds, educational qualifications, and work experience. The results from the two rounds of expert consultation showed that the experts' familiarity coefficients were 0.77 and 0.78, respectively, which are relatively high scores, indicating that the experts were capable of providing scientifically sound judgments. The judgment basis coefficients were 0.89 and 0.88 for the first and second rounds, respectively, yielding authority coefficients of 0.83 for both rounds. These values significantly exceed the acceptable threshold for expert authority reliability (0.70), reflecting the high authority of the consulted experts and affirming the reliability and scientific rigor of this study.

3.3.4.4 Expert opinion consensus coefficient

The statistical test results for both rounds of expert consultation are shown in Table 3.1. The Kendall's W coefficient for the first round was 0.507, and for the second round, it was 0.509, indicating a slight increase in consensus between the two rounds. Both rounds had Kendall's W values between 0.4 and 0.6, indicating good consistency among the experts. Additionally, the P-values for both rounds were 0.000, signifying that the results of this study are statistically significant.

Table 3.1 Statistical results of the expert consultation test

Inspection statistics	First round of expert consultation	The second round of expert consultation
The number of cases	20	20
Kendall coefficient of	0.507	0.509

concordance		
chi-square	354.631	335.619
free degree	35	33
Progressive significance	0.000	0.000

3.3.4.5 Inclusion of variables in the measurement indicator system

The Delphi expert consultation method used in this study primarily employed the boundary value method for indicator selection. The criteria for boundary values were defined as follows:

Boundary value for the arithmetic mean of importance scores = arithmetic mean of importance scores - standard deviation.

Boundary value for full score frequency = full score frequency mean - full score frequency standard deviation.

Boundary value for the coefficient of variation = arithmetic mean of the coefficient of variation + standard deviation of the coefficient of variation.

Indicators were included if they scored above the boundary values for importance scores and full score frequency and below the boundary value for the coefficient of variation. If an indicator failed to meet all three boundary criteria, it was excluded. If one or two criteria were not met, the indicator was classified as "pending deletion." These indicators were then reviewed with expert opinions and discussed by the research group, considering comprehensiveness, scientific validity, and feasibility before a final decision on deletion or retention was made. The boundary value standards for the first and second rounds of indicator selection are presented in Tables A.5 and A.6, respectively.

After two rounds of expert consultation, the average scores for the importance, full score frequency, and coefficient of variation of both primary and secondary indicators were calculated. The results of the expert opinion scores for the two rounds are presented in Tables A.7 and A.8.

After the first round of expert consultation, according to the indicator selection criteria, two secondary indicators did not meet the inclusion standards for the arithmetic mean, full score frequency, and coefficient of variation. These two indicators, "Experience working at a university or research institution" and "Political affiliation," were excluded. Additionally, a small number of both primary and secondary indicators failed to meet one or two of the inclusion criteria, but after discussion by the research team, these indicators were retained and included in the second round of consultation.

After the second round of expert consultation results, based on the boundary standards of the second round, the primary indicator "Overseas social capital" did not meet the criteria for all three boundary standards. However, its secondary indicator "Overseas experience" met the

inclusion criteria, and after discussion by the research group and expert opinions, "Overseas social capital" was retained for its feasibility and scientific relevance. Other primary and secondary indicators mostly met the boundary criteria, though a few indicators did not meet one or two standards. Among these, the primary innovation performance indicators "Number of patent applications filed by the company during the year" better represent innovation. Since the "Number of patents authorised during the year" is not available, it is removed. “The number of patents approved during that year” remains.

Through two rounds of expert consultation, the measurement index system was developed to include the following: entrepreneurs’ social capital with 4 primary indicators and 8 secondary indicators; dynamic capabilities with 3 primary indicators and 6 secondary indicators; innovation performance with 3 primary indicators; and control variable with 1 primary indicator and 6 secondary indicators. The detailed included indicators are presented in Table 3.2.

Table 3.2 Index evaluation system

Variable	Level 1 indicators	Level 2 indicators
Entrepreneur and social capital	Professional skills and social capital	Professional ranks and titles
		Record of formal schooling
		Professional background
	Political social capital	Political association
	Commercial social capital	Enterprise management experience
		Experience of working in a financial institution
		Industry association experience
	Overseas social capital	Overseas experience
Dynamic capability	Opportunity perception	R & d spending ratio
		Proportion of persons with a bachelor's degree or above
	Resource integration	Ratio of r & d personnel
		Industry-university-research cooperation
	Organizational reconfiguring capability	Senior management changes
		Roe
Innovative performance	Number of applied patents during that year	
	Number of applied clinical trial approvals during that year	
	Number of new products on the market during that year	
Controlled variable		Enterprise size
		Enterprise listing age
		Enterprise establishment age
		Enterprise nature
		Board size
		Share controlling of the general managers

3.4 Construction of verification model

Through the initial Delphi expert consultation process, the measurement indicator systems for entrepreneur social capital, dynamic capabilities, and innovation performance were established and confirmed. This work not only ensures the rigor and reliability of the study but also helps construct the verification model for entrepreneur social capital, dynamic capabilities, and corporate innovation performance.

As a talent-, knowledge-, and technology-intensive industry, innovation is essential for biopharmaceutical companies to gain core competencies and competitive advantages. However, relying solely on internal resources is often insufficient to meet competitive demands. Therefore, leveraging open social networks and dynamic external environments to explore valuable resources and pathways to satisfy innovation needs is crucial for biopharmaceutical companies to achieve competitive advantages. Corporate management involves participating in business activities and combining various production factors. Entrepreneurs, by making and organizing decisions related to business operations, serve the company. In this sense, entrepreneur social capital, which is shaped by both internal interpersonal networks and external social networks, provides reliable assurance for information gathering, resource acquisition, and mobilizing internal human resources (C. M. Chen & Zhou, 2001).

Moreover, research shows that companies need to consider institutional environments and the influence of top management when aiming to improve innovation performance. Entrepreneurial spirit can be an effective pathway to enhance performance and continuously gain competitive advantages (H. Gao, 2017). For instance, a theoretical model was developed to examine how political ties, business connections, overseas backgrounds, and personal professional skills—dimensions of entrepreneur social capital—affect the innovation performance of cultural and creative enterprises (Chu et al., 2019). Given that this study focuses on listed companies in the biopharmaceutical field, where rapid technological advancements occur, professional knowledge is critical for recognizing and seizing opportunities.

F. P. Ma (2011) developed a theoretical model where top managers' social capital, composed of political, business, and public social capital, influences technological innovation performance through resource acquisition, exploring the relationship between top managers' social capital and technological innovation performance. Similarly, F. Cui and Song (2022) constructed a model where entrepreneurial spirit affects innovation performance in small- and medium-sized enterprises through the mediating effect of dynamic capabilities, which comprise learning and absorption capacity, resource integration capability, and organizational

reconfiguration capacity. This model deeply analyzed the relationships among entrepreneurs, dynamic capabilities, and SMEs' innovation performance.

Further studies have directly constructed theoretical models to explore how enterprises' dynamic capabilities influence innovation performance. These studies suggest strategies such as enhancing investment in foundational R&D resources, strengthening collaboration with external research institutions, and optimizing internal knowledge networks to improve dynamic capabilities (Y. Wang & Li, 2024).

Based on the above research, this study employs the Delphi expert consultation method. Considering the characteristics of the biomedical industry, the study constructs the measurement dimensions for corporate innovation performance, including the number of patents filed by the firm, the number of clinical approval notices obtained, and the number of new products launched. The measurement dimensions of entrepreneurial social capital are categorized into professional skills social capital, political social capital, business social capital, and overseas social capital. The measurement dimensions of dynamic capabilities are divided into opportunity sensing capability, resource allocation capability, and organizational reconfiguration capability.

Based on these dimensions, the theoretical model shown in Figure 3.1 is refined, and the final verification model is shown as per Figure 3.3. This model aims to explore in-depth the impact of various dimensions of entrepreneurial social capital on the innovation performance of biomedical companies listed on the stock market. Additionally, it further analyzes the mediating effects of entrepreneurial social capital on innovation performance and the contingent factors involved.

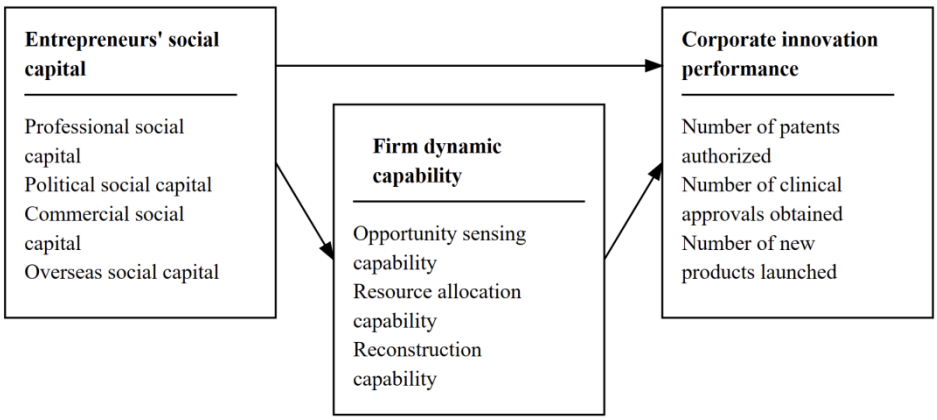

Figure 3.3 Verification model

3.5 Proposition of sub research hypotheses

Based on the theoretical model, the basic research hypotheses in 3.2 are refined and the sub-research hypotheses of the relationship between the dimensions of the variables are proposed.

3.5.1 Influence of entrepreneurs' social capital on corporate innovation performance

3.5.1.1 Professional skills social capital and innovation performance

The Professional skills social capital of entrepreneurs includes functional background, professional background, education level, professional titles, and whether they hold positions in universities or research institutions. Considering the talent- and knowledge-intensive nature of biopharmaceutical companies, and referencing the research of Chu et al. (2019), this study identifies the dimensions of entrepreneur Professional skills social capital as professional titles, educational level, and professional background.

The innovation performance of biopharmaceutical companies is closely related to the innovation capabilities of entrepreneurs, which are influenced by their professional expertise and research experience. According to a survey by J. J. Wu and Dai (2013) regarding high-tech enterprises in Xi'an, innovative talent must have a comprehensive knowledge system and strong creative motivation. Educational level is seen as a measure of the research and self-learning abilities of innovative talent, which can drive product innovation performance. Professional titles, on the other hand, serve as an indicator for efficiency-oriented talents, who acquire knowledge through experience and problem-solving in practice. Although professional titles may sometimes suppress product innovation performance, they enhance production efficiency. Other studies have noted that the innovation capabilities of top managers tend to improve with higher academic qualifications (Ding, 2011). Additionally, managers with advanced professional titles are more likely to be familiar with cutting-edge innovations in their industry, thereby promoting the company's overall innovation capacity (Custódio et al., 2017).

In terms of educational level, entrepreneurs with higher education are better equipped to explore information and accurately identify innovative opportunities, allowing them to seize new market avenues and help their companies remain competitive (T. Guo et al., 2018). For biopharmaceutical companies, which are highly knowledge- and technology-intensive, success depends not only on financial investment but also on the input of high-level professional talent. Professional backgrounds provide individuals with different values, attitudes, knowledge, and information-processing abilities, which play a crucial role in decision-making. A management

team with diverse professional backgrounds has a more refined awareness of their field, expands the company's cognitive scope, and tends to increase innovation investments to maintain a sustained competitive advantage (M. Li & Xia, 2022).

3.5.1.2 Political social capital and innovation performance

In the context of China's transitional economy, the market environment is still significantly influenced by the political environment. Entrepreneurs' governmental capital, reflected in their relationships with government departments or institutions, highlights the social standing and political background of entrepreneurs. Political connections are prevalent in private enterprises and serve as an alternative mechanism for companies seeking stability in markets where economic and legal systems are not fully developed. Research has indicated that by establishing political connections, private enterprises can send positive signals to stakeholders, thus addressing information asymmetry and facilitating easier access to financing (M. Li & Xia, 2022).

Furthermore, the government, as the policymaker and enforcer of public policy, formulates regulations and guidance for enterprises based on local development needs. Companies that align with government policies are likely to receive government support, such as policy incentives, financial subsidies, loans, and tax reductions. Such government backing can help businesses grow rapidly (Lei et al., 2014). Additionally, research on the impact of senior leadership on enterprise performance has shown that the political acumen of top corporate leaders can positively predict both short-term and long-term company performance, with political capabilities having a particularly significant role in promoting long-term performance (Y. Liang, 2019).

3.5.1.3 Entrepreneur commercial social capital and innovation performance

For entrepreneurs without political titles, they can protect their interests through commercial relationship networks. A commercial relationship network refers to the social relationships that entrepreneurs establish with external commercial organizations and authoritative associations (Jian et al., 2014), reflecting the relationships between a company and its suppliers, customers, and competitors (F. Liu et al., 2019). Through these networks, entrepreneurs can access innovation-related resources and reduce environmental uncertainty. This influence is primarily manifested in three aspects: First, it provides companies with innovation-related information, helping to alleviate information asymmetry. Second, it offers the necessary resources for innovation. Third, it brings innovation opportunities to the company (F. Liu et al., 2019).

In this study, commercial capital is measured through the entrepreneur's management experience, financial institution experience, and industry association roles. Entrepreneurial management experience reflects not only the entrepreneur's management abilities but also indicates whether the entrepreneur has established connections with other companies. Financial experience is particularly critical in the biopharmaceutical industry, where long R&D cycles and significant financial investments are essential. Such experience can assist with corporate financing, investment decisions, and financial risk mitigation. Additionally, industry associations serve as platforms for collaboration within the biopharmaceutical industry and holding a position in these associations reflects the entrepreneur's standing and influence in the sector.

Commercial social capital can influence innovation performance through two key mechanisms: First, it facilitates timely access to market information, which enhances innovation performance. Commercial relationships are vital pathways for transferring market information between organizations. Second, it promotes the transfer of technology and innovation knowledge, encouraging other organizations to participate in the company's innovation efforts and bringing technical and knowledge resources essential for innovation (F. Liu et al., 2019). Therefore, commercial relationships, primarily through access to market information and funding channels, provide convenience for enhancing corporate innovation capabilities.

3.5.1.4 Entrepreneur overseas social capital and innovation performance

In the biopharmaceutical industry, some overseas countries or regions have advanced earlier in both technical and corporate management aspects. Additionally, studying or working abroad plays a unique role in strengthening an entrepreneur's psychological resilience and adaptability. The unfamiliar language environment and living habits pose significant challenges to foreign individuals (J. Z. Zheng, 2004). Therefore, entrepreneurs with overseas backgrounds tend to have higher risk tolerance and greater resilience to failure, which can influence corporate operations and strategy execution. Studies have shown that overseas study and work experiences can affect professional performance and, consequently, corporate performance. Such experiences broaden entrepreneurs' international perspectives, allowing them to propose more innovative ideas and better fulfil advisory functions in their roles (Lan, 2023).

In the biopharmaceutical industry, entrepreneurs with overseas education or work experience may adopt superior foreign management concepts and drug development practices, leading them to prioritize R&D and innovation more than other executives. Some research

suggests increasing the proportion of executives with overseas backgrounds to further enhance corporate management philosophies and strengthen R&D innovation (Lan, 2023). This study examines the relationship between entrepreneur social capital and innovation performance, highlighting how the strength of social networks can significantly impact opportunity recognition. Furthermore, research indicates that entrepreneurs with overseas experience are adept at leveraging weak ties to identify business opportunities (P. S. Li & Li, 2011).

In summary, the following sub hypotheses are proposed:

H1a: There is a positive correlation between entrepreneurs' professional skills social capital and the corporate innovation performance;

H1b: There is a positive correlation between entrepreneurs' political social capital and the corporate innovation performance;

H1c: There is a positive correlation between entrepreneurs' commercial social capital and the corporate innovation performance;

H1d: There is a positive correlation between entrepreneurs' overseas social capital and the corporate innovation performance.

3.5.2 Entrepreneurs' social capital and dynamic capabilities

The value of entrepreneur social capital lies primarily in its capability to provide enterprises with access to external information, knowledge, and resources that help them overcome uncertainties in an ever-changing environment (Acquaah, 2007). The resources obtained through entrepreneur social capital positively impact the identification, integration, and reconfiguration of resources necessary for dynamic capabilities (Geng & Zhang, 2010). Entrepreneurs engage in exchanges, communication, and interaction within their network relationships, acquiring scarce external resources required for enterprise development. These new resources expand the enterprise's awareness of external opportunities and threats, potentially transforming into new internal resources. This process enables companies to integrate and reconfigure internal and external resources, thereby enhancing their capability to respond to changes in the external environment.

Each dimension of entrepreneur social capital has a significant positive influence on dynamic capabilities. The social capital resources obtained by entrepreneurs through social networks contribute to the enhancement and accumulation of dynamic capabilities within organizations. Additionally, empirical studies based on 173 private enterprises have shown that entrepreneurial spirit, particularly in relationship-building and technological aspects, plays a

positive moderating role in dynamic capabilities, and effective mobilization of Entrepreneur' social capital is essential for sustaining the development of organizational dynamic capabilities (J. Wu et al., 2019).

Non-institutional social capital, built by entrepreneurs through connections with government departments and agencies, helps enterprises access important information, favorable policies, financing, and other scarce resources. This resource restructuring—particularly the acquisition and reconfiguration of valuable, hard-to-obtain information—reduces uncertainty, mitigates risks, and decreases trial-and-error, thereby laying a resource foundation for improving dynamic capabilities (P. Zeng & Song, 2011). Social networks with industry associations and financial institutions allow entrepreneurs to gather information on customer preferences, understand industry dynamics, and reduce financial risks. This information facilitates resource allocation, knowledge absorption, and the capability to navigate a complex and changing environment, improving overall dynamic capabilities.

Moreover, entrepreneurs with overseas study or work experience possess international perspectives that aid in expanding market knowledge and adopting advanced biopharmaceutical technologies and management practices. The 2017 China Family Business Next-Generation Report pointed out that successors typically have broad international experience, which helps entrepreneurs in the biopharmaceutical industry gain insights into international market trends and apply cutting-edge management practices to drive dynamic capabilities (X. Wang & Chen, 2022). These advanced techniques and management ideas provide evidence and practical knowledge to support resource reconfiguration, enhancing firm dynamic capabilities.

Based on these insights, this study hypothesizes the impact of entrepreneurs' social capital in terms of professional skills, political social capital, commercial social capital and overseas social capital on different dimensions of dynamic capabilities. In summary, the following sub hypotheses are proposed.

H2a: There is a positive correlation between entrepreneurs' professional skills social capital and dynamic capabilities;

H2b: There is a positive correlation between entrepreneurs' commercial social capital and dynamic capabilities;

H2c: There is a positive correlation between entrepreneurs' political social capital and dynamic capabilities;

H2d: There is a positive correlation between entrepreneurs' overseas social capital and dynamic capabilities.

3.5.3 Dynamic capabilities and innovation performance

3.5.3.1 Opportunity sensing capability and innovation performance

In the biopharmaceutical industry, companies must accurately grasp market changes, including understanding customer needs, technological updates, responses from stakeholders, and changes in industry policies, in order to improve their sensitivity to opportunities and capability to seize them—referred to as opportunity sensing capability (Lv et al., 2020). This involves gathering critical information from various channels, analyzing signals of industry structural changes, identifying new technological opportunities, and adjusting strategies accordingly. The stronger the opportunity sensing capability, the more external information and opportunities a company can capture, the better it can avoid risks, and the greater its potential for innovation performance (L. X. Li et al., 2022).

Biopharmaceutical companies, operating in a highly innovation-dependent and rapidly evolving industry, are directly affected by the strength of their opportunity sensing capability, as it influences their capability to respond to favorable policies and capture market demands. Research has shown that firms with strong opportunity sensing capabilities can improve performance by identifying and leveraging market opportunities (H. X. Ge & Liang, 2020). Furthermore, strategies have been proposed that suggest companies should enhance their external sensing abilities, paying close attention to market information and changes, and using market demand to guide technological innovation. This would extend the innovation chain toward market and societal needs (D. R. Shen & Wang, 2012).

3.5.3.2 Resource allocation capability and innovation performance

Based on resource integration theory, the stronger a firm's resource integration capability, the more it can form core competitive advantages, thereby improving its operational capabilities and overall performance. According to innovation theory, innovation activities fundamentally involve analyzing and combining existing resources for optimal use. The more efficiently a firm can integrate and utilize its resources, the stronger its innovation activities will be.

Many scholars have explored the relationship between resource integration capability and innovation performance. For example, research on the mechanisms of self-driven innovation within enterprises has shown that resource integration supports the generation of innovative ideas, enhances research and development (R&D) capabilities, and facilitates the commercialization of new research outcomes (Rao, 2006). In addition, an analysis of technology-based small and micro enterprises found that resource integration capability, when

considered from the perspectives of identification, acquisition, allocation, and utilization, positively influences business model innovation (Z. H. Yi et al., 2018).

3.5.3.3 Organizational reconfiguration capability and innovation performance

Organizational reconfiguration involves adjusting and optimizing organizational flexibility to adapt to external environmental changes. It is an attempt by enterprises to gain competitive advantages by enhancing organizational flexibility. Biopharmaceutical companies operate in a rapidly changing technological environment, and strong organizational flexibility management is essential for adapting to future strategic shifts and correcting past decision-making errors(L. L. Zhang et al., 2014).

When external environments are dynamically changing, an enterprise's capability to maintain long-term profitability depends on its capacity to redistribute its organizational structure and assets in response to market or technological shifts. The key to enhancing innovation capability lies in reconfiguring internal and external resources and transforming organizational structures. Current research has reflected on organizational reconfiguration both from the perspective of significant changes in organizational structure and indirectly through financial performance. Empirical research based on a sample of 303 companies found that organizational reconfiguration capability significantly positively affects disruptive innovation, suggesting that firms need to focus on enhancing this capability (Z. J. Li, 2019). Organizational reconfiguration is considered a critical factor in the transition to new technologies, products, and operational models.

In summary, the following sub hypotheses are proposed.

H3a: There is a positive correlation between opportunity sensing capability and corporate innovation performance;

H3b: There is a positive correlation between resource allocation capability and corporate innovation performance;

H3c: There is a positive correlation between organizational reconfiguration capability and corporate innovation performance.

3.5.3.4 Organizational reconfiguration capability and innovation performance

As key participants of the market economy, the dynamic capabilities and innovation performance of the listed companies are not only subject to the influence of social capital, but also affected by a variety of factors, such as the enterprise nature, the enterprise listing age, and the proportion of the general manager's shareholding. First, the different natures of enterprises,

especially the division of state-owned enterprises and non-state-owned enterprises, will cause significant differences in resource allocation, business objectives and policy systems (Tang & Li, 2020). The state-owned enterprises have a special political and economic background, and the pressure of their tax burdens is significantly different from that of non-state-owned enterprises, which may affect the economic pressure of the enterprises and thus their resource allocation (Bao, 2020). In addition, state-owned enterprises with political and economic background may enjoy more favorable resource conditions and policy support, thus presenting better corporate dynamic capabilities and innovation performance. Second, the enterprise listing age reflects the market maturity and financing ability. Huynh and Petrunia pointed out that there is a non-linear "positive U-shaped" relationship between enterprise age and enterprise growth. Meanwhile, Evans (1987) contends that the enterprise age is an important determinant of its growth rate, and the growth rate decreases as the age increases. With the increase of listing age, the growth of the enterprise may increase accordingly, but it may also decrease due to the poor adaptability of the enterprise. Analysis of the listed enterprises shows that the listing age presents a negative correlation with enterprise growth (Liu, 2009). In other words, with the increase of the listing age, the enterprise may face more market challenges and competitive pressures. In addition, the shareholding percentage of the general manager is an effective link between the general manager and the long-term interests of the enterprise. The convergence of the general manager's interests with other shareholders' interests stimulates him to focus on the long-term development of the enterprise and enhance the innovation ability (Li, 2006). Chen (2009) pointed out that general manager's shareholding is positively correlated with the corporate performance through the analysis of 872 listed enterprises, and a possible reason may be that a higher shareholding percentage of the general manager can motivate him to pay more attention to the long-term development of the enterprise and the improvement of innovation ability, so that the enterprise can maintain competitiveness in the long term. In summary, the following supplementary hypotheses are proposed.

H5: There are significant differences between certain control variables of listed companies in terms of corporate innovation performance;

H6: There are significant differences between certain control variables of listed companies in terms of corporate dynamic capabilities.

3.6 Chapter summary

This chapter builds on the literature review and theoretical analysis in Chapter 2. Based on the

measurement frameworks developed through the Delphi method and the theoretical analysis derived from the literature, hypotheses were proposed regarding the relationships between entrepreneur social capital, dynamic capabilities, and innovation performance. Entrepreneur social capital is represented by four dimensions: professional skill capital, political social capital, commercial social capital, and overseas social capital. The innovation performance of biopharmaceutical companies is represented by the number of patents applied, clinical trial approvals obtained, and new products launched. Dynamic capabilities are categorized into three dimensions: opportunity sensing, resource integration, and organizational reconfiguration.

This chapter provides an in-depth exploration of how various dimensions of entrepreneur social capital influence innovation performance, while also examining the mediating role of dynamic capabilities in the relationship between entrepreneur social capital and innovation performance. Through logical inference, this chapter demonstrates the scientific relationships among entrepreneur social capital, innovation performance, and dynamic capabilities, and proposes corresponding hypotheses, as outlined in Table 3.3. The hypotheses suggest that the four dimensions of entrepreneur social capital significantly influence the innovation performance of biopharmaceutical companies, while also positively affecting the two dimensions of dynamic capabilities. Additionally, the three dimensions of dynamic capabilities positively influence innovation performance and act as mediators in the relationship between entrepreneur social capital and innovation performance.

Table 3.3 Hypotheses summary

H1	There is a positive correlation between Entrepreneur' social capital and corporate innovation performance.
	H1a: There is a positive correlation between entrepreneurs' professional skills social capital and the corporate innovation performance; H1b: There is a positive correlation between entrepreneurs' political social capital and the corporate innovation performance; H1c: There is a positive correlation between entrepreneurs' commercial social capital and the corporate innovation performance; H1d: There is a positive correlation between entrepreneurs' overseas social capital and the corporate innovation performance.
H2	Enterprise social capital has a positive correlation with the enterprise dynamic capability. H2a: There is a positive correlation between entrepreneurs' professional skills social capital and dynamic capabilities; H2b: There is a positive correlation between entrepreneurs' commercial social capital and dynamic capabilities; H2c: There is a positive correlation between entrepreneurs' political social capital and dynamic capabilities; H2d: There is a positive correlation between entrepreneurs' overseas social capital and dynamic capabilities.
H3	Enterprise dynamic capability is positively correlated with corporate innovation performance. H3a: There is a positive correlation between opportunity sensing capability and corporate innovation performance;

	H3b: There is a positive correlation between resource allocation capability and corporate innovation performance; H3c: There is a positive correlation between organizational reconfiguration capability and corporate innovation performance.
H4	Dynamic capability has an intermediary effect between entrepreneurs' social capital and innovation performance.
H5	There are significant differences between certain control variables of listed companies in terms of corporate innovation performance.
H6	There are significant differences between certain control variables of listed companies in terms of corporate dynamic capabilities.

Chapter 4: Research Design and Methods

4.1 Overall research design

This study adopts a mixed-methods approach, integrating both qualitative and quantitative research, to establish the dimensions and indicators of entrepreneurs' social capital, firms' dynamic capabilities, and firms' innovation performance. Drawing on the Schumpeterian innovation model and prior research findings, a hypothetical model is proposed. The relationships among entrepreneurs' social capital, firm dynamic capabilities, and corporate innovation performance are empirically tested using five years of panel data from listed biopharmaceutical companies. The research roadmap is presented in Figure 4.1.

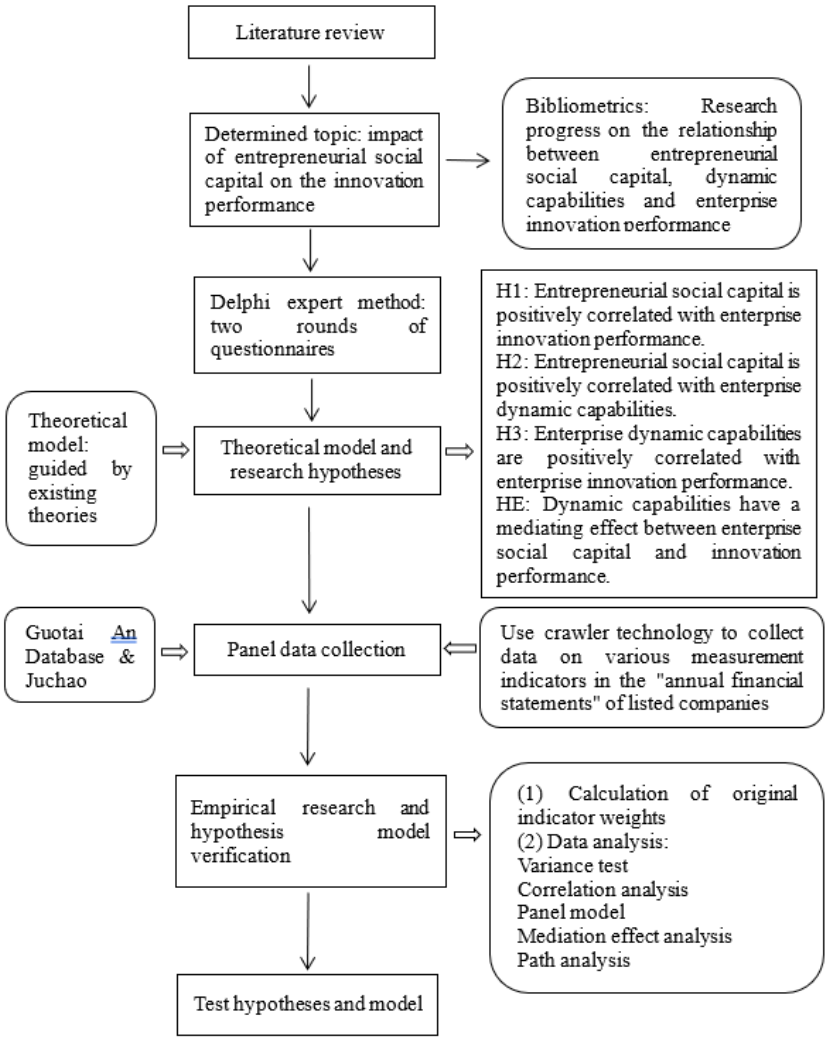

Figure 4.1 Research roadmap

4.2 Theoretical foundation and research method selection

Based on a comprehensive literature review, this study employed the Delphi expert consultation method. Feedback from 20 experts in the biopharmaceutical field was collected and analyzed to optimize and refine the measurement framework for entrepreneurs' social capital, dynamic capabilities, and innovation performance. This process resulted in the development of a scientifically rigorous and highly operational measurement system. Grounded in the theoretical framework of the Schumpeterian innovation model and incorporating relevant research findings, a systematic research hypothesis model was proposed.

To ensure the rationality and validity of the model, advanced web scraping techniques were utilized to collect relevant data, followed by data cleaning and organization using Excel to ensure accuracy and standardization. During the data analysis phase, the coefficient of variation method was first applied to calculate indicator weights. Subsequently, analysis of variance was used to conduct a preliminary assessment of significant differences in the data. Further exploration of the intrinsic relationships between variables was conducted using correlation analysis, and panel data modelling was employed to examine the dynamic effects of temporal and individual variations.

In addition, this study introduced mediation effect models and path models to uncover the complex causal relationships between variables. Through these methods, the hypothetical model underwent comprehensive validation, ensuring the scientific robustness of the theoretical framework and the empirical reliability of the model design. The methodological approach adopted in this study is systematic and rigorous, while the data analysis is thorough and in-depth, providing solid support for the validation of the research hypotheses.

4.3 Definition of research subjects

4.3.1 Biopharmaceutical companies

Biopharmaceutical companies refer to various types of enterprises engaged in the research and development (R&D), production, operation, and provision of services related to pharmaceuticals and medical devices. These companies primarily include pharmaceutical and medical device firms, manufacturers of drugs and devices, distribution enterprises, logistics companies, contract research and manufacturing organizations (CROs and CMOs), sales companies, as well as consulting and information service providers.

4.3.2 Chinese A-Share Main Board and GEM listed biopharmaceutical companies

This research focuses on the listed companies in the biopharmaceutical and medical device sectors within the Chinese A-share Main Board and the Growth Enterprises Market (GEM).

Chinese A-Share Main Board Listed Companies, also known as the companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange Main Board markets, are a crucial part of China's capital market. These markets provide mature, large-scale enterprises with access to financing and trading platforms. The Main Board market, being the primary means for investors to participate in China’s stock market, has relatively high listing standards and stringent regulatory requirements. These companies play a significant role in the national economy, demonstrating stable profitability and holding a substantial market share.

GEM Listed Companies refer to enterprises listed on the Growth Enterprises Market of the Shenzhen Stock Exchange. The GEM was established to support innovative and high-growth SMEs, which have different requirements than the Main Board. GEM-listed companies generally exhibit high growth potential, strong technological innovation capabilities, and significant market opportunities.

In summary, GEM-listed biopharmaceutical companies are small to medium-sized enterprises with significant growth and innovation potential, operating in the biopharmaceutical sector. These companies use the GEM to raise funds and drive further business development and industry innovation.

4.4 Research sample and data screening

This study focuses on listed companies in the biopharmaceutical and medical device sectors on China's A-share market. Based on the Shenwan Industry Classification Standard (2021 revised edition), the biopharmaceutical industry was meticulously categorized into subfields, including chemical pharmaceuticals, traditional Chinese medicine (TCM) II, biopharmaceuticals, and medical devices. Under strict screening criteria, an initial sample of 414 companies was selected. This selection process ensured the diversity and representativeness of the sample, providing a solid foundation for an in-depth analysis of the characteristics and market performance of enterprises across different subfields.

During the further refinement of the sample, companies under special treatment (ST or *ST) due to significant uncertainties flagged by the stock exchange were excluded. This decision was made considering the atypical risk factors associated with these companies, which might

adversely affect the generalizability and accuracy of the research findings. Additionally, to ensure data consistency and research coherence, listed companies that underwent significant business adjustments or transformations during the observation period were also excluded. Following this rigorous screening process, 216 companies meeting the study's research requirements and quality standards were finalized as the sample.

4.4.1 Data Sources

This study utilizes data from the Shenwan Industry Classification Standard (2021 revised edition), the CSMAR database (CSMAR), CNINFO (China Securities Regulatory Commission's official disclosure platform), and the National Medical Products Administration (NMPA) official website.

(1) Shenwan Industry Classification Standard

The Shenwan Industry Classification Standard, developed by Shenwan Hongyuan Securities Research Institute, is an investment-oriented industry classification system. It primarily considers the intrinsic connections and associations between products and services, while fully taking into account the current development status and characteristics of industries in China. This standard is designed for use by professionals in the investment field to conduct comparative analyses of company valuations, allocate industry assets, and evaluate investment performance.

The core philosophy of the Shenwan classification standard lies in capturing the intrinsic connections and associations between products and services. During its development, the standard carefully considered the unique features and current development of industries in China, aiming to meet the needs of investment professionals in company valuation, industry asset allocation, and investment performance assessment. By aligning with investors' understanding of industries, the classification ensures consistency in financial and market performance metrics, enhancing its applicability for investment management purposes.

Compared with global industry classification standards provided by renowned index providers such as MSCI and FTSE, the Shenwan standard reflects China's unique economic development and securities market characteristics. In defining industry categories, Shenwan not only takes an investment management perspective but also considers practical research requirements, particularly the alignment of industry statistical data. Specifically, in its second- and third-level industry classifications, the Shenwan standard integrates government and industry regulatory classification systems, ensuring high compatibility with existing industry

data and thereby improving its utility for macroeconomic analysis and industry research.

(2) CSMAR Database (China Stock Market Accounting Research)

The CSMAR Database, a leading data service provider in finance, economics, and management in China, is renowned for its data comprehensiveness, timeliness, high quality, and robust analytical tools. It covers a wide range of financial market information, including the stock market, bond market, and fund market, as well as key areas such as macroeconomics and corporate finance. The database supports teaching and research across disciplines like economics, finance, and management, facilitating policy studies, academic writing, and market analysis. It also provides comprehensive data resources for companies in market positioning, competitive analysis, and risk management.

Emphasizing data timeliness, the CSMAR database ensures users can access the latest market trends and economic indicators through regular updates. Its data undergo rigorous review and curation processes to ensure accuracy and reliability. With its authoritative data and comprehensive services, the CSMAR database is a vital resource widely used by universities, research institutions, and enterprises.

(3) CNINFO (www.cninfo.com.cn)

CNINFO, the official information disclosure platform designated by the China Securities Regulatory Commission (CSRC), was established in 1995 as China's earliest professional securities information website. It is also the first platform to comprehensively disclose announcements and market data for over 2,500 listed companies in Shanghai and Shenzhen. Operated by Shenzhen Securities Information Co., Ltd., CNINFO is recognized as an authoritative information disclosure platform for China’s capital market.

The platform is highly regarded for its comprehensive information disclosure, timely and accurate data updates, diverse service features, and user-friendly interface design. CNINFO provides extensive coverage of announcements, periodic reports, and interim reports for all listed companies in China’s securities market. Through real-time updates of market information and corporate announcements, the platform ensures users can access the latest market developments promptly.

Both the CSMAR Database and CNINFO hold significant influence in China's financial and economic fields, offering researchers, investors, and market analysts a wealth of data and convenient query tools.

(4) National Medical Products Administration (NMPA) Official Website

The National Medical Products Administration (NMPA) is a state administration directly under the State Council of the People's Republic of China. It is responsible for the regulation

of pharmaceuticals, medical devices, and cosmetics. The NMPA's primary responsibilities include:

a) Formulating Regulations and Policies: Drafting and implementing laws, regulations, and policy documents related to the management of pharmaceuticals, medical devices, and cosmetics.

b) Approval and Registration: Overseeing the approval and registration of pharmaceuticals, medical devices, and cosmetics, including clinical trial approvals for new drugs and marketing authorizations.

c) Quality Supervision: Conducting quality inspections to ensure that pharmaceuticals, medical devices, and cosmetics meet national standards.

d) Risk Management: Monitoring and evaluating adverse reactions to pharmaceuticals, medical devices, and cosmetics while issuing risk warnings and implementing control measures.

e) Law Enforcement: Investigating and addressing violations related to pharmaceuticals, medical devices, and cosmetics to maintain market order.

f) International Cooperation: Engaging in collaboration and exchanges with international regulatory agencies and participating in global pharmaceutical regulatory affairs.

The official website of the National Medical Products Administration (NMPA) of China allows users to query clinical registration and product registration information for enterprise products.

4.4.2 Data collection and cleaning

To enhance the efficiency of data collection, this study employed web scraping technology to efficiently extract 1,080 annual financial reports spanning five consecutive years for 216 companies from the CSMAR database and CNINFO repository. These reports are referred to as "annual reports" in the text. By searching various fields in these reports and organizing the retrieved data using Excel spreadsheets, the study ultimately obtained measurement values for indicators across different dimensions of the key variables.

The study focuses on three primary variables—entrepreneurs' social capital, firms' dynamic capabilities, and firms' innovation performance—along with control variables. The selection of these indicators aims to comprehensively evaluate and analyze the financial performance and market behavior of the sample firms, providing robust data support for an in-depth understanding of the underlying mechanisms and development trends within the biopharmaceutical industry.

(1) Data Sources for Measurement Indicators of Entrepreneurs' Social Capital Dimensions

The measurement indicators of entrepreneurs' social capital primarily refer to the professional skills, political, business, and overseas social capital of senior executives (specifically, the chairpersons and general managers serving in listed pharmaceutical companies in 2022). Key aspects include professional identity, professional background, political affiliation, corporate management experience, positions in financial institutions, roles in industry associations, and overseas study or work experience. Data were sourced from the CSMAR database using the following process.

First, data related to the chairpersons or general managers was filtered from the database, exported, and subjected to cleaning. This process involved removing non-target information and addressing cases where multiple individuals held the same position. Next, based on the cleaned data and the "Descriptive Statistics Table for Entrepreneurs' Social Capital Variables," measurement values were assigned to indicators such as the highest educational qualification, professional title, career background, overseas background, academic background, professional background, corporate management experience, and financial background of the entrepreneurs. Finally, the personal resumes of the entrepreneurs were reviewed to identify their roles in industry associations. These roles were then organized and assigned measurement values in conjunction with the descriptive statistics table for entrepreneurs' social capital variables.

(2) Data Sources for Measurement Indicators of Firms' Dynamic Capabilities Dimensions

Using the CSMAR database, panel data for the selected 216 firms were collected on key metrics, including "annual R&D expenditure," "annual sales revenue," "number of employees with a bachelor's degree or above," "number of technical staff," "total number of employees," "changes in senior management (chairperson and general manager)," "earnings before interest and taxes (EBIT)," and "average total assets."

First, data for listed pharmaceutical companies from 2018 to 2022, including R&D investment, personnel structure, governance information, financial metrics, and executive tenure, were exported from the database using specific filters in Excel format. Next, the AVERAGE function in Excel was used to compute the average total assets for each firm over the observation period. Data were cleaned using the filtering function in Excel, and variables related to senior management changes were assigned values accordingly. Last, to determine whether firms engaged in industry-academia collaboration, terms such as "technology licensing," "technology transfer," "joint development," "commercialization collaboration," and "industry-academia collaboration" were input into a web scraping tool to extract relevant information from 1,080 annual reports. The presence of industry-academia collaboration within

the five-year period was statistically analyzed, and the variable was assigned values in Excel using the descriptive statistics table for entrepreneurs' social capital variables. This method ensures accurate and comprehensive data collection, enabling robust measurement of firms' dynamic capabilities and their contributing factors.

(3) Data Sources for Measurement Indicators of Firms' Innovation Performance Dimensions

Using the CSMAR database, directly download the annual number of patent applications for firms. For the statistics on the number of clinical trial approvals obtained, web scraping technology was used to extract the "clinical trial approval" field from 1,080 annual reports. The annual reports containing this field were manually filtered. The number of clinical trial approvals was counted from the filtered reports. For the statistics on the number of new product launches, the operating licenses for drugs and medical devices of the 216 firms were first downloaded from the official website of the NMPA. Based on the drug names and launch dates, it was determined whether the firm had new product launches in that year. Using Excel spreadsheets, the annual patent application count, clinical trial approval count, and new product launch count for each firm were consolidated.

(4) Data Sources for Measurement Indicators of Control Variables

Entrepreneur-level (age, gender) and firm-level variables. Control variables include the following: firm size, industry classification, firm age, listing age, ownership type, board size, and CEO shareholding ratio. Among these, industry classification and ownership type are categorical variables. Firm size, listing age, board size, and CEO shareholding ratio are quantitative variables. Most of the data were directly sourced from the CSMAR database while some data were obtained through simple calculations.

4.4.3 Index weight calculation explanation

Based on the variable descriptions provided earlier, corporate innovation performance, Entrepreneur’ social capital, and dynamic capabilities are all composite indices. The corporate innovation performance index comprises three raw indicators; the Entrepreneur’ social capital index is constructed from four sub-dimension indices: professional skills capital, Political social capital, Business social capital, and overseas capital. The dynamic capabilities index is composed of three sub-dimension indices: opportunity sensing capability, resource allocation capability, and organizational reconfiguration capability. The calculation of index weights for these indicators is explained as follows:

Corporate innovation performance Index is composed of three raw indicators: the number of patents applied, the number of authorized clinical trial approvals, and the number of new products launched. The weight calculation for this index is relatively straightforward. Based on the standardization of the raw indicators, this study adopts the coefficient of variation method to calculate the comprehensive innovation performance index.

Entrepreneurs' Social Capital Index involves a more complex weight calculation due to its multi-layered indicator structure and the consideration of two categories of Entrepreneur' social capital: chairman's social capital and general manager's social capital. First, this study treats the chairman's and general manager's social capital separately. After standardizing the raw indicators, the coefficient of variation method is used to calculate the sub-dimension indices. Next, equal weights are assigned to the Chairman's and General Manager's social capital indices, which are then weighted and combined to form the overall Entrepreneur' social capital index.

Dynamic Capabilities Index weight calculation involves determining the weights of the three sub-dimensions—opportunity sensing capability, resource allocation capability, and organizational reconfiguration capability—along with the raw indicators within each sub-dimension. The coefficient of variation method is also applied to calculate the weights for these components.

In the fields of economics and social sciences, panel data, with its unique structure that combines both cross-sectional and time-series dimensions, provides a wealth of information. It enables comparisons across different individuals and time points, yielding more valuable insights. However, utilizing panel data for modelling involves complex model specification and parameter estimation. Choosing appropriate analytical tools is a critical step to ensure the accuracy of the analysis results (X. Hu et al., 2024).

The data for this study comes from listed biopharmaceutical companies on the Main Board and Growth Enterprise Market (GEM) of China's A-share market. Given the large volume and frequent updates of this data, manual collection is prone to incompleteness or omissions. Therefore, this study primarily employs web scraping technology to automatically access and collect data from web pages. Additionally, Stata 15 software is used to conduct the analysis. The Hausman test is first applied to determine the appropriate model type, followed by regression analyses using the Fixed Effects Model (FEM) and the Random Effects Model (REM) for the research model.

4.4.3.1 Weight calculation method explanation

A web crawler (also known as a spider) is an automated internet access program that traverses web pages and follows links to collect information. Its purpose is to download target webpage data locally for subsequent data analysis. This technology is widely used in fields such as search engines, data mining, and web monitoring.

In this study, the crawler program was written in Python, an object-oriented, interpreted, high-level programming language designed by Dutch programmer Guido van Rossum in 1991. Python is widely praised for its concise and readable syntax and powerful functionality. It has broad applications in web development, data analysis, artificial intelligence, and scientific computing (J. Wu et al., 2019).

The data for this study comes from the continuous five-year information datasets of biopharmaceutical companies listed on the Main Board and GEM of China's A-share market. Due to the large volume and frequent updates of the data, the use of a crawler program to automate webpage access and data collection helps to reduce errors and omissions that may arise from manual collection.

4.4.3.2 Data analysis methods

During data analysis, the study utilized software including Excel and Stata to process and analyze the data. The specific analysis methods are as follows:

Analysis of variance is a statistical method used to compare whether there are significant differences between the means of multiple groups. It examines the sources of variation in the data by decomposing total variation into between-group variation and within-group variation. This allows for assessing whether group factors have a significant effect on the outcomes. In this study, analysis of variance was used to examine whether there are significant differences in dynamic capabilities and innovation performance among firms with different ownership types (private, state-owned, and joint ventures) and across industry classifications (pharmaceuticals, medical devices, and a combination of both).

Correlation analysis evaluates the strength and direction of relationships between two or more variables. Common methods include Pearson and Spearman correlation coefficients. Pearson Correlation Coefficient is Applicable to continuous variables that follow a normal distribution. Spearman Rank Correlation Coefficient is Suitable for continuous variables or ordinal variables that do not follow a normal distribution. It is a non-parametric method that calculates correlation based on the ranks of variable values rather than their actual values. In this study, Spearman correlation analysis was employed to assess the relationships between

quantitative control variables and firms' dynamic capabilities and innovation performance.

A panel model is a commonly used econometric and statistical model designed to handle data with both cross-sectional (e.g., across individuals, regions, or companies) and temporal dimensions. Panel data consist of observations from multiple units (e.g., individuals, firms, or countries) across several time points. Compared with cross-sectional and time-series data, panel data provide more information, allowing for better control of individual heterogeneity and improved estimation efficiency. The advantages of panel models include: a) Improved Estimation Accuracy: Panel data fully utilize information across different times and individuals, enhancing the understanding and prediction of economic phenomena. b) Controlling Heterogeneity: By accounting for differences among individuals, panel models effectively capture latent heterogeneity and reduce omitted variable bias. c) Examining Dynamic Relationships: Panel data incorporate temporal information, enabling researchers to analyze the dynamic relationships between variables. In this study, as the data consist of five years of operational data from listed companies, it is necessary to consider the cross-temporal impacts of entrepreneurs' social capital on firms' dynamic capabilities and innovation performance. Therefore, the panel model was employed to analyze the effects of the independent variables on the dependent variables.

The path model is a statistical analysis method designed to study complex networks of relationships among multiple variables. It constructs a model comprising multiple linear equations to describe the direct and indirect effects among variables.

In a path model, each variable may be influenced by other variables while also influencing others. The relationships among variables are visually represented using causal diagrams, where arrows indicate paths and their directions represent the causal flow. By estimating the coefficients of these paths, researchers can quantify the strength and direction of effects among variables. Path models reveal not only the direct effects of one variable on another but also the indirect effects mediated by other variables. This method is widely applied in social sciences, psychology, and business research to understand complex dynamics among variables and provide a scientific basis for decision-making.

In this study, a path model was used to test the hypothetical relationships and paths among entrepreneurs' social capital, firms' dynamic capabilities, and innovation performance.

4.5 Definition and measurement of variables

4.5.1 Dependent variable: innovation performance

As knowledge-intensive enterprises, biopharmaceutical companies rely on continuous innovation as the source of their vitality and sustainable development. In a knowledge-intensive industry where technological advances and market demands are rapidly evolving, only companies that possess sustained innovation capabilities can adapt to these changes and enhance their market competitiveness. A comprehensive review of the literature, both domestic and international, shows that innovation performance is widely regarded as a key indicator of competitive advantage in high-tech industries.

Innovation performance refers to the outcomes achieved by a company through a series of innovation activities and can be understood as the returns obtained from investing internal system resources into the innovation process (Alegre & Chiva, 2013). It not only reflects the input-output efficiency of a firm's innovation activities but also represents the substantive impact of technological innovation on the enterprise. Innovation capability is the core factor determining a company's innovation performance.

This study, considering the characteristics of biopharmaceutical companies, takes a comprehensive approach to evaluating innovation performance by integrating several factors such as patent applications, the acquisition of clinical trial approvals, and the introduction of new products. By assessing innovation from these multiple dimensions, a more accurate measurement of the innovation potential and performance of listed biopharmaceutical companies is achieved, as outlined in Table A.9.

In the biopharmaceutical industry, innovation activities are unique due to the long R&D cycles, high entry barriers, and the close connection between scientific discoveries and industrial technologies. In academic research, patents are frequently used as a significant indicator to measure a company's innovation performance, including both the number of patents granted and the number of patents applied for each year (X. Huang et al., 2023; W. T. Liu et al., 2011; Y. Xie, 2022). Some scholars have highlighted that patent can enhance a company's business performance by improving its financing environment, boosting its corporate image, and indirectly promoting its operational success. Patents are also a crucial tool for measuring innovation, as they directly reflect a company's innovation capability (C. W. Zhao et al., 2023). Given that patent data is publicly available, follows standardized formats, is easy to collect, and is highly comparable, this study uses the annual number of new patent applications as one of

the key metrics for measuring innovation performance, reflecting the company's innovation efforts and outcomes.

Additionally, according to regulations set by the NMPA of China, drugs and medical devices must obtain clinical trial approvals before conducting clinical trials. This underscores the significance of clinical trial approvals in measuring innovation performance. In China, the 2006 Accounting Standards allow companies to capitalize R&D expenditures under certain conditions, recognizing them as intangible assets, a practice that continues today and aligns with the standards of countries such as the UK, Japan, France, and Australia. This measure aims to encourage companies to increase investment in R&D and innovation (L. J. Liu, 2022).

According to the Biotechnology Innovation Organization (BIO) report Clinical Development Success Rates 2006-2015, the success rates for clinical trial phases I, II, and III were reported as 63.2%, 30.7%, and 58.1%, respectively (Hernandez, 2016). Based on information disclosed over the past five years about the R&D spending of pharmaceutical companies, it was noted that many pharmaceutical companies use the approval for phase III clinical trials as a key development milestone. Of the 55 companies that did not specify clinical trial phases, 49 indicated the acquisition of clinical trial approvals as a key development stage for capitalizing R&D expenditures (L. J. Liu, 2022).

Given the diversity of products and drugs in the biopharmaceutical industry, this study includes the number of authorized clinical trial approvals as a key indicator in the measurement of innovation performance. By counting the number of NMPA-approved clinical trial approvals that a company obtains each year, this metric serves to assess the company's innovation capabilities. This multidimensional evaluation method of innovation performance provides a comprehensive reflection of biopharmaceutical companies' innovation output and potential.

In today's market environment, the shortening of product lifecycles and the trend toward personalized customer demands have driven companies to place greater emphasis on the development and launch of new products. The capability to bring new products to market quickly has become a key strategy for companies to establish and maintain a competitive advantage. Studies examining the impact of new product launch speed as an intermediary variable on corporate performance suggest that the timely launch of new products significantly enhances company performance (Kong et al., 2013).

Many scholars also use new product launches as a measure of innovation performance, typically focusing on metrics such as the number of new product launches, new product developments, and surveys comparing consumer perceptions of new and old products. Studies have adopted the number of new product launches as an innovation performance variable

(Ferreras-Méndez et al., 2021; Y. Q. Yi et al., 2018). This study adopts the number of new product launches as one of the key indicators for measuring innovation performance.

Considering the specific characteristics of the biopharmaceutical industry, "new products" in this context primarily refer to drugs and medical devices. Therefore, the study measures the number of new products by counting the number of production licenses for drugs or medical devices obtained by the companies within a given year. This approach directly reflects the company's capacity and efficiency in developing and bringing new products to market, thus providing a comprehensive assessment of its innovation performance. By using such quantifiable indicators, this study provides a more objective evaluation of biopharmaceutical companies' achievements in innovation and their market competitiveness.

4.5.2 Independent variable: entrepreneurs' social capital

In academic research, Entrepreneur' social capital is a multidimensional concept that encompasses various aspects such as professional skills, political connections, business networks, and overseas ties. In measuring Entrepreneur' social capital, this study adopts a four-dimensional framework, aligning with the standard practice in the existing literature.

First, Professional skills social capital reflects the entrepreneur's knowledge and expertise in their specialized field, often linked to their educational background, professional qualifications, and industry experience. Second, Political social capital pertains to the entrepreneur's relationships with government officials or political institutions, which may provide the company with advantageous access to policy support and resources. Third, Business social capital refers to the entrepreneur's connections and networks within the business sector, including relationships with other executives, industry associations, and market partners. Lastly, overseas social capital focuses on the entrepreneur's connections and influence in international markets.

In modern corporate governance, the roles of entrepreneurs are typically shared by the Chairman of the Board and the CEO. According to the Guidelines for the Articles of Association of Listed Companies in China, both the Chairman and CEO are vested with governance and management control, highlighting their critical roles in corporate governance and daily operations (Qin et al., 2021).

By employing this multidimensional measurement approach, the study aims to comprehensively assess the potential influence of entrepreneur' social capital on corporate innovation performance. This approach allows for a deeper understanding of the role of

entrepreneurs in driving innovation and enhancing competitiveness in their organizations.

(1) Entrepreneurs' professional skills capital

Biopharmaceutical companies are part of a highly competitive, innovation-driven, and technologically demanding high-tech industry. Innovation in these companies relies heavily on the professional capabilities of key members (Y. M. Yu et al., 2019). As the core and leadership figure of a company's innovation efforts, an entrepreneur with advanced professional skills possesses extensive domain-specific knowledge, which can significantly enhance their capability to manage, innovate, and guide the company's future development (Chu et al., 2019). Furthermore, an entrepreneur's personal traits and abilities are closely linked to their educational background and professional qualifications (J. Z. Wang & Gao, 2017). Educational attainment not only reflects the entrepreneur's level of education but also influences their cognitive abilities. According to H. L. Chen et al. (2010), the decision-making capability and information retrieval skills of senior management are influenced by their level of education. The higher their education, the greater their commitment to R&D investment and the stronger their capacity for innovation (H. L. Chen et al., 2010).

Professional titles, on the other hand, indicate that the entrepreneur has acquired broad knowledge and experience in areas such as technology, production, or R&D, which enhances the degree of innovation in the company. Y. M. Zhou (2019), through a study of high-tech companies in China's National Innovation Demonstration Zones, found that the education level and professional titles of entrepreneurs have a significant impact on corporate profitability. In addition, when making strategic decisions about the company's development and innovation, entrepreneurs are often influenced by their own technical background. J. Z. Zheng (2004), based on a survey of private technology companies in Zhejiang Province, found a significant positive correlation between the entrepreneur's academic background and company performance. Entrepreneurs with specialized knowledge and advanced information processing capabilities have a keener sense of industry trends, which allows them to expand the company's cognitive horizons and increase innovation investment, thereby gaining a competitive advantage.

Innovation in enterprises requires not only capital investment but also a highly skilled workforce. Drawing from Chu et al, (2019), the measurement methods for Professional skills social capital, this study measures entrepreneurial professional skills through three indicators: professional identity (measured by professional titles and education levels) and professional background (whether the entrepreneur graduated from institutions or programs related to the biopharmaceutical industry). These indicators comprehensively reflect the entrepreneur's knowledge and capability to access relevant information in the biopharmaceutical field.

Detailed measurement indicators are listed in Table A.10.

(2) Entrepreneurs' political social capital

In China's unique political environment and cultural context, the political connections of entrepreneurs play a crucial role in shaping business outcomes. These connections can bring a range of potential benefits to firms, such as creating a more favorable environment for R&D and innovation, expanding financing channels, obtaining fiscal resources, and increasing opportunities to access innovative talent (X. L. Wang & Li, 2015). Many scholars studying the impact of political connections on firms have found that such ties can mitigate the effects of strategic changes caused by external factors (Choi et al., 2021). Political connections are an important external resource for firms, helping them gain government support and protection, access scarce resources, and improve communication efficiency (Ren & Sun, 2019).

Drawing on the measurement methods for Political social capital proposed by Chu et al. (2019), this study uses entrepreneurial political connections as a key measure of government capital. Specifically, the study divides Political social capital into two dimensions: political affiliation and political status. Political affiliation is assessed based on whether the entrepreneur is a member of the Communist Party of China or any other political party. Political status is evaluated based on whether the entrepreneur holds official political positions, such as serving as a delegate to the National People's Congress or as a member of the Chinese People's Political Consultative Conference (CPPCC).

This detailed measurement approach aims to thoroughly analyze how an entrepreneur's Political social capital influences the firm's innovation performance and to explore the role and value of political connections in corporate development. This method not only helps quantify Political social capital but also provides an analytical framework for understanding how Political social capital promotes innovation through various pathways. The specific measurement indicators and scoring criteria are detailed in Table A.11 of this study. By employing this method, the research can more accurately assess the impact of Political social capital on the innovation performance of biopharmaceutical companies.

(3) Entrepreneurs' commercial social capital

An entrepreneur's commercial capital is an essential component of their social capital. It helps establish connections between the entrepreneur's unique resources and external industry resources, attracts attention from external investors, and positively impacts the firm's development (Bai et al., 2023). Several scholars have found that entrepreneurial business connections have a significant influence on a firm's innovation investments (N. Wang et al., 2019), not only facilitating information sharing and resource integration (L. Chen, 2021) but

also helping to reduce corporate risks and alleviate financial constraints (Gu & Bian, 2020).

These connections are typically measured by evaluating the entrepreneur's level of participation in industry associations, the number of part-time positions held at other firms, and financial work experience. Management experience is assessed by determining whether the entrepreneur holds positions at other companies, reflecting the breadth of their network and opportunities to connect with external entities. Financial work experience is evaluated by considering whether the entrepreneur has worked in sectors like banking, securities firms, or fund companies, indicating their capacity to manage corporate financial risks. Positions in industry associations are scored based on the entrepreneur's role and rank within the association, which reflects their influence and recognition within the industry. The detailed scoring criteria and specific measures are presented in Table A.12, providing a quantitative approach to assess the impact of entrepreneurial commercial capital on a firm's innovation performance.

(4) Entrepreneurs' overseas social capital

An entrepreneur's upbringing and educational background significantly shape their knowledge structure, thinking patterns, and decision-making behavior. Experiences gained through education at international institutions or work in foreign enterprises not only help entrepreneurs develop a global perspective but also enable them to accumulate advanced management experience and acquire cutting-edge knowledge and technologies (S. J. Guo et al., 2019). Studies have shown that executives with overseas backgrounds can significantly enhance a firm's innovation output and ease financial constraints (Y. Zheng et al., 2023). In the field of biopharmaceuticals, executives with overseas experience are more likely to focus on research and development (R&D) activities due to their exposure to advanced management practices abroad and their heightened sensitivity to international market risks and the latest trends in drug development (L. Wang, 2020).

Drawing on panel data and based on X. Wang and Chen (2022) methodology for measuring overseas experience, this study incorporates entrepreneurs' overseas experiences as a key part of their social capital. The assessment of an entrepreneur's international perspective and market sensitivity is measured by evaluating whether they have studied or worked abroad, as well as the number of board members with overseas backgrounds. Specifically, if an entrepreneur has studied or worked overseas, they are assigned scores of 1 or 2 based on the context; if they lack any overseas education, the score is 3. Detailed scoring criteria are presented in Table A.13. The overseas experience of the management team is measured by counting the number of directors with overseas backgrounds. This quantitative approach allows the study to assess how an entrepreneur's overseas experience impacts innovation performance and provides new insights

into the role of social capital in driving corporate innovation.

4.5.3 Mediating variable: dynamic capabilities

Currently, empirical research on dynamic capabilities often relies on survey questionnaires to collect data, which serve as the basis for measurement. These questionnaires typically focus on evaluating a firm's opportunity sensing capability, resource integration capability, and organizational restructuring capability. Opportunity sensing capability reflects a firm's capacity to identify and seize market opportunities; resource integration capability pertains to the firm's capability to acquire and allocate resources effectively in varying environments; and organizational restructuring capability describes the firm's capability to adjust its organizational structure and processes in response to market changes.

When examining dynamic capabilities, thus study has drawn upon the methodological approaches of scholars (C. Peng et al., 2022; L. Yang et al., 2020). Using panel data for in-depth analysis, dynamic capabilities are decomposed into three key dimensions: opportunity sensing capability, resource allocation capability, and organizational restructuring capability, with corresponding indicators selected for each dimension for quantifiable measurement. Opportunity sensing capability can be measured by assessing the firm's sensitivity to market trends and its capability to identify new business opportunities. Resource allocation capability can be evaluated by the firm's capacity to acquire key resources, technologies, and talent, as well as the efficiency of resource allocation. Organizational restructuring capability can be reflected in the firm's organizational flexibility, process innovation, and capability to rapidly respond to market changes.

Through detailed examination of these dimensions, this study aims to uncover how dynamic capabilities serve as a mediating variable affecting the innovation performance of firms. The specific measurement indicators and methods are outlined in Table A.14. This provides a systematic framework for understanding the role of dynamic capabilities in the innovation process.

(1) Opportunity sensing capability

The establishment of opportunity sensing capability means that a firm must continuously seek out relevant technologies and information to adapt to changes in the market environment. This includes understanding customer needs, technological possibilities, structural changes in the industry and market, and potential reactions from suppliers and stakeholders (Lv et al., 2020). Opportunity sensing is primarily achieved through three paths: generating market

intelligence, disseminating market intelligence, and responding to market intelligence (Jia et al., 2023). This study posits that these sensing abilities can be developed through processes that deeply involve the firm's employees. The higher the knowledge level of employees, the better their insight into external market conditions.

Drawing from relevant research, this study uses the proportion of employees with a bachelor's degree or higher as an indicator to measure the firm's capability to sense external opportunities or threats. This serves as a proxy for employee quality and knowledge acquisition capabilities. A higher proportion of employees with higher education levels indicates better professional skills and learning abilities, which in turn enhances the firm's capacity to perceive opportunities or threats in the external environment (Ai & Peng, 2021).

Additionally, the R&D expenditure ratio—the ratio of a firm's R&D spending to its sales revenue—reflects the firm's emphasis on knowledge and innovation, indirectly indicating its capability to perceive market needs. A higher R&D intensity also contributes to the effective acquisition of external technologies, making it a valuable factor to include in this research (P. Liu & Wu, 2022; Mo et al., 2023).

(2) Resource allocation capability

A firm's resources can be broadly divided into internal and external resources. Employees, particularly in high-tech enterprises, are considered internal resources, with R&D personnel being the core source of innovation. High-tech enterprises rely more heavily on their R&D personnel as these employees directly reflect the firm's level of innovation and internal resource acquisition capability (Y. D. Hu & Zhong, 2011). Drawing from the measurement method used by C. Peng (2022), this study uses the proportion of technical personnel to assess internal resource capability. The ratio of technical personnel to the total number of employees serves as an indicator of the firm's core competitiveness.

Industry-academia-research cooperation refers to collaborations between companies and universities or research institutions, typically where the company is the demand-side entity seeking technology, and the university or research institution is the supply-side provider of such technology. This cooperation is an important means for enterprises to acquire external innovation resources (Z. G. Zhang et al., 2017). Research has shown that industry-academia-research cooperation helps improve the quality of corporate innovation (J. Y. Wang et al., 2023). Additionally, establishing R&D bases within the enterprise and collaborating with academic or research institutions fosters a more stable and effective innovation-to-market pipeline, helping to overcome barriers to the commercialization of technological innovations and thereby enhancing a firm's innovation performance (W. Cui et al., 2022).

Referencing Y. Xia and Jia's (2023) method for measuring industry-academia-research cooperation, this study measures a firm's capability to access external resources by assessing whether it participates in industry-academia-research projects. Specifically, the method involves checking the firm's website, annual reports, and semi-annual reports to determine whether the firm has engaged in cooperation with other companies, universities, or research institutions in a given year. If the firm cooperates with universities or research institutions, it is assigned a value of 1; cooperation with other companies is assigned a value of 2, and if no cooperation is reported, the value is 0.

(3) Organizational reconfiguration capability

Organizational reconfiguration capability is a key concept in operational management. Existing literature suggests that reconfiguration capability refers to a firm's capability to reorganize and restructure its current operational capabilities in response to a volatile external market environment (Chi et al., 2020). Additionally, organizational reconfiguration capability has been shown to have a positive effect on disruptive innovation within firms (Z. J. Li, 2019). Many scholars define organizational reconfiguration as the firm's capability to make appropriate adjustments in response to external changes, such as adopting new strategies, delegating new authority, or undergoing management changes (F. Cui & Song, 2022). Drawing from Peng Cheng and Meng Wei's methods for measuring reconfiguration capability (Meng, 2016; C. Peng et al., 2022), this study uses management changes and return on assets to assess organizational reconfiguration capability.

First, under conditions of environmental uncertainty, firms need to make timely management changes to sustain growth, as such changes are mechanisms for strategic transformation (A. C. Pan & Wang, 2011). Management is central to corporate governance, and research indicates that senior executives contribute significantly to the firm's market value compared to other employees (R. B. Liang et al., 2021). Additionally, the capabilities of senior managers tend to increase with their tenure, as longer tenures can foster a sense of belonging and entrepreneurial spirit (Qin et al., 2021). Thus, this study incorporates management change as an indicator of organizational reconfiguration capability. Specifically, the study measures whether a firm experienced changes in its chairman or CEO positions during the year. A value of 1 is assigned if either position changed, and 0 otherwise.

Based on existing literature, return on assets (ROA) has also been considered a key indicator of reconfiguration capability, as it reflects a firm's resource utilization and operational efficiency, thus highlighting its resource integration capacity (Ai & Peng, 2021). Following this approach, this study uses ROA, calculated as the ratio of earnings before interest and taxes

(EBIT) to the average total assets, to measure the firm's resource integration capability and evaluate its organizational reconfiguration capability (see Table A.15).

4.5.4 Control variables

Apart from the influence of Entrepreneur' social capital and dynamic capabilities, a firm's level of innovation is also affected by various other factors at both the entrepreneur and firm level. Drawing on relevant literature concerning the factors influencing corporate innovation, this study incorporates the following control variables from both entrepreneur-level and firm-level dimensions into the model, as summarized in Table A.16

(1) Entrepreneur-Level Variables

First, Entrepreneur Age: Age is an important individual characteristic variable that reflects an entrepreneur's life experience, accumulated knowledge, and mental maturity. These factors can influence the entrepreneur's decision-making style, preferences, and strategic choices, which in turn impact the firm's innovation performance. Research suggests a U-shaped nonlinear relationship between entrepreneurial age and innovation spirit (Cheng & Han, 2016). Moreover, entrepreneurs of different ages exhibit varying motivations for innovation. Older entrepreneurs tend to be more motivated by opportunities than younger ones (Sedaghat & Lei, 2020). Therefore, age is included as a control variable, with the entrepreneur's actual age, typically the chairman's, categorized and added to the model as a categorical variable.

Second, Entrepreneur Gender: Historically and socially, research on entrepreneurship has often focused on male entrepreneurs, leading to stereotypes associating business success primarily with men. This bias has contributed to a perception that female entrepreneurs are less capable than their male counterparts (Z. J. Li, 2019). Gender differences may also influence an individual's capability to perceive certain risks. For instance, research shows that male and female entrepreneurs perceive financial risks differently (Kozubíková et al., 2017), while in small firms, female entrepreneurs have been shown to positively affect product and technology innovation (Zastempowski & Cyfert, 2021). Additionally, studies on the impact of CEO gender on corporate social responsibility (CSR) decisions indicate that the gender of senior executives significantly affects CSR quality. When the CEO is female or when there is a higher proportion of women in the executive team, the quality of CSR improves. In this study, entrepreneur gender is defined based on the chairman's gender. If the chairman is male, a value of 1 is assigned; if female, a value of 0 is assigned.

(2) Firm-level variables

First, Firm Size: The scale of a company reflects its resource base, and different firm sizes can have a positive impact on both innovation decisions and outputs. Expanding firm size may enhance a company's research and development (R&D) capabilities and efficiency (J. Yu et al., 2023). Following the measurement approach used by W. Cui et al. (2022), this study uses the natural logarithm of the number of employees to measure firm size.

Second, Firm Listing Age: According to the corporate life cycle theory, as a firm's listing age increases, factors such as brand recognition, stability, and goodwill may change, which in turn influences its access to investment and the degree of financing constraints (Z. Huang, 2021). Research has shown that the age of a firm's listing can significantly affect its operational scale and efficiency as it matures (H. M. Lei et al., 2014). In this study, the listing age is measured by subtracting the firm's listing year from the observation year.

Third, Firm Ownership: The nature of a firm's ownership is a fundamental attribute that can affect many aspects, including resource allocation, business objectives, and policy frameworks (H. X. Tang & Li, 2020). In this study, firms are categorized as state-owned enterprises (SOEs) or non-state-owned enterprises (non-SOEs). If a firm is state-owned, a value of 1 is assigned; if non-state-owned, a value of 0 is assigned.

Fourth, Industry Classification: The industry classification has the following three types: pharmaceuticals, medical devices, and a combination of pharmaceuticals and medical devices.

Pharmaceutical industry is focused on the R&D, production, and sales of drugs. the impact on firm innovation mainly lies in continuous drug development to meet demand and maintain competitive advantages. Medical device industry is focused on the R&D, production, and sales of equipment. The influence lies in technological breakthroughs and product iteration, requiring new technology development to enhance performance, safety, and usability. As for the combination of pharmaceuticals and medical devices, the impact is more complex and comprehensive, requiring firms to balance innovation in both drugs and devices. This necessitates cross-disciplinary R&D and resource integration capabilities. Collaborative development provides better solutions for patients.

Fifth, Board Size: The size of a firm's board can influence decision-making. In firms with limited resources, a larger board can provide management with diverse experiences, information, and resources, facilitating resource integration and promoting business development (Ren & Sun, 2019). The size of the board is measured by the number of board members. See Table A.16 for the detailed assignment of control variable values.

Sixth, General Manager's Shareholding Ratio: The relationship between management shareholding and firm performance is debated in the literature, with two main viewpoints:

alignment effect and entrenchment effect. The alignment effect suggests that managerial shareholding aligns the interests of managers and shareholders, reducing agency costs and positively impacting the firm. On the other hand, the entrenchment effect argues that as the shareholding ratio of management, especially the general manager, increases, their control over the firm strengthens, which might lead them to divert resources for personal benefit at the expense of shareholders (R. Wang, 2017). Therefore, the shareholding ratio of the general manager is added as a control variable to assess its potential influence on the innovation performance of biopharmaceutical firms.

4.6 Chapter summary

This chapter defined the research subjects and elaborated on the selection process of the research sample, the data sources, and the technical procedures used for data screening. The steps involved in data filtering were detailed to ensure the accuracy and reliability of the data. For the three main variables—entrepreneurs' social capital, firm dynamic capabilities, and corporate innovation performance—along with the control variables, this chapter has explained the criteria for selecting the measurement indicators for each dimension.

Additionally, this study conducted a statistical descriptive analysis of the collected data to gain a preliminary understanding of its characteristics and distribution. The chapter also introduced the statistical tools, specific analysis methods, and the econometric model used in this research, laying a solid foundation for the subsequent data analysis and discussion of results. Through these rigorous steps and methodologies, this study aims to ensure the scientific rigor and reliability of the research.

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Chapter 5: Research Results

From July to August 2024, this study conducted a statistical analysis of relevant data from 216 publicly listed companies in China's pharmaceutical industry. The sample included data from five fiscal years, from 2018 to 2022, yielding a total of 1080 rows of observational data.

For data analysis, software tools such as Excel, SPSS, Stata, and AMOS were utilized. Excel was employed for descriptive statistical analysis of the basic information on the subjects, detailing entrepreneurs' social capital, dynamic capabilities, and innovation performance levels. Stata was used to analyze panel models, while SPSS version 22 was utilized for variance testing, correlation analysis, linear regression analysis, and mediation effect analysis. AMOS was used for model path analysis.

The main findings are as follows: Entrepreneurs' social capital is significantly positively correlated with corporate innovation performance. Similarly, entrepreneurs' social capital and corporate dynamic capabilities are significantly positively correlated. Dynamic capabilities are also significantly positively correlated with innovation performance. Corporate dynamic capabilities partially mediate the relationship between entrepreneurs' social capital and corporate innovation performance. Significant differences were observed in innovation performance depending on the nature of the business and the year of listing, as well as in dynamic capabilities based on the nature of the business and the percentage of shares held by the general manager.

5.1 Descriptive statistical analysis

This thesis conducted a descriptive statistical analysis on the basic information of publicly listed companies, entrepreneurs' social capital, corporate dynamic capabilities, and innovation performance levels. The sample included 216 companies, comprising 1080 rows of observational data, covering basic information such as the nature of the business, industry sector, company size, year of listing, board size, and the percentage of shares held by the general manager. The specific analysis results are as follows:

5.1.1 Basic information analysis statistics

Table A.16 reveals multiple dimensions of information about the sample companies, including year of listing, company size, board size, percentage of shares held by the general manager, nature of the business, and industry sector (pharmaceutical/medical devices).

Regarding the year of listing, the data shows a clear concentration trend. Specifically, the majority of companies, 102, were listed between 2010 and 2017, accounting for 47.2% of the sample. Fewer companies were listed in earlier intervals (1992-1998, 1998-2004), accounting for 17.6%, reflecting a trend of increasing listings over time.

In terms of company size, the data shows a normal distribution. The majority of companies, 106, fall within the 2.97-3.56 range, accounting for 49.1% of the sample, indicating that the majority of companies are of medium size. Both larger and smaller companies are relatively less common, reflecting a balanced distribution of company sizes.

Regarding board size, the data shows a concentration in larger board sizes. The majority of companies, 55%, have a board size of more than 7 people, indicating a preference for setting up larger boards. Companies with smaller or much larger boards are relatively less common, accounting for 30.833% and 1.6% respectively.

The percentage of shares held by the general manager reveals both the prevalence and diversity of shareholding among the sample companies. A large majority of companies (87.222%) have a general manager shareholding of 15.3% or less, indicating that while it is common for general managers to hold shares, the percentages are relatively low.

In terms of the nature of the business, privately owned companies are the most common, accounting for 71% of the sample, indicating the dominant position of private enterprises. State-owned and joint venture companies are relatively less common, accounting for 23.9% and 5.1% respectively, reflecting the distribution of different ownership types within the sample.

In terms of sector, the pharmaceutical company has the largest number, accounting for 57.5% of the sample, indicating that pharmaceutical companies constitute a significant proportion of the sample. Medical device companies and those involved in both pharmaceuticals and medical devices are relatively less common, accounting for 23.1% and 19.4% respectively.

5.1.2 Descriptive statistical analysis of entrepreneurs' social capital, dynamic capabilities, and innovation performance levels

Tables A.17 to A.19 display the scores of the study subjects in terms of entrepreneurs’ social capital, dynamic capabilities, and corporate innovation performance, including their

performance across various dimensions and overall scores.

Entrepreneurs' Social Capital includes four dimensions: Professional Skills Capital, Political social capital, Business social capital, and Overseas Social Capital. The scoring details for each dimension are as follows:

Professional Skills Social Capital: Mean scores is 0.381, showing a wide span, which indicates that the level of Professional skills social capital is moderately high on average. The standard deviation of 0.197 suggests relatively small individual differences. The median of 0.296 is slightly below the average, implying a slight right skew in the data distribution. The variance of 2.701 further verifies a moderate dispersion in the data distribution. A kurtosis of 1.838 indicates that the data distribution is slightly more peaked than a normal distribution, and a skewness of 1.838 clearly points to the data's right-skewed characteristic. A coefficient of variation of 0.516 indicates a moderate relative volatility of Professional skills social capital within the sample.

Political Social Capital: The average score is 0.319, indicating that Political social capital is generally moderate but slightly lower than professional skills capital. The standard deviation of 0.258 shows relatively larger individual differences. The median of 0.037 is significantly lower than the average, indicating a significant right skew in the data distribution. The coefficient of variation of 0.602 indicates that the volatility of Political social capital in the sample is relatively high.

Commercial Social Capital: Scores range from 0 to 1, covering the entire spectrum from zero to maximum. The average score is 0.373, suggesting that the overall level of Business social capital is moderately high. The standard deviation of 0.190 indicates a relatively compact data distribution. The median of 0.036 is significantly lower than the average, suggesting a significant right skew in the data distribution. A kurtosis of 0.582 is small, indicating a low degree of dispersion. A skewness of 1.006 indicates a rightward skew, and a coefficient of variation of 0.509 indicates that the relative volatility of Business social capital in the sample is moderate.

Overseas Social Capital: Scores range from 0 to 1, with an average score of 0.212, indicating that overall, the level of overseas social capital is relatively low. The standard deviation of 0.216 suggests a more dispersed data distribution. The median of 0.045 is significantly lower than the average, indicating a clear right skew in the data distribution. A variance of 2.803 is relatively high, reflecting a higher degree of dispersion in the data distribution. Kurtosis of 2.5 and skewness of 1.955 respectively reveal the peaked nature of the data distribution and its rightward skew. A coefficient of variation of 0.718 indicates that the

volatility of overseas social capital in the sample is relatively high.

Overall Entrepreneurs' Social Capital: The mean is 0.335, indicating that the overall level of entrepreneurs' social capital is moderate. The standard deviation of 0.128 indicates a relatively compact data distribution. The median of 0.304 is slightly lower than the average, suggesting a slight right skew in the data distribution. A coefficient of variation of 0.383 indicates that the relative volatility of entrepreneurs' social capital in the sample is relatively low.

Corporate Dynamic Capabilities consist of three dimensions: Opportunity Sensing Capability, Resource Allocation Capability, and Organizational Reconfiguration Capability. The scoring details for each dimension are as follows:

Opportunity Sensing Capability: Scores range between the maximum and minimum values, with an average of 0.271, indicating that the overall sample is at a moderately low level in opportunity sensing capability. The standard deviation of 0.133 suggests relatively small individual differences, albeit with some variation. The median of 0.254, slightly below the average, suggests a slight rightward skew in the data distribution. A variance of 0.018 further confirms a moderate level of data dispersion. A kurtosis of 3.408 indicates that the data distribution is steeper than a normal distribution, with more extreme values; a skewness of 1.233 indicates a rightward skew. The coefficient of variation of 0.49 indicates that the relative volatility of opportunity sensing capability is moderate.

Resource Allocation Capability: Scores range between 1 and 0, covering the entire spectrum of resource allocation capability. The average score is 0.248, showing that the overall sample also has a relatively low level of resource allocation capability; the standard deviation of 0.112 indicates relatively small individual differences. The median of 0.235, slightly below the average, suggests a rightward skew. A small variance of 0.012 indicates a relatively concentrated data distribution. A kurtosis of 2.874 and a skewness of 1.013 respectively reveal the steepness and direction of the data distribution skew. The coefficient of variation of 0.449 indicates that the relative volatility of resource allocation capability is slightly lower than that of opportunity sensing capability.

Organizational Reconfiguration Capability: Scores range between 1 and 0, indicating that the variable covers the full range of possible values. The average score of 0.308 is relatively high, suggesting that the overall sample has good organizational reconfiguration capability; however, a high standard deviation of 0.317 indicates very large individual differences, with a fairly dispersed data distribution. The median of 0.161, much lower than the average, strongly suggests a severe skew in the data distribution. A larger variance of 0.101 further confirms the

data's dispersion. A kurtosis of -0.468 and a skewness of 1.164 indicate a relatively flat distribution with a rightward skew. A high coefficient of variation of 1.029 indicates that the relative volatility of organizational reconfiguration capability is very high.

Overall Dynamic Capabilities: Scores range between 1 and 0, displaying the complete range of variable values. The average score of 0.36 indicates that the overall sample performs well in terms of dynamic capabilities; the standard deviation of 0.25 suggests moderate individual differences. The median of 0.269, slightly below the average but not by a large margin, suggests a relatively balanced data distribution. A smaller variance of 0.062 indicates a relatively concentrated data distribution. A kurtosis of -0.53 and a skewness of 0.932 respectively reveal the flatness and skew direction of the data distribution. A relatively low coefficient of variation of 0.694 indicates that the relative volatility of dynamic capabilities is low, with a stable data distribution.

The innovation performance is a single-dimension variable, with scores ranging from a maximum of 0.671 to a minimum of 0. The average score is 0.044, reflecting a relatively low average level of innovation performance across the sample. The standard deviation of 0.054 indicates a moderate degree of dispersion around the average, yet there is still some variability. The median of 0.029, which is lower than the average, reveals a potential leftward skew in the data distribution, suggesting that most of the sample's innovation performances are concentrated at lower levels. A variance of 0.003 further confirms the small range of fluctuation in the data, but coupled with a kurtosis value of 30.828, which far exceeds the normal distribution's standard kurtosis value of 3, this indicates an extremely peaked distribution, with data values concentrated near the mean and extreme values, though few, deviating significantly. A skewness of 4.246, significantly greater than 0, shows a strong positive skewness, indicating that the data skews leftward, with lower performance values occurring more frequently. The coefficient of variation (CV) of 1.238 suggests that the variability of innovation performance is relatively high compared to its average value, indicating significant differences in innovation performance among the samples.

5.2 Analysis of variance

5.2.1 Firm nature

Table A.20 shows that the mean values for dynamic capabilities are 0.343 for private enterprises, 0.413 for state-owned enterprises, and 0.36 for joint ventures. Due to the non-homogeneity of

variances, Welch's ANOVA was utilized. The results show a P-value of 0.002***, which is less than or equal to 0.05, indicating significant statistical differences in dynamic capabilities among different types of enterprises. For innovation performance, the mean values are 0.041 for private enterprises, 0.052 for state-owned enterprises, and 0.046 for joint ventures. As the assumption of homogeneity of variances was met, one-way ANOVA was conducted, with a P-value of 0.026 ≤ 0.05, thus indicating significant differences in innovation performance among different enterprise types.

5.2.2 Industry sector

Table A.21 shows the mean values for dynamic capabilities in the pharmaceutical, medical devices, and combined enterprises are 0.359, 0.359, and 0.364, respectively. One-way ANOVA was conducted as the assumption of homogeneity of variances was satisfied. The P-value was 0.969 > 0.05, hence the results are not statistically significant, indicating no significant differences in dynamic capabilities across these industry sectors. The mean values for innovation performance are 0.043 for pharmaceutical, 0.04 for medical devices, and 0.051 for combined enterprises. Again, homogeneity of variances was satisfied, and one-way ANOVA resulted in a P-value of 0.053 > 0.05, suggesting no significant differences in innovation performance across these sectors.

5.3 Correlation analysis

Before conducting the correlation analysis on quantitative data, a normality test was performed to determine the appropriate method of analysis. As the normality was not satisfied for variables such as company size, year of listing, board size, general manager's shareholding, dynamic capabilities, and innovation performance, Spearman's correlation analysis was employed. Table A.22 reveals that there is a significant correlation between the general manager's shareholding and dynamic capabilities, and between the year of listing and innovation performance.

5.4 Panel model analysis

Panel data model is a commonly used econometric and statistical model often applied to handle data across time and across entities (such as regions, companies). Panel data consist of observations from multiple units (like individuals, companies, or countries) at multiple time points. Compared to cross-sectional data and time-series data, panel data provide more

information, enabling the control of heterogeneity among individuals and enhancing the efficiency of estimations.

Basic types of panel models are:

1. Fixed Effects Model (FEM): This model assumes that each individual's characteristics do not change over time and these characteristics may correlate with explanatory variables. The fixed effects model controls for individual differences to estimate the impact of explanatory variables on the dependent variable.

2. Random Effects Model (REM): The random effects model assumes that individual characteristics are random and uncorrelated with the explanatory variables. Unlike the fixed effects model, the random effects model treats individual characteristics as part of the random error component in estimating the model.

3. Pooled Model (POOL): In this model, there are no differences between individuals or between time terms. Panel data can be mixed together and the parameters estimated using ordinary least squares.

Advantages of panel data models are as followed:

a) Improved estimation accuracy: Panel data make full use of data across different times and individuals, enhancing the understanding and accuracy of economic phenomena prediction.

b) Control of heterogeneity: By controlling differences among individuals, panel models capture potential heterogeneity better, avoiding omitted variable bias.

c) Examination of dynamic relationships: Panel data provide cross-time information, allowing researchers to analyze the dynamic relationships between variables.

Panel models utilize data from each sample (individual items) over time series (time items) to study the impact of independent variables X on dependent variables Y. Panel data models are widely used in fields such as economics, sociology, medicine, and market research. For example, in analyzing a company’s productivity, consumer behavior, or clinical studies, panel data models offer a more detailed and accurate analytical framework.

Choosing the appropriate form of panel data model involves testing whether fixed effects exist. For individual fixed effects testing, an F-test is commonly used to decide between a POOL model and an FE model, the Breusch-Pagan test to choose between an RE model and a POOL model, and the Hausman test to decide between an RE model and an FE model. The choice of the most suitable model is based on the combined results of these tests. For time fixed effects testing, linear regression via the least squares method is typically used. If the time terms are significant on the dependent variable, a time fixed effects model is employed.

5.4.1 Fixed effects test

During the individual and time fixed effects tests, the appropriate panel models for analyzing the direct effects between entrepreneurs' social capital, corporate dynamic capabilities, and innovation performance are as follows. A time fixed effects model is used when verifying the relationship between entrepreneurs' social capital and corporate innovation performance. A random effects model is used when verifying the relationship between entrepreneurs' social capital and corporate dynamic capabilities. A time fixed effects model is used when verifying the relationship between corporate dynamic capabilities and innovation performance.

5.4.1.1 Individual fixed effects test

(1) Entrepreneurs' Social Capital and Corporate Innovation Performance

According to the F-test, the significance P-value is 0.000***, indicating significance, leading to the rejection of the null hypothesis and the selection of the FE model. However, according to the Breusch-Pagan test, the significance P-value is 0.000***, indicating significance and the rejection of the null hypothesis, leading to the selection of the RE model. The Hausman test shows a P-value of 0.907, which is not significant, suggesting acceptance of the null hypothesis and selection of the RE model. Considering these test results, the RE model is appropriate for analysis. The results are shown in Table A.23. The three tests all support the selection of RE model for further analysis.

(2) Entrepreneurs' Social Capital and Corporate Dynamic Capabilities

According to the F-test, the significance P-value is 0.001***, indicating significance, leading to the rejection of the null hypothesis and the selection of the FE model. However, the Breusch-Pagan test shows a significance P-value of 0.040**, indicating significance and the rejection of the null hypothesis, leading to the selection of the RE model. The Hausman test presents a P-value of 0.179, which is not significant, suggesting acceptance of the null hypothesis and selection of the RE model. These test results indicate that the RE model is suitable for analysis. The results are shown in Table A.24. The three tests all support the selection of RE model for further analysis.

(3) Corporate Dynamic Capabilities and Innovation Performance

According to the F-test, the significance P-value is 0.000***, indicating significance, leading to the rejection of the null hypothesis and the selection of the FE model. However, the Breusch-Pagan test also shows a significance P-value of 0.000***, indicating significance and the rejection of the null hypothesis, leading to the selection of the RE model. The Hausman test

results in a P-value of 0.207, which is not significant, suggesting acceptance of the null hypothesis and selection of the RE model. Given these test results, the RE model is appropriate for analysis. The results are shown in Table A.25. The three tests all support the selection of RE model for further analysis.

5.4.1.2 Time fixed effects test

(1) Time Items and Corporate Innovation Performance

The results of the time variable linear regression indicate a significance P-value of 0.032 (see Table A.26), demonstrating statistical significance. This suggests a significant positive correlation between the time variable and innovation performance, making the time-fixed effects model appropriate for analysis.

(2) Time Items and Corporate Dynamic Capabilities

The results of the time variable linear regression indicate a significance P-value of 0.116, which does not exhibit significance (see Table A.27). There is no significant correlation between time items and dynamic capabilities, making the time fixed effects model inapplicable.

5.4.2 Panel model validation results

In the panel model, the independent variables are entrepreneurs' social capital and firm dynamic capabilities, and the dependent variables are corporate dynamic capabilities and innovation performance. Control variables that have a significant relationship with the dependent variables were also included in the model. Specifically, when the dependent variable is corporate innovation performance, the control variables are the nature of the enterprise (state-owned, private, joint venture) and the year of listing. When the dependent variable is corporate dynamic capabilities, the control variables are the nature of the enterprise and the percentage of shares held by the general manager.

5.4.2.1 Impact of entrepreneurs' social capital on corporate innovation performance

Table A.28 reveals the impact of entrepreneurs' social capital on corporate innovation performance.

The coefficient of entrepreneurs' social capital on corporate innovation performance is 0.136, with a standard error of 0.012, a t-value of 10.94, and a P-value significant at the 1% level. This indicates that entrepreneurs' social capital has a significant positive effect on innovation performance; an increase of one unit in entrepreneurs' social capital results in an average increase of 0.136 units in innovation performance. This result underscores the crucial

role of entrepreneurs' social capital in fostering innovation.

Regarding the control variables: a) Year of Listing: The coefficient is -0.001 with an extremely small standard error (close to zero), a t-value of -3.251, and a P-value significant at the 1% level (P<0.001***). The significant level of this coefficient may be influenced by the sample size or data characteristics due to the very small standard error. b) Nature of the Enterprise**: The coefficient is 0 with a standard error of 0.3 and a t-value nearly zero (0.001), not statistically significant (P=0.999). This indicates that the nature of the enterprise does not have a significant impact on innovation performance in the model, suggesting no significant differences in innovation performance across different types of enterprises.

Tables A.29 to A.32 reveal the impacts of the four dimensions of entrepreneurs' social capital on innovation performance, with the following interpretation of the data. As for Professional Skills Capital, coefficient of 0.036, standard error of 0.009, t-value of 4.204, P-value less than 0.001, indicating a significant positive effect on innovation performance. As for Political social capital, coefficient of 0.092, standard error of 0.008, t-value of 11.265, P-value less than 0.001, indicating a significant positive effect on innovation performance. As for Business social capital, coefficient of 0.066, standard error of 0.008, t-value of 7.774, P-value less than 0.001, indicating a significant positive effect on innovation performance. As for Overseas Social Capital, coefficient of 0.027, standard error of 0.008, t-value of 3.422, P-value equals 0.001, indicating a significant positive effect on innovation performance.

5.4.2.2 Impact of entrepreneurs' social capital on corporate dynamic capabilities

Table A.33 reveals the impact of entrepreneurs' social capital on corporate dynamic capabilities. As for Entrepreneurs' Social Capital, the coefficient is 0.428 with a standard error of 0.057, and the P-value is significant at the 1% level (P<0.01). This indicates that an increase of one unit in entrepreneurs' social capital leads to a significant enhancement of 0.428 units in dynamic capabilities, affirming the crucial role of entrepreneurs' social capital in boosting corporate dynamic capabilities.

Regarding the control variables, General manager’s shareholding ratio has a significant negative impact on dynamic capabilities, with a coefficient of -0.001, a standard error of 0.001, and a t-value of -2.545, significant at the 5% level (P=0.01). This indicates that an increase in the CEO's equity holding ratio does not enhance dynamic capabilities; instead, it has a slight inhibiting effect. This may reflect the impact of equity concentration, where the general managers' decision-making tends to be more conservative, potentially hindering the cultivation and development of the firm's dynamic capabilities. The impact of nature of the enterprise on

dynamic capabilities is not significant, with a coefficient of 0.02, a standard error of 0.014, a t-value of 1.4, and a P-value of 0.162. This indicates that in this sample, the nature of the enterprise (such as state-owned, private) does not have a clear impact on dynamic capabilities, or it might be influenced by other variables not included in the model.

Tables A.34 to A.37 detail the impact of the four dimensions of entrepreneurs' social capital on dynamic capabilities. As for Professional Skills Capital, the impact coefficient is 0.205 with a standard error of 0.036 and a t-value of 5.691, significant at less than 0.001. This demonstrates that Professional skills social capital has a significant positive effect on dynamic capabilities. As for Political social capital, the impact coefficient is 0.113 with a standard error of 0.045 and a t-value of 2.497, significant at less than 0.05. This indicates that Political social capital significantly positively affects dynamic capabilities. As for Business social capital, the impact coefficient is 0.23 with a standard error of 0.041 and a t-value of 5.605, significant at less than 0.001. This shows that Business social capital has a significant positive effect on dynamic capabilities. As for Overseas Social Capital, the impact coefficient is 0.17 with a standard error of 0.038 and a t-value of 4.507, significant at less than 0.001. This demonstrates that overseas social capital significantly positively affects dynamic capabilities.

5.4.2.3 Impact of corporate dynamic capabilities on innovation performance

Table A.38 elucidates the influence of corporate dynamic capabilities on innovation performance.

As for the impact of corporate dynamic capabilities on innovation performance, the coefficient is 0.032 with a t-value of 4.924, and the P-value is less than 0.001, significant at the 1% level. This indicates a significant positive impact of dynamic capabilities on innovation performance, suggesting that stronger dynamic capabilities are associated with higher innovation performance. This result supports the dynamic capabilities theory, emphasizing the importance for firms to adapt resources and capabilities in response to environmental changes to maintain a competitive advantage.

As for Control Variables: a) Year of Listing: The coefficient is -0.001 with a t-value of -1.185 and a P-value of 0.236, indicating that the year of listing does not have a significant relationship with innovation performance. This suggests that the length of time a company has been publicly listed does not directly determine its level of innovation performance; instead, it is likely influenced by more complex factors. b) Nature of the Enterprise: The coefficient is 0.005 with a t-value of 1.574 and a P-value of 0.116. Although the coefficient is positive, it is not statistically significant, indicating that the nature of the enterprise (such as state-owned or

private) does not have a noticeable impact on innovation performance.

Tables A.39 to A.41 explore the effects of the three dimensions of corporate dynamic capabilities on innovation performance. The impact coefficient of opportunity sensing capability is 0.094 with a standard error of 0.012, a t-value of 7.524, and a P-value less than 0.001. This indicates that opportunity sensing capability significantly positively affects innovation performance. The impact coefficient of resource allocation capability is 0.095 with a standard error of 0.015, a t-value of 6.326, and a P-value less than 0.001. This demonstrates that resource allocation capability significantly positively influences innovation performance. The impact coefficient of organizational reconfiguration capability is 0.017 with a standard error of 0.005, a t-value of 3.205, and a P-value of 0.001. This signifies that organizational reconfiguration capability significantly positively impacts innovation performance.

5.4.3 Mediation effect test results

Regression model coefficient tables (Table A.42) and mediation effect summary (Table A.43) reveal complex interrelations among variables. For the mediation test of "Entrepreneurs' Social Capital → Dynamic Capabilities → Innovation Performance," the results are as follows:

First, Total Effect (c) The total effect of entrepreneurs' social capital on innovation performance is significant, with a coefficient of 0.132, indicating a positive impact.

Second, Mediator Effect. The regression coefficient of entrepreneurs' social capital on dynamic capabilities is 0.425 ($p<0.001$), meaning it significantly enhances dynamic capabilities. Dynamic capabilities, in turn, predict innovation performance with a coefficient of 0.02 ($p<0.001$), indicating a positive predictive effect.

Third, Mediation Effect (a*b). Calculated as 0.009 with a p-value of 0.007, indicating statistical significance of the mediation effect. The 95% Bootstrap confidence interval does not include zero, further confirming the presence of mediation.

In terms of Direct Effect (c'), even after accounting for the mediating role of dynamic capabilities, the direct effect coefficient of 0.123 ($p<0.001$) suggests that entrepreneurs' social capital still directly and significantly influences innovation performance. Since both direct and mediating effects are significant and directionally consistent, partial mediation is present (Effect Proportion: a*b/c = 6.82%). This means that entrepreneurs' social capital directly promotes innovation performance and also indirectly affects it through enhancing dynamic capabilities.

5.4.4 Path model analysis

Path analysis is a statistical method used to study causal relationships between variables through regression analysis and graphical models. It enables the simultaneous analysis of direct and indirect effects among multiple variables. Extending beyond simple regression, path analysis can manage multiple causality relationships and allows for the estimation of multiple regression equations at once. In path analysis, relationships between variables are represented in path diagrams, where each arrow indicates a relationship and the coefficient on each arrow represents the regression coefficient (path coefficient). This method validates direct effects, indirect effects, mediating effects, and causal relationships, helping to reveal potential causal chains between variables and providing robust support for empirical research.

5.4.4.1 Model fit indicators

Model fit indices are used to assess how well a model matches the actual data. Good fit indices indicate that the theoretical model can adequately explain the observed data. Some indices are chosen for evaluation, and meeting some of these criteria is usually sufficient. According to Table A.44, the fit indices for the path analysis model, including GFI, CFI, NFI, and RMR, all meet the standards, suggesting that the path analysis model fits the data well.

5.4.4.2 Path model analysis results

Based on the path diagram in Figure 5.1 and the model path coefficient in Table A.45.

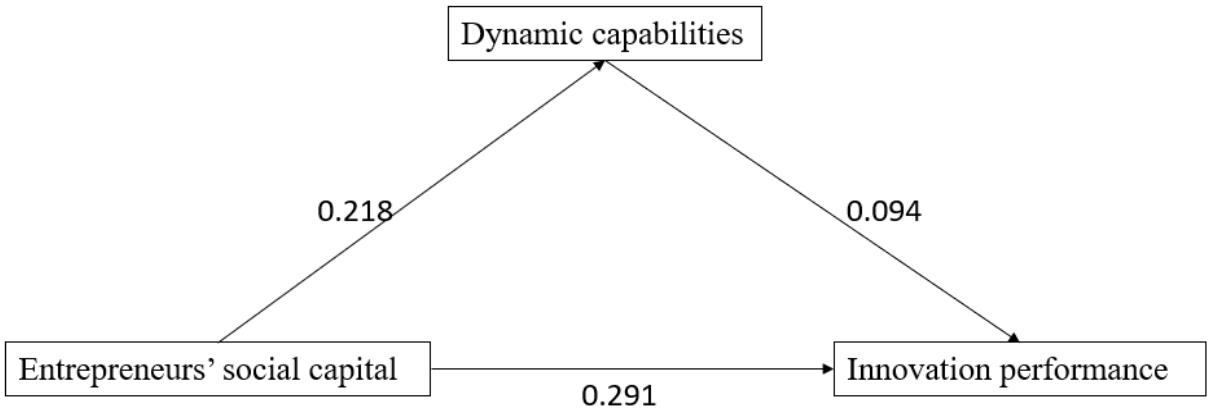

Figure 5.1 Path analysis model

Entrepreneurs' Social Capital to Corporate Dynamic Capabilities: The significance P-value is 0.000***, indicating a significant relationship, thus the null hypothesis is rejected, making this path valid with an impact coefficient of 0.218.

Entrepreneurs' Social Capital to Corporate Innovation Performance: The significance P-value is 0.000***, indicating a significant relationship, thus the null hypothesis is rejected,

making this path valid with an impact coefficient of 0.291.

Corporate Dynamic Capabilities to Innovation Performance: The significance P-value is 0.001***, indicating a significant relationship, thus the null hypothesis is rejected, making this path valid with an impact coefficient of 0.094.

The regression coefficients and simultaneous significance tests ensure the reliability of these relationships statistically. Specifically:

Entrepreneurs' Social Capital on Dynamic Capabilities shows a significant positive impact (unstandardized coefficient = 0.425, standardized coefficient = 0.218, $P < 0.001$). This indicates that the richer the social capital possessed by entrepreneurs, the stronger the dynamic capabilities exhibited by their companies. The standardized coefficient of 0.218 illustrates the importance of entrepreneurs' social capital in predicting dynamic capabilities, explaining 28% of the variability in dynamic capabilities.

Entrepreneurs' social capital also has a significant positive impact on innovation performance (unstandardized coefficient = 0.123, standardized coefficient = 0.291, $P < 0.001$). This means that an increase in entrepreneurs' social capital significantly enhances a firm's innovation performance, predicting 29.1% of the variability in innovation performance, making it a crucial factor.

Additionally, dynamic capabilities show a significant effect on innovation performance (unstandardized coefficient = 0.02, standardized coefficient = 0.094, $P = 0.001$), though the impact is relatively smaller. This indicates that stronger dynamic capabilities lead to higher innovation performance, but compared to entrepreneurs' social capital, dynamic capabilities explain a weaker portion (9.4%) of the variability in innovation performance.

Overall, the path analysis not only reveals direct effects but also highlights the mediating role of corporate dynamic capabilities between entrepreneurs' social capital and corporate innovation performance, thereby enhancing the model’s explanatory and predictive power concerning real-world phenomena. These findings underscore the critical role of entrepreneurs' social capital in enhancing corporate dynamic capabilities and performance, providing empirical support for theoretical research and practical applications in the related fields.

5.5 Hypothesis testing results

H1: There is a positive correlation between entrepreneurs' social capital and corporate innovation performance. H1 is confirmed by both the panel model (coefficient = 0.136, $P<0.001$) and the path model (coefficient = 0.291, significant at the 1% level). This establishes that

entrepreneurs' social capital significantly fosters innovation performance.

H1a: Professional skills social capital is significantly positively correlated with corporate innovation performance. Panel model results show that the impact coefficient of Professional skills social capital is 0.036, with a P-value less than 0.001, indicating that Professional skills social capital has a significant positive impact on innovation performance. Therefore, hypothesis H1a is supported.

H1b: Political social capital is significantly positively correlated with corporate innovation performance. Panel model results show that the impact coefficient of Political social capital is 0.092, with a P-value less than 0.001, indicating that Political social capital has a significant positive impact on innovation performance. Therefore, hypothesis H1b is supported.

H1c: Business social capital is significantly positively correlated with corporate innovation performance. Panel model results show that the impact coefficient of Business social capital is 0.066, with a P-value less than 0.001, indicating that Business social capital has a significant positive impact on innovation performance. Therefore, hypothesis H1c is supported.

H1d: Overseas social capital is significantly positively correlated with corporate innovation performance. Panel model results show that the impact coefficient of overseas social capital is 0.027, with a P-value of 0.001, indicating that overseas social capital has a significant positive impact on innovation performance. Therefore, hypothesis H1d is supported.

H2: Positive correlation between entrepreneurs' social capital and corporate dynamic capabilities. It is strongly supported by significant coefficients in both the panel (0.428, $P<0.001$) and path models (0.218, significant at the 1% level), indicating that entrepreneurs' social capital robustly enhances dynamic capabilities.

H2a: Professional skills social capital is significantly positively correlated with corporate dynamic capabilities. Panel model results show that the impact coefficient for Professional skills social capital is 0.205, with a P-value less than 0.001, indicating that Professional skills social capital has a significant positive impact on dynamic capabilities. Therefore, hypothesis H2a is supported.

H2b: Political social capital is significantly positively correlated with corporate dynamic capabilities. Panel model results show that the impact coefficient for Political social capital is 0.113, with a P-value less than 0.05, indicating that Political social capital has a significant positive impact on dynamic capabilities. Therefore, hypothesis H2b is supported.

H2c: Business social capital is significantly positively correlated with corporate dynamic capabilities. Panel model results show that the impact coefficient for Business social capital is 0.23, with a P-value less than 0.001, indicating that Business social capital has a significant

positive impact on dynamic capabilities. Therefore, hypothesis H2c is supported.

H2d: Overseas social capital is significantly positively correlated with corporate dynamic capabilities. Panel model results show that the impact coefficient for overseas social capital is 0.17, with a P-value less than 0.001, indicating that overseas social capital has a significant positive impact on dynamic capabilities. Therefore, hypothesis H2d is supported.

H3: Corporate dynamic capabilities are significantly positively correlated with innovation performance. Panel model results show an impact coefficient of 0.032 for dynamic capabilities on innovation performance, highly significant ($P<0.001$). Path model analysis shows that the path "corporate dynamic capabilities -> innovation performance" is significant at the 1% level with an impact coefficient of 0.094, validating the path. Therefore, it is demonstrated that enhancing corporate dynamic capabilities significantly boosts innovation performance, supporting hypothesis H3.

H3a: Opportunity sensing capability is significantly positively correlated with innovation performance. Panel model results show an impact coefficient of 0.094 for opportunity sensing capability, with a P-value less than 0.001, indicating that opportunity sensing capability has a significant positive impact on innovation performance. Therefore, hypothesis H3a is supported.

H3b: Resource allocation capability is significantly positively correlated with innovation performance. Panel model results show an impact coefficient of 0.095 for resource allocation capability, with a P-value less than 0.001, indicating that resource allocation capability has a significant positive impact on innovation performance. Therefore, hypothesis H3b is supported.

H3c: Organizational reconfiguration capability is significantly positively correlated with innovation performance. Panel model results show an impact coefficient of 0.017 for organizational reconfiguration capability, with a P-value of 0.001, indicating that organizational reconfiguration capability has a significant positive impact on innovation performance. Therefore, hypothesis H3c is supported.

H4: Corporate dynamic capabilities play a partial mediating role in the relationship between entrepreneurs' social capital and corporate innovation performance. According to mediation effect model results, since a, b, and c' are all significant and a*b has the same sign as c', with a mediation effect value of 0.009 accounting for 6.82%, it indicates that dynamic capabilities have a partial mediating effect. This means that entrepreneurs' social capital not only directly promotes innovation performance but also enhances it indirectly by boosting dynamic capabilities. Therefore, hypothesis H4 is supported.

5.6 Responses to research questions

Through rigorous empirical analysis, this study provides the following answers to the research questions:

First, the findings reveal that entrepreneurs' social capital significantly and positively influences both the dynamic capabilities and innovation performance of listed biopharmaceutical companies. Entrepreneurs' social networks provide essential resources and capability support, which not only enhance dynamic capabilities but also directly contribute to improved innovation performance.

Second, dynamic capabilities demonstrate a significant positive impact on innovation performance. Enhanced dynamic capabilities enable firms to effectively integrate resources and respond swiftly to market changes, thereby driving substantial improvements in innovation outcomes.

Third, dynamic capabilities serve as a partial mediator in the relationship between entrepreneurs' social capital and innovation performance. Entrepreneurs' social capital directly influences innovation performance and indirectly enhances it by improving dynamic capabilities.

Additionally, the analysis identifies that firm ownership and listing year show significant differences in their effects on innovation performance, while firm ownership and the CEO's equity holding ratio significantly influence dynamic capabilities. These factors were thoroughly considered in the empirical analysis to ensure the accuracy and reliability of the findings, providing robust support for understanding the factors affecting innovation performance in biopharmaceutical enterprises.

Finally, based on the findings, the pathways to enhance innovation performance are as follows: strengthen the accumulation of entrepreneurs' social capital, enhance government policy communication and incentive mechanisms, foster the development of dynamic capabilities, protect intellectual property rights, optimize the clinical trial approval process, improve talent cultivation and recruitment efforts, encourage resource sharing and collaborative innovation within the industry, and strengthen market orientation in research and development activities so as to improve the innovation performance.

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Chapter 6: Discussion and Conclusions

This study conducted an empirical analysis of 216 biopharmaceutical companies listed on China's A-share Main Board and Growth Enterprises Market (GEM) between 2018 and 2022. These enterprises hold a significant position in the Chinese national economy, characterized by stable profitability and substantial market size. The study systematically explored the complex relationships among Entrepreneur' social capital, dynamic capabilities, and innovation performance. The findings are as follows:

Entrepreneur' social capital significantly influences innovation performance. The four dimensions of Entrepreneur' social capital—professional skills capital, political social capital, commercial capital, and international social capital—positively contribute to enhancing innovation performance. Dynamic capabilities play a critical role in the innovation process. Through dimensions such as opportunity sensing, resource allocation, and organizational restructuring, dynamic capabilities effectively improve innovation performance. Dynamic capabilities serve as a mediator between Entrepreneur' social capital and innovation performance. This indicates that in the biopharmaceutical industry, Entrepreneur' social capital indirectly enhances innovation performance by strengthening a firm's dynamic capabilities.

6.1 Status quo of entrepreneurs' social capital, dynamic capabilities, and innovation performance in the pharmaceutical industry

The descriptive analysis shows the characteristics and shortcomings of entrepreneurs' social capital, dynamic capabilities, and innovation performance in 216 listed pharmaceutical companies. The overall level of entrepreneurs' social capital is moderate, but the lack of international resources and the imbalance in Political social capital may hinder collaborative development in the industry. Dynamic capabilities show weaknesses in opportunity sensing and resource allocation, while organizational restructuring is a potential strength. The overall low level of innovation performance and the large differences among companies highlight the need for more effective policy support and resource integration mechanisms.

6.1.1 Status quo of entrepreneurs' social capital

There are huge differences between the social capital of entrepreneurs in the pharmaceutical industry. The score for professional skills capital is relatively high, indicating that most entrepreneurs have accumulated professional skills, and a few firms may have exceeded the industry average. The score of political capital is relatively low with a right-skewed distribution, and it may be closely related to personal background and external opportunities. Commercial capital is relatively balanced, but there are also large differences, suggesting that market activities and industrial cooperation play an important role in capital accumulation. The score of overseas social capital is the lowest, showing entrepreneurs' shortcomings in internationalization, and it has limited the global competitiveness of their firms. Generally speaking, entrepreneurs present unbalanced performance in social capital building, and their political capital and overseas social capital, in particular, need to be further improved.

6.1.2 Status quo of corporate dynamic capabilities

The dynamic capabilities of entrepreneurs in the pharmaceutical industry are uneven. The opportunity sensing capability is relatively weak, and many entrepreneurs are mediocre in recognizing market opportunities, especially in environments with high technological barriers and long R&D cycles. The resource allocation capability is also at a relatively low level, reflecting the difficulties in allocation of industrial resources. In contrast, the score of organizational restructuring capability is relatively high, indicating that some firms are highly adaptable and flexible, but others face challenges due to organizational rigidity. Generally speaking, as for the dynamic capabilities of pharmaceutical companies, they are relatively weak in terms of opportunity sensing and resource allocation, while their organizational restructuring capability presents certain potential.

6.1.3 Status quo of corporate innovation performance

Innovation performance in the pharmaceutical industry is generally low, and the data show a high degree of concentration, with very few firms having relatively outstanding innovation performance. High R&D cost and long R&D cycle may be important factors restricting innovation, and the high coefficient of variation indicates that different enterprises face huge differences in R&D investment, technological capability and marketization. Generally speaking, the innovation capability of the pharmaceutical industry is still facing big challenges, and more investment and support are needed to improve the overall innovation level.

6.2 Relationship between entrepreneurs' social capital, dynamic capabilities, and innovation performance

6.2.1 Relationship between entrepreneurs' social capital and innovation performance

This study confirmed that Entrepreneur' social capital has a significant positive impact on corporate innovation performance (H1 supported). Both the panel model and the path model provided empirical evidence supporting this hypothesis, with the positive impact coefficients of Entrepreneur' social capital on innovation performance being 0.136 and 0.291, respectively, both highly significant at the 1% level. This finding is basically consistent with the results of W. Li et al. (2018), Hanifah et al. (2020), and Vu et al. (2023). It is universally believed that there is a significant positive correlation between entrepreneurs' social capital and corporate innovation performance, and once again the crucial role played by entrepreneurs' social capital in driving innovation performance has been validated.

Additionally, the study examined multiple dimensions of social capital, including professional skills capital, Political social capital, commercial capital, and international social capital, to explore their specific impacts on corporate innovation performance.

6.2.1.1 Positive correlation between Professional skills social capital and innovation performance

The study found a significant positive correlation between entrepreneurs' Professional skills social capital and corporate innovation performance. This result indicates that entrepreneurs who accumulate professional knowledge and technical expertise can significantly enhance their enterprises' innovation capabilities. This echoes the findings of C. Huang et al. (2022), which indicates that the accumulation of entrepreneurs' professional skills social capital will enable entrepreneurs to lead their enterprises to better cope with market changes and make innovations. In addition, according to the absorptive capacity theory proposed by Cohen and Levinthal (1990), professional skills social capital equips enterprises with the necessary technical abilities and industry knowledge to effectively absorb and transform external innovation resources. This, in turn, improves the quality and efficiency of innovation activities. Additionally, entrepreneurs' professional competence and reputation within the industry can help enterprises secure more innovation opportunities and technical collaborations, thereby fostering improved innovation performance.

6.2.1.2 Positive correlation between Political social capital and innovation performance

Entrepreneurs' political social capital also has a significant positive impact on corporate innovation performance. This finding suggests that by establishing close connections with governments, policymakers, and regulatory agencies, entrepreneurs can secure more policy support and reduce institutional constraints, thereby improving the efficiency of resource acquisition for innovation. This is highly consistent with the finding of Ren et al. (2022) that political affiliation is an important external resource for enterprises and facilitates their access to scare resources. Political social capital not only helps enterprises access funding, tax incentives, and market entry opportunities but also enables them to obtain critical information about industries and technological domains. This information enhances the accuracy of innovation decision-making and the commercialization potential of innovation outcomes.

6.2.1.3 Positive correlation between commercial capital and innovation performance

The study demonstrates a significant positive correlation between entrepreneurs' commercial capital and corporate innovation performance. This finding further validates the critical role of business networks in the innovation process. This finding is consistent with the conclusion of Bai et al. (2023) which emphasizes that commercial social capital is a core element of social capital that drives corporate growth through the integration of external resources and investor attention. Specifically, commercial capital enables firms to collaborate more effectively with suppliers, customers, and industry associations, facilitating the sharing of technology and information to drive innovation activities. Moreover, business networks help firms better identify market demands during product development, improving the market adaptability and competitiveness of their innovations (Burt, 2000).

6.2.1.4 Positive correlation between international social capital and innovation performance

The study also reveals a significant positive impact of entrepreneurs' international social capital on innovation performance, albeit with a relatively lower coefficient. This finding aligns with the research of Giannetti et al. (2015), which also confirms that executives with overseas backgrounds can enhance firm performance, though the effectiveness of this positive influence often depends on factors such as incentive structures.

The positive impact of international social capital suggests that entrepreneurs can leverage overseas networks to access cutting-edge technologies, market information, and collaboration opportunities in the biopharmaceutical field, thereby strengthening the firm's technological

innovation capabilities. However, the study notes that international social capital has an insignificant effect on the number of patent applications and new product launches. This could be attributed to the challenges entrepreneurs face in aligning their overseas experiences with domestic market demands, given differences in cultural, commercial, and legal environments. These discrepancies may hinder accurate positioning and acceptance of patents and new products in the local market.

The findings align with the resource-based view (Barney, 1991), which posits that entrepreneur' social capital, as a vital intangible resource, supports innovation activities by integrating internal and external resources, thereby enhancing innovation capabilities. Entrepreneurs who build extensive social networks—drawing from professional, governmental, commercial, and international resources—provide critical support for their firms' innovation activities in the biopharmaceutical sector. This highlights the importance of cultivating Entrepreneur' social capital in listed biopharmaceutical companies to secure high-quality external resources and enhance innovation performance.

6.2.2 Relationship between dynamic capabilities and innovation performance

The study confirms a significant positive relationship between entrepreneur' social capital and dynamic capabilities (H2 supported). Results from the panel model and path analysis indicate that Entrepreneur' social capital has a strong impact on dynamic capabilities, with a coefficient of 0.428 and high significance ($P<0.001$). This demonstrates that entrepreneurs, by building and leveraging social capital networks, can significantly enhance their firms' dynamic capabilities, enabling them to gain competitive advantages in constantly changing market environments.

6.2.2.1 Positive correlation between Professional skills social capital and dynamic capabilities

The study found a significant positive correlation between entrepreneurs' Professional skills social capital and dynamic capabilities. This indicates that by accumulating and applying industry knowledge, technical expertise, and professional skills, entrepreneurs can enhance their firms' ability to adapt to market changes and foster innovation. The accumulation of professional skills social capital enables entrepreneurs to better respond to market changes and make innovations, and helps enterprises to quickly identify and respond to external opportunities (C. Huang et al., 2022). For example, entrepreneurs with a strong technical background can more accurately assess technological trends, select appropriate innovation

paths, and make swift resource allocation decisions, thereby improving the firm's dynamic capabilities. This finding aligns with Cohen and Levinthal's (1990) absorptive capacity theory, which emphasizes that firms can enhance their innovation and market responsiveness by learning and mastering external knowledge. Moreover, professional skills not only improve entrepreneurs' technical capabilities but also enhance their ability to navigate complex market environments and make strategic decisions, thus boosting overall dynamic capabilities (Zahra & George, 2002).

6.2.2.2 Positive correlation between Political social capital and dynamic capabilities

The study also demonstrates a significant positive impact of entrepreneurs' Political social capital on dynamic capabilities. This suggests that by leveraging political relationships within their social networks, entrepreneurs can improve their firms' external environments, enabling them to better adapt to changing market and policy conditions.

Political social capital helps entrepreneurs secure favorable policy support, market access, and opportunities for resource sharing with governments and other stakeholders (Li, 2017; Wang, 2017; Liu, 2020). For instance, entrepreneurs with strong political connections can access crucial information, gain policy benefits, and seize market expansion opportunities. These advantages enable firms to adapt more rapidly to external environmental changes, thereby enhancing their dynamic capabilities.

The role of Political social capital extends beyond resource acquisition; it also facilitates the rapid adjustment of strategic directions and operational models, further strengthening firms' dynamic capabilities. This underscores the importance of cultivating Political social capital as a critical resource for navigating and succeeding in dynamic and complex market environments.

6.2.2.3 Positive correlation between commercial capital and dynamic capabilities

The study reveals a significant positive correlation between entrepreneurs' commercial capital and their firms' dynamic capabilities. By maintaining close ties with other businesses, suppliers, customers, and industry associations, entrepreneurs can facilitate vital information flows, secure technical support, and identify market opportunities, thereby enhancing their firms' innovation and adaptability (Onginjo, 2021; Omar, 2022). Through commercial capital, entrepreneurs effectively access market trend information, recognize innovation opportunities, and respond swiftly to changes in market demands, enabling their firms to gain competitive advantages in highly contested markets. Commercial capital contributes to dynamic capabilities in several ways. First, the collaborative relationships established through business networks

allow entrepreneurs to share resources, technology, and information, enabling firms to quickly adjust strategies and improve their responsiveness to external changes. Second, commercial capital helps entrepreneurs identify and exploit resource gaps in the market. This is particularly crucial in emerging industries and high-technology fields, where entrepreneurs can leverage their commercial capital to gain critical market entry opportunities, driving technological innovation and business transformation.

6.2.2.4 Positive correlation between international social capital and dynamic capabilities

The study also finds a significant positive impact of entrepreneurs' international social capital on their firms' dynamic capabilities, though the effect is relatively smaller. This finding underscores the strengthening role of transnational resource networks in enhancing firms' dynamic capabilities in the era of globalization.

Through international social capital, entrepreneurs gain access to international markets, cross-cultural knowledge, and global technological trends, all of which are crucial for innovation activities and market strategies (Fu et al, 2022). For instance, by collaborating with overseas companies, entrepreneurs can acquire advanced technologies, managerial expertise, and opportunities to enter new markets, thereby improving their firms' market adaptability and innovation capabilities.

The impact of international social capital also extends to resource sharing and technology transfer among multinational enterprises. Participation in international collaborations allows firms to accelerate technological innovation and gather diverse market demand information through cross-cultural exchanges, further enhancing their flexibility and innovation capabilities (Zheng et al., 2023). This global resource integration provides firms with broader innovation opportunities and market expansion potential, making it a critical factor for improving dynamic capabilities.

In summary, Entrepreneur' social capital significantly enhances firms' dynamic capabilities by leveraging resources and networks across different dimensions. Whether through professional skills, political relationships, business networks, or international social capital, entrepreneurs help their firms quickly identify and respond to external opportunities and threats. This, in turn, improves their flexibility, innovation capabilities, and market adaptability.

6.2.3 Relationship between entrepreneurs' social capital and dynamic capabilities

The study confirms a significant positive impact of dynamic capabilities on innovation performance (H3 supported). Results from the panel model show an influence coefficient of

0.032, while the path model yields a coefficient of 0.094, both highly significant at the 1% level. These findings indicate that enhancing dynamic capabilities can effectively improve innovation performance. Specifically, the three core dimensions of dynamic capabilities—opportunity sensing, resource allocation, and organizational restructuring—all have a significant positive influence on innovation performance. This effect is particularly pronounced in the biopharmaceutical industry, where the long development cycles and substantial funding requirements for new drug development make acute market insights crucial for adjusting R&D directions and resource allocation, thereby increasing innovation success rates and market responsiveness (Li et al., 2022).

6.2.3.1 Positive correlation between opportunity sensing and innovation performance

The study finds a significant positive relationship between opportunity sensing capability and innovation performance. Opportunity sensing reflects the ability of a firm to identify changes and potential opportunities in its external environment (Helfa et al., 2007). By accurately recognizing market demands and technological trends, firms can secure advantageous positions in competitive markets (Lyu et al., 2020; Jia et al., 2023). This study supports these findings, further emphasizing that opportunity sensing is foundational to the success of innovation activities. By effectively identifying opportunities, firms can rapidly transform external changes into internal action plans, thereby accelerating the innovation process and improving performance.

6.2.3.2 Positive correlation between resource allocation and innovation performance

The study also reveals a significant positive impact of resource allocation capability on innovation performance. This demonstrates that dynamic capabilities play a vital role in optimizing resource integration to enhance innovation outcomes. Resource allocation capability represents a firm's ability to dynamically adjust and optimize its internal resources according to strategic demands (Peng et al., 2022). For example, firms can efficiently allocate resources across different innovation projects, prioritizing those with higher potential to maximize overall innovation performance.

Moreover, the findings highlight that resource allocation capability not only improves resource utilization efficiency but also minimizes resource waste, creating greater innovation value for the firm. This capability enables firms to respond more effectively to changing demands and align their innovation activities with strategic priorities, thereby boosting their innovation success rates and overall performance.

6.2.3.3 Positive correlation between organizational restructuring capability and innovation performance

The study reveals a significant positive correlation between organizational restructuring capability and innovation performance. This finding indicates that firms can support innovation activities by adjusting and restructuring their organizational structures (Li, 2019). For example, optimizing the composition of innovation teams and redesigning workflows can improve team collaboration efficiency, thereby accelerating the realization of innovation outcomes. Moreover, organizational restructuring capability allows firms to better adapt to rapid changes in market environments, providing the flexibility needed to support innovation activities effectively.

In summary, dynamic capabilities significantly and positively influence innovation performance in biopharmaceutical firms, primarily through the three dimensions of opportunity sensing, resource allocation, and organizational restructuring. These capabilities enable firms to adapt flexibly to market changes, improve product R&D success rates, and enhance overall innovation performance.

Dynamic capabilities strengthen firms' adaptability and responsiveness, providing robust support for innovation activities. In an environment characterized by rapid technological iteration and high market uncertainty, dynamic capabilities help firms remain competitive by quickly identifying opportunities, integrating resources, and adjusting organizational structures. These actions collectively improve the efficiency and quality of innovation efforts, as emphasized by Teece et al. (1997).

6.2.4 The mediating role of firm's dynamic capabilities between entrepreneurs' social capital and corporate innovation performance

The results of the empirical analysis clearly reveal the positive impact of Entrepreneur' social capital on corporate innovation performance, further confirming the critical mediating role that dynamic capabilities play in this process. Specifically, Entrepreneur' social capital not only directly enhances innovation performance but also indirectly influences it through the mediating effect of dynamic capabilities, accounting for 6.82% of the total effect. This finding strongly supports the key intermediary role of dynamic capabilities between entrepreneurs' social capital and corporate innovation performance. This result is highly consistent with the research result of Valio et al. (2021) on 65 companies in the Brazilian industrial sector that dynamic capabilities show a mediating role between centralization and integration in the innovation performance of project teams. In addition, Dias et al. (2021b) also support this view

by proposing an integrative model that explores the relationship between entrepreneurs' social capital, dynamic capabilities, and innovation performance, namely, entrepreneurs who are rich in social capital are likely to build strong dynamic capabilities to drive innovation activities and improve innovation performance.

In this study, entrepreneurs' social capital enhances corporate dynamic capabilities—including opportunity-sensing, resource allocation, and organizational restructuring—which in turn drive improvements in innovation performance. Similar to the patterns in the manufacturing sector, this study also demonstrates that in the biopharmaceutical industry, entrepreneur' social capital promotes innovation performance growth by strengthening corporate dynamic capabilities (X. Chen, 2023). Specifically, social capital derived from entrepreneurs' professional skills, business networks, international connections, and potential political relationships brings diverse information and resources to the firm. These resources and information, when transformed and applied through dynamic capabilities, become a significant driving force for corporate innovation.

Further analysis reveals that different dimensions of social capital promote innovation performance through dynamic capabilities in distinct ways. Political social capital demonstrates a synergistic effect with dynamic capabilities by securing policy support and institutional advantages, creating a favorable external environment for the development of dynamic capabilities. For example, policy resources can be leveraged by dynamic capabilities to develop more competitive innovative products. Commercial capital plays an integrative role by strengthening industrial networks and customer collaborations, facilitating efficient resource allocation through dynamic capabilities, and promoting the realization of innovative outcomes. International social capital provides crucial support for internationalization and advanced technology adoption, compensating for firms' shortcomings in technology and market experience. This enables dynamic capabilities to drive innovation in global markets and expedite the application of cutting-edge technologies.

The mediating effect analysis confirms that dynamic capabilities serve as both a necessary pathway for transforming Entrepreneur' social capital into innovation performance and a critical driver of innovation efficiency. However, the proportion of the total effect mediated by dynamic capabilities is relatively low, at only 6.82 percent. This suggests that Entrepreneur' social capital still exerts a strong direct effect on innovation performance. The findings indicate that the direct and indirect effects of social capital on innovation performance arise from different mechanisms. On the one hand, entrepreneurs directly utilize their social capital to access market information and resources, leading to an immediate boost in innovation

performance. On the other hand, the development and application of dynamic capabilities require time to accumulate, meaning their indirect impact may be constrained in the short term, limiting the scope of their mediating effect.

These results suggest that while leveraging dynamic capabilities is crucial, firms should also emphasize direct resource integration alongside long-term capability building to optimize their innovation strategies. In biopharmaceutical firms, the process through which Entrepreneur' social capital enhances innovation performance via dynamic capabilities demonstrates the multidimensional role of social capital in enterprise innovation. Social capital not only directly provides resources essential for innovation but also enables effective integration and utilization of these resources through dynamic capabilities.

6.2.5 Impact of control variables on dynamic capabilities and innovation performance

This study further analyzed the impact of control variables on dynamic capabilities and innovation performance. The results indicate that firm ownership and the year of listing significantly affect innovation performance, while firm ownership and the CEO's equity holding ratio significantly influence dynamic capabilities (partial support for H5 and H6). These findings highlight the critical role of control variables in the development of firm capabilities and performance, providing empirical evidence for understanding how internal and external conditions influence dynamic capabilities and innovation performance.

Firm ownership, as a key control variable, demonstrates significant differences in its impact on innovation performance and dynamic capabilities. The findings support the notion that differences in resource access, policy support, and governance structures across ownership types are critical for the development of firm capabilities (Teng & Yi, 2017). State-owned enterprises (SOEs) benefit from advantages in resource access and policy incentives but may face limitations in innovation due to governance inefficiencies (Cardinale et al., 2024). In contrast, private firms, driven by market forces, exhibit greater flexibility and risk tolerance, enhancing their dynamic capabilities and fostering innovation (Acharya & Xu, 2017).

The significant impact of the year of listing on innovation performance highlights how a firm's maturity and market experience directly affect its innovation capacity. This finding aligns with the dynamic capability development model. Firms with longer listing durations tend to accumulate more market resources and experience, which not only improves their chances of obtaining investments, but also enhances their responsiveness to market changes. (Huang, 2021). However, excessively long listing durations may reduce innovation motivation,

particularly in mature industries, where firms may prioritize resource optimization over new technology development (Carnes et al., 2017).

The significant relationship between the general manager's equity holding ratio and dynamic capabilities underscores the importance of managerial power concentration in shaping strategic capabilities. A higher equity holding ratio may empower executives with stronger decision-making authority and strategic flexibility, facilitating the development of dynamic capabilities (Hou et al., 2015). However, excessively concentrated equity holdings could lead to issues of information asymmetry and agency problems, potentially exerting negative effects on innovation performance, especially in complex external environments (Balsmeier & Czarnitzki, 2014).

The study also observed interaction effects between control variables and other firm characteristics. For instance, firm ownership and the CEO's equity holding ratio may jointly influence strategic choices and the allocation of innovation resources. Such interactions reveal the moderating role of control variables in the relationship between dynamic capabilities and innovation performance (Tang & Li, 2020; Cui, et al., 2022).

The influence of control variables on dynamic capabilities and innovation performance highlights the significance of managerial decision-making factors in the innovation process. These variables are closely linked to the industry environment and internal governance structures of firms.

6.3 Discussion based on resource-based view and dynamic capabilities

The findings of this study are well-aligned with the Resource-Based View (RBV) and Dynamic Capabilities View (DCV), both of which provide robust theoretical frameworks for understanding the sources of competitive advantage and the ways in which firms can sustain and enhance innovation performance in complex and dynamic market environments. RBV posits that a firm's competitive advantage stems from its unique resources, encompassing both tangible and intangible assets (Barney, 1991). Tangible resources include physical assets such as equipment, facilities, and funding, while intangible resources consist of technology, talent, and social capital. In this study, social capital emerges as a critical intangible resource with characteristics of inimitability and rarity, making it an essential driver for innovation within firms. The DCV further complements this view by emphasizing how firms maintain a competitive advantage by integrating and reconfiguring resources to adapt to rapidly changing market environments (Teece, 2007).

First, according to RBV, entrepreneurs' social capital enhances a firm's capability to acquire critical resources by facilitating connections with government entities, suppliers, academic institutions, and other external stakeholders (Sun, 2018; Dias et al., 2022). This capacity to access and integrate external resources forms the foundation for sustaining innovation capabilities amid intense market competition. In the highly knowledge-intensive and technology-driven biopharmaceutical industry, social capital is particularly valuable. Partnerships with government agencies provide firms with critical insights into policy directions, regulatory processes, and potential funding opportunities, which are essential for new drug development and market entry. Collaborations with suppliers and academic institutions enable firms to tap into the latest technological advancements and research findings, offering scientific and technical support for pharmaceutical innovation. Thus, social capital significantly strengthens a firm's resource base, establishing a strong foundation for continuous innovation in competitive markets (Liu, 2018; Dias et al., 2021).

While resources form the basis of competitive advantage, they alone are insufficient to ensure a firm's long-term success. The effective utilization, allocation, and reconfiguration of resources in response to market changes are key to sustaining a competitive edge. This is precisely the focus of dynamic capabilities view, which posits that firms need to adapt and lead changes in dynamic markets by integrating and reconfiguring both internal and external resources (Peng et al., 2022). In this study, social capital not only serves as a fundamental resource but also indirectly enhances innovation performance by influencing the firm's dynamic capabilities.

Dynamic capabilities involve three primary components—opportunity sensing, resource allocation, and organizational reconfiguration (Teece, 2014). The results of this study indicate that social capital, through its impact on these capabilities, indirectly promotes a firm's innovation performance. For example, opportunity sensing enables firms to leverage their social networks to detect technological and demand shifts in the market and respond rapidly. In the pharmaceutical industry, this capability is especially crucial, as drug development and market entry often face significant time and financial constraints as mentioned in Chapter Five. Resource allocation, a central element of dynamic capabilities, allows firms to optimize their limited resources, supporting innovation activities effectively (Qiu, 2022). Organizational reconfiguration, the capability to adjust internal structures and management processes in response to environmental shifts, ensures that firms are well-positioned to support innovation efforts.

Furthermore, by integrating the RBV and DCV, this study finds that in biopharmaceutical

companies, entrepreneurs can more effectively assess and allocate R&D resources to drive new product development and market launch through connections with external academic and technical partners as mentioned in Chapter Five. Organizational restructuring capability, another critical component of dynamic capabilities, enables firms to adapt their internal structures in response to external environmental shifts, thereby enhancing support for innovation activities (Chi et al., 2020; Fang, 2020; Meng, 2017). Social capital plays a pivotal role in this process; by connecting with industry regulators and other stakeholders, companies can swiftly access policy information and adjust internal management processes. This process, whereby social capital enhances organizational restructuring capabilities, further boosts the firm's innovation efficiency and responsiveness to market demands (J. C. Zhang & Long, 2022).

In summary, the RBV and DCV together provide a solid foundation for this study. RBV explains the importance of social capital as a unique resource for firms, while Dynamic Capabilities Theory reveals how social capital indirectly enhances innovation performance by influencing a firm's opportunity recognition, resource allocation, and organizational restructuring capabilities. The integration of these two theories not only deepens the understanding of the relationship between social capital and innovation performance but also offers valuable insights into how companies can effectively utilize and allocate resources in a rapidly changing market environment to maintain sustained innovation capabilities (Dias et al., 2020; Patrício et al., 2019).

6.4 Research conclusions

This study focuses on the innovation performance of biopharmaceutical enterprises and employs a combination of theoretical research, the Delphi expert consultation method, and empirical analysis. By analyzing panel data from listed biopharmaceutical companies, the study explores the complex relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance. The findings reveal that entrepreneurs' social capital and dynamic capabilities significantly influence innovation performance, with dynamic capabilities acting as a mediator in this relationship.

6.4.1 Current status of entrepreneurs' social capital, dynamic capabilities, and innovation performance

Through empirical analysis of 216 Chinese listed biopharmaceutical enterprises, the study identifies the following key conclusions:

(1) Unbalanced development of social capital

Entrepreneurs' social capital in biopharmaceutical enterprises exhibits an unbalanced development, characterized by a focus on professional skills and commercial capital, while political and international social capital receive comparatively less attention. This indicates deficiencies in resource integration and internationalization capabilities, particularly in cross-border collaboration and global resource allocation.

(2) Uneven development of dynamic capabilities

Dynamic capabilities in biopharmaceutical enterprises are unevenly developed. Due to high technological barriers and lengthy R&D cycles, firms face challenges in market opportunity recognition and resource allocation, resulting in relatively weak opportunity sensing and resource allocation capabilities. However, they demonstrate stronger organizational adaptability and flexibility, reflecting an uneven development pattern in dynamic capabilities.

(3) Low overall innovation performance

Innovation performance in the biopharmaceutical industry is generally low, constrained by high R&D costs and extended development cycles. While a few companies excel in innovation, the majority face significant challenges and bottlenecks, resulting in poor innovation outcomes.

6.4.2 Relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance

The core findings of this study focus on the intricate relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance in listed biopharmaceutical companies:

(1) The role of entrepreneurs' social capital

Entrepreneurs' social capital plays a pivotal role in enhancing innovation performance. In a sector heavily reliant on innovation and technological progress, entrepreneurs leverage extensive social resource networks—particularly professional skills, commercial capital, and international social capital—to support innovation activities. These networks facilitate access to cutting-edge technologies and market insights while fostering effective communication and collaboration with external partners, thereby enhancing the competitiveness of firms' innovation outputs.

(2) The mediating role of dynamic capabilities

The study reveals that dynamic capabilities mediate the relationship between entrepreneurs' social capital and innovation performance. Entrepreneurs' social capital enhances opportunity

sensing, resource allocation, and organizational restructuring capabilities, which in turn improve innovation performance. Specifically, improved resource integration capabilities enable firms to more effectively utilize internal and external resources, increasing efficiency and innovation outcomes.

(3) The direct impact of dynamic capabilities on innovation performance

Dynamic capabilities themselves exert a significant positive influence on innovation performance. Beyond the resource support provided by entrepreneurs' social capital, firms' innovation performance is also shaped by external environmental factors and internal resource allocation mechanisms. Enhancements in opportunity sensing, resource allocation, and organizational restructuring capabilities enable firms to respond more rapidly to market changes and develop competitive new products and services, thereby boosting innovation performance.

6.5 Research contributions

The findings of this study have significant contributions for both business management practices and theoretical research. Specifically, by examining the relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance, the study enhances the theoretical and empirical understanding of organizational behavior and strategic management. The key impacts on existing research are as follows:

(1) Extending the applicability of entrepreneurs' social capital theory

The study reveals the central role of entrepreneurs' social capital in improving innovation performance. By segmenting social capital into professional skills capital, Political social capital, commercial capital, and international social capital, the research highlights the multidimensional influence of social capital on innovation. By emphasizing entrepreneurs' ability to integrate resources within complex social networks, the study extends the application of social capital theory to the domain of organizational innovation, providing a more structured framework for future research.

(2) Enhancing the explanatory power of dynamic capabilities theory

The research demonstrates that dynamic capabilities are not only essential tools for firms to adapt to external environmental changes but also serve as a mediating mechanism for transforming social capital into innovation performance. This finding broadens the scope of dynamic capabilities theory by elaborating on its endogenous characteristics. The study further illustrates that dynamic capabilities act as a critical bridge for effective resource allocation and innovation breakthroughs in complex competitive environments, offering new theoretical

insights into the conversion mechanism between internal resources and external performance.

(3) Revealing the boundary effects of firm characteristics in innovation

The study identifies significant impacts of firm characteristics, such as ownership type, listing year, and CEO equity holding ratio, on dynamic capabilities and innovation performance. These findings indicate that both internal and external firm characteristics play crucial roles in resource integration and capability deployment. This result provides a foundation for developing more precise theoretical models in future research and underscores the constraints imposed by firm characteristics on the efficiency of resource and capability transformation.

(4) Refining the resource-based view

By conceptualizing entrepreneurs' social capital as a strategic resource, the research elucidates the relationships among resource scarcity, inimitability, and innovation performance. This finding not only expands the applicability of the resource-based view (RBV) in dynamic environments but also highlights the unique value of intangible resources. It offers insights for enterprises in emerging economies on how to achieve innovation breakthroughs under resource-constrained conditions.

(5) Advancing multilevel analytical approaches

The study integrates analytical frameworks at the individual, organizational, and performance levels, providing a model for multilevel research. This approach overcomes traditional research limitations and offers a systematic pathway for exploring complex relational networks, thereby deepening studies on enterprise innovation.

(6) Reinforcing the central role of entrepreneurs in innovation research

The study underscores the critical role of entrepreneurs in building social capital and enhancing dynamic capabilities, further highlighting their dominant contributions to innovation activities. This finding emphasizes the importance of entrepreneur-focused research and provides new perspectives for understanding how entrepreneurial behaviors influence firms' long-term development.

In conclusion, this study significantly contributes to the development and refinement of social capital theory, dynamic capabilities theory, and the resource-based view. By incorporating the unique context of listed biopharmaceutical firms and employing a multilevel analytical framework, the research provides a valuable reference for the integration of theory and practice. It also lays the groundwork for future studies to explore more complex innovation-driven mechanisms.

6.6 Managerial insights

At the practical management level, the findings of this study provide specific strategic recommendations for biopharmaceutical enterprises to enhance innovation performance through social capital and dynamic capabilities in a competitive market environment.

First, governments should strive to enhance policy fairness in the biopharmaceutical industry and constructively leverage entrepreneurial political connections to promote innovation performance. In the post-pandemic era, the biopharmaceutical sector has been growing rapidly, requiring the government to go beyond financial support and adopt flexible policy adjustments to inject innovation momentum into enterprises. Previous research has demonstrated that targeted fiscal incentives positively impact the innovation performance of manufacturing firms, while entrepreneurial political connections can lead to biased government policies and funding (J. C. Zhang & Long, 2022; Lei, 2021). To address this, governments should actively promote equitable policy implementation, constructively guide political connections, and foster innovation within the biopharmaceutical industry. This requires creating a fair environment for government support by ensuring transparent policies, offering innovation-oriented incentives, and providing targeted fiscal support.

Second, listed biopharmaceutical enterprises should emphasize the construction and maintenance of diverse social capital. The 21st century has brought unprecedented opportunities for entrepreneurs to access resources through diversified means, driving innovation. Biopharmaceutical firms must seize these opportunities by strengthening collaborations with external stakeholders in line with their entrepreneurial strengths and changing external environments. This includes establishing and maintaining diverse social capital connections with governments, industry associations, research institutions, and commercial partners. Such networks provide vital policy support, technical knowledge, and market information, serving as critical pathways for improving innovation capabilities. Studies have shown a positive correlation between the quantity of entrepreneurs' social capital and the stability of relationship networks (Vu et al., 2023).

Third, biopharmaceutical firms should prioritize the cultivation of dynamic capabilities, particularly enhancing opportunity sensing, resource allocation, and organizational restructuring capabilities to improve their adaptability to market changes. The study reveals that innovation performance is influenced not only by entrepreneurs' social capital but also by dynamic capabilities. These capabilities not only have a direct impact on innovation performance but also act as mediators between entrepreneurs' social capital and innovation

performance. Ai and Peng (2021) have similarly emphasized that dynamic capabilities help firms sustain or enhance competitiveness amidst environmental changes. Biopharmaceutical firms should consider the chain-mediating mechanism of "entrepreneurs' social capital–dynamic capabilities–innovation performance" and actively utilize this framework to drive innovation performance.

In conclusion, biopharmaceutical enterprises should take timely and effective measures to cultivate and strengthen dynamic capabilities while leveraging entrepreneurs' social capital to optimize resource integration and capability development. This dual approach will enable firms to enhance their innovation performance and maintain competitiveness in a rapidly changing market environment.

6.7 Research limitations and future prospects

In exploring the impact of entrepreneurs' social capital on dynamic capabilities and innovation performance in Chinese listed biopharmaceutical companies, this study provides valuable managerial insights. However, it inevitably faces several limitations stemming from its scope, methodology, contextual focus, and sample selection. These limitations highlight areas for future research development.

6.7.1 Research limitations

First, sample selection reflects distinct national and industry characteristics. Due to resource constraints, the data in this study are derived from biopharmaceutical enterprises listed on China's Main Board and GEM as of December 31, 2017. This sample exhibits specific national and industry attributes tied to the Chinese regulatory and operational context. According to China's listing rules, firms must have at least three years of stable operations and meet certain revenue thresholds (e.g., a minimum of RMB 100 million in annual revenue or RMB 50 million in annual net profit). Consequently, the sample comprises firms with over eight years of operational history and considerable scale and revenue. These factors may limit the generalizability of the findings to other countries, industries, or enterprises of varying sizes and stages of development.

Second, the data period is relatively short. This study employs panel data analysis to examine the dynamic interactions and long-term relationships among entrepreneurs' social capital, dynamic capabilities, and innovation performance. However, the dataset spans from 2018 to 2022, limiting its ability to capture long-term causal relationships. While panel data can

control for individual heterogeneity, short-term fluctuations may fail to fully reveal deeper connections among the variables.

Third, the dimensions of entrepreneurs' social capital may not be comprehensive. This study focuses on dimensions of entrepreneurs' social capital such as professional skills, political, commercial, and international social capital. However, prior literature highlights additional critical components, including entrepreneurial spirit and reputation. These factors reflect personal characteristics and values that influence organizational innovation culture, decision-making efficiency, and market reputation, ultimately impacting innovation performance. Due to the difficulty in directly quantifying such dimensions and reliance on qualitative methods such as subjective evaluation and interviews, these aspects were not incorporated into the study's analytical framework.

Fourth, a focus on external social capital excludes internal organizational factors. This study primarily considers external social capital, such as relationships with governments, industries, and global partners, without addressing internal dimensions like organizational learning and corporate culture. These internal aspects of social capital play a critical role in fostering an innovation-friendly environment and may interact with external social capital in influencing innovation outcomes.

6.7.2 Future research directions

Future research could focus on expanding the sample scope, not only encompassing a broader range of Chinese biopharmaceutical enterprises but also extending to other industries and global contexts to test the generalizability of this study's conclusions. Comparative analysis across industries and countries would provide a more comprehensive understanding of the specific impacts of entrepreneurs' social capital on dynamic capabilities and innovation performance in diverse contexts. Additionally, studying failed enterprises and their reasons for failure, particularly those that did not survive long enough to go public, could offer deeper theoretical insights and practical guidance.

Extending the data period in future studies would allow for analysis of the dynamic evolution of entrepreneurs' social capital, dynamic capabilities, and innovation performance over a longer timeframe. Employing more sophisticated methods to address endogeneity issues, such as instrumental variable techniques or generalized method of moments (GMM) estimation, could improve causal inference and enhance the accuracy and reliability of conclusions (Ullah et al., 2018).

Future research could also benefit from employing mixed-method approaches that combine quantitative and qualitative analyses to capture and analyze the multidimensional characteristics of entrepreneurs' social capital more comprehensively. This would address the limitations in the current study regarding the selection of social capital dimensions and provide a richer understanding of the mechanisms at play.

Incorporating diverse data sources would further strengthen future research. Beyond panel financial statement data and publicly available media information, incorporating interview data, survey responses, and other qualitative data could enhance data diversity and research robustness (Ai & Peng, 2021; F. Cui & Song, 2022; (Zastempowski & Cyfert, 2021). By reflecting firms' actual circumstances and innovation dynamics in a multidimensional and comprehensive manner, such an approach would not only enrich the scope of the research but also address potential information biases stemming from reliance on single data sources, thereby increasing the persuasiveness and applicability of research findings.

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Annex A: Other Tables

Table A.1 Tops papers about dynamic capabilities

Year	Author	Title	Keyword	Cited by
2021	Kodama M.	Managing IT for innovation: Dynamic capabilities and competitive advantage	Innovation, dynamic capabilities	2
2012	Salavisa I.; Fontes M.	Social networks, innovation and the knowledge economy	Innovation	2
2020	Ferreira J.; Coelho A.; Moutinho L.	Dynamic capabilities, creativity and innovation capability and their impact on competitive advantage and firm performance: The moderating role of entrepreneurial orientation	Competitive advantage; Creativity; Dynamic capabilities; Entrepreneurial orientation; Exploitation; Exploration; Innovation capability; Performance	288
2022	Crespo N.F.; Simões V.C.; Fontes M.	Uncovering the factors behind new ventures' international performance: Capabilities, alertness and technological turbulence	Crisis; Entrepreneurial alertness; International new ventures; International performance; Opportunity recognition	9
2009	Stringfellow L.; Shaw E.	Conceptualizing entrepreneurial capital for a study of performance in small professional service firms	Capital; Human capital; Small enterprises; Social capital.	24
2014	Krikken M.	Social capital and its impact on born transnational firms	Social capital	0
2017	Ferreira J.; Coelho A.	Dynamic capabilities, managerial and marketing capabilities and their impact on the competitive advantage and firm performance	Competitive advantage and performance; Dynamic capabilities; Entrepreneurial orientation; Exploration and exploitation capabilities; Managerial capabilities; Marketing capabilities	12
2022	Coelho A.S.; Lisboa A.; Pinho J.C.M.R.	Entrepreneurial Orientation and Dynamic Capabilities: The Case of Family Firms	Dynamic Capabilities; entrepreneurial Orientation	0
2014	Engelen A.; Kube H.;	Entrepreneurial orientation	Absorptive capacity;	213

	Schmidt S.; Flatten T.C.	in turbulent environments: The moderating role of absorptive capacity	Entrepreneurial orientation; Survey research	
2018	Adomako S.	THE MODERATING EFFECTS of ADAPTIVE and INTELLECTUAL RESOURCE CAPABILITIES on the RELATIONSHIP between ENTREPRENEURIAL ORIENTATION and FINANCIAL PERFORMANCE	Adaptive capability; Entrepreneurial orientation; financial performance; Ghana; intellectual resources; SMEs	7
2016	Swoboda B.; Olejnik E.	Linking Processes and Dynamic Capabilities of International SMEs: The Mediating Effect of International Entrepreneurial Orientation	Dynamic Capabilities; entrepreneurial Orientation	78
2015	Monferrer D.; Blesa A.; Ripollés M.	Born globals trough knowledge-based dynamic capabilities and network market orientation	Ambidextrism; Dynamic capabilities; International entrepreneurship; Network market orientation	63
2022	Shi Z.; Yuan L.; Lee S.H.	Dynamic capabilities and entrepreneurial performance of Chinese start-ups: the mediating roles of managerial attitude towards risk and entrepreneurial behaviour	Chinese start-ups; dynamic capabilities; entrepreneurial behaviour; entrepreneurial performance; managerial attitude towards risk	9
2018	Uhl-Bien M.; Arena M.	Leadership for organizational adaptability: A theoretical synthesis and integrative framework	Ambidexterity; Complexity leadership; Dynamic capabilities; Innovation; Networks	249
2018	García-Villaverde P.M.; Rodrigo-Alarcón J.; Parra-Requena G.; Ruiz-Ortega M.J.	Technological dynamism and entrepreneurial orientation: The heterogeneous effects of social capital	Entrepreneurial orientation; Moderating role; Social capital; Technological dynamism	40
2012	Bojica A.M.; Arroyo M.R.; Fuentes M.M.F.	Knowledge acquisition through inter-firm relationships and entrepreneurial orientation: The mediating role of second order social capital	Entrepreneurial orientation; Knowledge acquisition; Knowledge heterogeneity; Social capital	25
2018	Mahringer C.A.; Renzl B.	Entrepreneurial initiatives as a microfoundation of dynamic capabilities	Corporate entrepreneurship; Dynamic capabilities; Entrepreneurial	22

			initiatives; Intrapreneurship; Microfoundations; Multi-level	
2010	Jiao H.; Wei J.; Cui Y.	An empirical study on paths to develop dynamic capabilities: From the perspectives of entrepreneurial orientation and organizational learning	Dynamic capabilities; Entrepreneurial orientation; Mediation effect; Organizational learning	41
2022	Zaato S.G.; Ismail M.; Uthamaputhran S.; Owusu-Ansah W.; Owusu J.; Md. Shuaib A.S.; Hassan H.	How Social Capital Activates the Entrepreneurial Orientation of SMEs Performance in an Emerging Country in Covid-19 Pandemic	Covid-19 pandemic; Emerging country; Entrepreneurial orientation; Entrepreneurship; Ghana; Resource base view; SMEs/Firm performance; Social capital	2
2023	Hernández-Linares R.; López-Fernández M.C.; García-Piqueres G.; Pina e Cunha M.; Rego A.	How knowledge-based dynamic capabilities relate to firm performance: the mediating role of entrepreneurial orientation	Entrepreneurial orientation; Knowledge-based dynamic capabilities; Performance; SMEs	3
2020	Aslam H.; Blome C.; Roscoe S.; Azhar T.M.	Determining the antecedents of dynamic supply chain capabilities	Dynamic supply chain capabilities; Entrepreneurial orientation; Market sensing; Structural equation model; Supply chain adaptability; Supply chain agility; Supply chain learning orientation; Supply-chain management	52

Table A.2 Expert judgment basis coefficient (Ca) assignment

Judgment basis	Expert Self-assessment (extent)		
	big	centre	small
theoretical analysis	0.3	0.2	0.1
hands-on	0.5	0.4	0.3
For the domestic and foreign counterparts understand	0.1	0.1	0.05
Intuitive analysis	0.1	0.1	0.05
amount to	1	0.8	0.5

Table A.3 Expert familiarity coefficient (Cs) assignment

degree of familiarity	Very familiar with	know sth. or sb. well	Generally familiar with	be unfamiliar with	Very unfamiliar
assignment	1	0.7	0.5	0.3	0

Table A.4 Basic information of the experts

Class	Base situation	Number of people	Constituent ratio (%)
Sex	man	15	75.0%
	woman	5	25.0%
Age	Age 40-49	10	50.0%
	50-59 Years old	6	30.0%
	Over 60 years old	4	20.0%
Highest education	doctoral candidate	15	75.0%
	Master Degree Candidate	4	20.0%
	undergraduate college	1	5.0%
Technical title	Is advanced	12	60.0%
	Deputy senior	2	10.0%
	middle rank	3	15.0%
	elementary	1	5.0%
	No / other	2	10.0%
Nature of work unit	Universities or scientific research institutes	8	40.0%
	enterprise and institution	9	45.0%
	Association / Society	3	15.0%
Current major	Professor / scholar	9	45.0%
	entrepreneur	8	40.0%
	Head of the trade association	3	15.0%
Number of years of the current major	10-20 Years	12	60.0%
	21-30 Years	3	15.0%
	More than 30 years (excluding 30 years)	5	25.0%

Table A.5 The limits of the first round

Index level	Mean value of the importance score	Full marks frequency	Coefficient of variation (CV)
Level 1 indicators	4.18	32.8%	0.165
Secondary indicators	3.03	5.0%	0.317

Table A.6 The limits of the second round

Index level	Mean value of the importance score	Full marks frequency	Coefficient of variation (CV)
Level 1 indicators	4.18	33.5%	0.164
Secondary indicators	3.17	-0.3%	0.264

Table A.7 Degree of expert opinion coordination for first-level indicators

Variable	Level 1 indicators	The first round of results			The second round of results			Screening results
		Mean	Full marks frequency	Coefficient of variation	Mean	Full marks frequency	Heteromorphosis Coefficient	
Social capital of entrepreneurs (independent variable)	specialized skill social capital	4.85	85.0%	0.076	4.70	70.0%	0.100	continue to have
	Political social capital	4.15	25.0%	0.141	4.20	35.0%	0.166	continue to have
	Commercial social capital	4.55	55.0%	0.112	4.65	65.0%	0.105	continue to have
	Overseas social capital	3.90	10.0%	0.142	3.85	15.0%	0.174	continue to have
Dynamic capability (mediation variable)	Opportunity perception	4.95	95.0%	0.045	4.80	80.0%	0.085	continue to have
	Resource integration capability	4.95	95.0%	0.045	4.95	95.0%	0.045	continue to have
	Organizational remodeling capability	4.80	80.0%	0.085	4.85	85.0%	0.076	continue to have
Innovation performance (dependent variable)	The number of patents applied for by enterprises in that year	4.15	35.0%	0.180	4.20	30.0%	0.147	reject
	The number of patents granted in that year	4.20	40.0%	0.183	4.20	35.0%	0.166	continue to have
	New products on the market quantity	4.70	75.0%	0.122	4.60	65.0%	0.130	continue to have
	Number of clinical trial approvals obtained	4.55	60.0%	0.133	4.45	50.0%	0.136	continue to have
Control variable	entrepreneur individual level	4.45	55.0%	0.154	4.50	55.0%	0.135	continue to have
	Enterprise level	4.40	50.0%	0.155	4.50	60.0%	0.153	continue to have

Table A.8 Expert coordination coefficient for the secondary indicators

Variable	One-level Metric	Secondary indicators	The first round of results			The second round of results			
			Mean	Full marks frequency	Heteromorphosis Coefficient	Mean	Full marks frequency	Coefficient of variation	Dressing by screening Bear fruit
Social capital of entrepreneurs (independent variable)	Specialty Technical capability Society Capital	Professional ranks and titles	3.50	10.0%	0.236	3.35	5.0%	0.243	Continue to have
		Record of formal schooling	4.15	30.0%	0.162	4.00	15.0%	0.140	Continue to have
		Professional background	4.10	35.0%	0.208	4.40	45.0%	0.136	Continue to have
		Experience in universities / research institutes	2.80	0.0%	0.319				Reject
	Politics Society Capital	Political status	2.45	0.0%	0.362				Reject
		Political association	2.85	5.0%	0.382	2.90	0.0%	0.294	Continue to have
	Comme-rce Society Capital	Business administration	3.85	30.0%	0.270	3.85	15.0%	0.194	Continue to have
		Go through Banking institution	3.00	15.0%	0.375	3.00	10.0%	0.342	Continue to have
		Office experience Guild Take office	2.90	10.0%	0.369	3.05	5.0%	0.271	Continue to have
	Overseas Society Capital	Overseas experience	3.80	15.0%	0.202	3.80	10.0%	0.183	Continue to have
Dynamic capability (mediation variable)	Opportunity perception	R&D pay Scale	4.30	35.0%	0.133	4.30	35.0%	0.133	Continue to have
		Bachelor degree or above Proportion	4.00	20.0%	0.162	4.00	15.0%	0.140	Continue to have
	Resource integration capability	Research staff Scale	4.00	20.0%	0.162	4.05	20.0%	0.149	Continue to have
		Industry-university-	3.75	25.0%	0.258	4.00	35.0%	0.229	Continue to have

		research cooperation							
	Organizational remodeling capability	Senior management changes	3.95	25.0%	0.209	3.80	20.0%	0.219	Continue to have
		ROE	4.00	20.0%	0.162	4.00	15.0%	0.140	Continue to have
Controlled variable	Entrepreneur individual Bedding	Entrepreneur age	3.80	15.0%	0.235	3.85	5.0%	0.127	Continue to have
		Entrepreneur gender	3.05	5.0%	0.249	3.10	0.0%	0.207	Continue to have
	Enterprise Bedding	Scale	3.65	10.0%	0.204	3.55	0.0%	0.170	Continue to have
		Listing of a company	3.35	5.0%	0.175	3.25	0.0%	0.197	Continue to have
		Age limit							
		Enterprise establishment	3.25	5.0%	0.197	3.40	0.0%	0.176	Continue to have
		Age limit							
		Enterprise nature	3.60	20.0%	0.291	3.70	16.0%	0.250	Continue to have
		Board size	3.25	5.0%	0.262	2.90	0.0%	0.294	Continue to have

Table A.9 Measures of innovation performance

Dimension	Definition	Unit
Patent application	Number of patent applications filed by enterprises in the year	numerical value
Clinical trial approvals obtained	Number of clinical trial approvals authorized by the enterprise in the year	numerical value
New Products	Number of drug or medical device manufacturing licenses obtained by the enterprise in the year	numerical value

Table A.10 Criteria for assigning capital to entrepreneurs' specialized skills

Variable	Definition of indicators	Description of the assignment
Professional capacity	Title	Job titles are assigned values of 1, 2 and 3 for junior, intermediate, and senior levels respectively.
	Education attainment	Academic qualifications are assigned the values 1, 2, 3, 4, 5 and 0 for secondary school and below, junior college, bachelor's degree, master's degree, doctoral degree, and others (qualifications published in their form, see the remarks of the record for details), respectively.
Professional background	Whether graduated from an institution or program related to the biomedical industry	Yes, assign the value 1; No, assign the value 0.

Table A.11 Criteria for assigning political social capital

Dimension	Definition	Description of the assignment
Political profile of entrepreneurs	Whether a member of the CPC or other democratic parties	Yes, CPC members or other democrats are assigned a value of 1; No. Assign the value 0.
Entrepreneurial political identity	Whether a deputy to the National People's Congress or a member of the Chinese People's Political Consultative Conference	Yes, 4, 3, 2, 1 depending on the administrative level (central, provincial, prefectural, district and county); No, 0.

Table A.12 Criteria for assigning value to entrepreneurs' Business social capital

Variable	Definition of indicators	Description of the assignment
Corporate management experience	Whether they have worked in other enterprises	Yes, assign the value 1; No, assign the value 0.
Experience in financial institutions	Have you worked in the financial industry, such as banks, securities companies, fund companies.?	Yes, assign the value 1; No, assign the value 0.
Industry association experience	Whether serving on a trade association	Yes, member, director, executive director, secretary general, vice president (vice president), president (president), assigned the value of 1, 2, 3, 4, 5, 6, respectively; No, assigned the value 0.

Table A.13 Overseas social capital assignment criteria

Variable	Definition of indicators	Description of the assignment
Overseas experience	Whether the entrepreneur has studied or worked abroad	If yes, assign 1 and 2 according to overseas posting and overseas study respectively; otherwise, i.e. no overseas study experience, assign 3.
Management Overseas Experience	Number of directors with overseas background	Numeric variable

Table A.14 Dynamic capability Measurement Scale

Dimension	Metrics	Reference
Opportunity perception	R&D expenditure ratio (R&D expenses/sales)	Fombmn & Ginsberg (1990) Teece et al. (1994; 1997; 2000; 2007), Peng Cheng (2022), XuFang (2022), Ai Yuhong (2021), Yang Lin (2020), Xiu'e Zhang (2021), Jichang Zhang (2022)
	Percentage of personnel with graduate degrees and above	
Resource allocation capacity	Ratio of R&D staff (Number of R&D staff/total number of employees)	
	Availability of industry-academia-research cooperation	
Organizational reconfiguration capacity	Changes in senior management (whether it involves changes in the positions of Chairman and Managing Director)	
	return on assets	

Table A.15 List of Dynamic Capacity Measurement Indicators

Dimension	Indicator	Definition	Assignment description/unit
Opportunity perception	Ratio of R&D expenditures	R&D expenditures for the year / sales revenue for the year	specific value
	Bachelor's Degree and above percentage	Number of people with bachelor's degree or above in the year/number of employees	specific value
Resource allocation capacity	Percentage of technical staff	Number of technicians/total number of employees for the year	specific value
	Availability of industry-academia-research cooperation	Whether the year involved cooperation with other enterprises, universities, and research institutes	Yes, cooperation with universities or research institutions is assigned a value of 1, and cooperation with enterprises is assigned a value of 2; No, a value of 0 is assigned.
Organizational reconfiguration capacity	Changes in senior management	Whether the year involved personnel changes in the positions of Chairman and General Manager	Involves a change, assigns a value of 1; Otherwise, assign 0.
	Return on assets	Ratio of corporate EBIT to average total assets	Specific value

Table A.16 Descriptive statistics of basic information of research subjects

Name	Option	Frequency	Percentage (%)	Cumulative Percentage (%)
Year of Listing	[1992.0,1998.25)	190	17.593	17.593
	[1998.25,2004.5)	201	18.611	36.204
	[2004.5,2010.75)	180	16.667	52.87
	[2010.75,2017.0]	509	47.13	100
Total		1080	100.000	100.000
Firm Size	[2.377,2.97)	231	21.389	21.389
	[2.97,3.563)	530	49.074	70.463
	[3.563,4.157)	272	25.185	95.648
	[4.157,4.75]	47	4.352	100
Total		1080	100.000	100.000
Board Size	[5.0,7.5)	333	30.833	30.833
	[7.5,10.0)	594	55	85.833
	[10.0,12.5)	135	12.5	98.333
	[12.5,15.0]	18	1.667	100
Total		1080	100.000	100.000
General	[0.0,15.312)	942	87.222	87.222
Managers'	[15.312,30.625)	76	7.037	94.259
Shareholding	[30.625,45.938)	41	3.796	98.056
Ratio	[45.938,61.25]	21	1.944	100
Total		1080	100.000	100.000
Firm Nature	Private	767	71.019	71.019
	Public	258	23.889	94.907
	Joint Venture	55	5.093	100
Total		1080	100.000	100.000
Industry	Pharmaceuticals	621	57.5	57.5
Classification	Medical Devices	249	23.056	80.556
	Both	210	19.444	100
Total		1080	100.000	100.000

Table A.17 Overall description of entrepreneur social capital scores

Variable	Sample size	Max	Mini	Mean	SD	Median	SD	Kurtosis	Skewness	CV
Professional skills capital	1080	1	0.126	0.381	0.197	0.296	0.039	2.701	1.838	0.516
Political social capital	1080	1	0.088	0.319	0.192	0.258	0.037	1.825	1.494	0.602
Commercial capital	1080	1	0	0.373	0.19	0.338	0.036	0.582	1.006	0.509
Overseas social capital	1080	1	0	0.295	0.212	0.216	0.045	2.803	1.955	0.718
Entrepreneurs' social capital	1080	1	0.049	0.335	0.128	0.304	0.016	2.845	1.342	0.383

Table A.18 Overall description of enterprise dynamic capability scores

Variable	Sample size	Max	Mini	Mean	SD	Median	SD	Kurtosis	Skewness	CV
Opportunity sensing capability	1080	1	0	0.271	0.133	0.254	0.018	3.408	1.233	0.49
Resource allocation capability	1080	1	0	0.248	0.112	0.235	0.012	2.874	1.013	0.449
Organizational restructuring capability	1080	1	0	0.308	0.317	0.161	0.101	-0.468	1.164	1.029
Dynamic capabilities	1080	1	0	0.36	0.25	0.269	0.062	-0.53	0.932	0.694

Table A.19 Overall description of corporate innovation performance scores

Variable	Sample size	Max	Mini	Mean	SD	Median	SD	Kurtosis	Skewness	CV
Innovation performance	1080	0.671	0	0.044	0.054	0.029	0.003	30.828	4.246	1.238

Table A.20 Analysis of variance results (enterprise nature)

Variable	Content	Sample size	Mean	SD	SD test	Welch's SD test
Dynamic capabilities	Private	767	0.343	0.239	F=7.794 P=0.000***	F=6.601 P=0.002***
	SOE	258	0.413	0.279		
	JV	55	0.36	0.221		
	Total	1080	0.36	0.25		
Innovation performance	Private	767	0.041	0.051	F=3.661 P=0.026**	F=2.998 P=0.053*
	SOE	258	0.052	0.063		
	JV	55	0.046	0.041		
	Total	1080	0.044	0.054		

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.21 Analysis of variance results (industry)

Variable	Content	Sample size	Mean	SE	SD test	Welch's SD test
Dynamic capabilities	Pharmaceuticals	621	0.359	0.254	F=0.032 P=0.969	F=0.033 P=0.967
	Medical devices	249	0.359	0.248		
	Both	210	0.364	0.242		
	Total	1080	0.36	0.25		
Innovation performance	Pharmaceuticals	621	0.043	0.053	F=2.954 P=0.053*	F=2.857 P=0.058*
	Medical devices	249	0.04	0.057		
	Both	210	0.051	0.054		
	Total	1080	0.044	0.054		

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.22 Spearman correlation coefficient table of quantitative variables

	Dynamic capabilities	Innovation performance
Firm size	0.014(0.652)	0.009(0.779)
Year of listing	-0.036(0.243)	-0.079(0.009***)
Board size	-0.004(0.897)	0.043(0.154)
General manager's shareholding ratio	0.134(0.000***)	0.028(0.355)

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.23 Individual fixed effect test 1

Test	Statistics	P	Conclusion
F test	4.357	0.000***	FEModel
Breusch-Pagantest	347.205	0.000***	REModel
Hausmantest	0.552	0.907	REModel

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.24 Individual fixed effect test 2

Test	Statistics	P	Conclusion
F test	1.398	0.001***	FE Model
Breusch-Pagantest	10.036	0.040**	RE Model
Hausmantest	4.909	0.179	RE Model

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.25 Individual fixed effect test 3

Test	Statistics	P	Conclusion
F test	5.133	0.000***	FE Model
Breusch-Pagantest	435.598	0.000***	RE Model
Hausmantest	4.558	0.207	RE Model

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.26 Time fixed effect test 1

	Unstandardized coefficients		Standardized coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	-5.002	2.355	-	-2.124	0.034**	-	0.004	0.003	F=4.591 P=0.032**
Year	0.002	0.001	0.065	2.143	0.032**	1			
Dependent Variable: Innovation performance									

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.27 Time fixed effect test 2

	Unstandardized coefficients		Standardized coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	-16.717	10.852	-	-1.54	0.124	-	0.002	0.001	F=2.476 P=0.116
Year	0.008	0.005	0.048	1.574	0.116	1			
Dependent Variable: Dynamic Capabilities									

Table A.28 Time fixed effect model (independent variable: Entrepreneur' social capital; dependent variable: innovation performance)

Variable	Coefficient	SD	t	P	R^2	F
const	1.343	0.414	3.246	0.001***	within=0.009	F=42.705
Entrepreneurs' social capital	0.136	0.012	10.94	0.000***	between=0.18 overall=0.106	P=0.000***
Year of listing	-0.001	0	-3.251	0.001***		
Firm nature	0	0.003	0.001	0.999		
Dependent Variable: Innovation performance						

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.29 Time fixed effect model (independent variable: professional skill capital; dependent variable: innovation performance)

Variable	Coefficient	SD	t	P	R^2	F
const	1.151	0.439	2.621	0.009***	within=0.006	F=8.461
Professional skills capital	0.036	0.009	4.204	0.000***	between=0.038 overall=0.023	P=0.000***
Firm nature	0.004	0.003	1.43	0.153		
Year of listing	-0.001	0	-2.565	0.010**		
Dependent Variable: Innovation performance						

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.30 Time fixed effect model (independent variable: Political social capital; dependent variable: innovation performance)

Variable	Coefficient	SD	t	P	R^2	F
const	0.391	0.41	0.952	0.341	within=0.006	F=45.127
Political social capital	0.092	0.008	11.265	0.000***	between=0.191 overall=0.111	P=0.000***
Firm nature	0.003	0.003	1.126	0.260		
Year of listing	0	0	-0.929	0.353		
Dependent Variable: Innovation performance						

Table A.31 Time fixed effect model (independent variable: Business social capital; dependent variable: innovation performance)

Variable	Coefficient	SD	t	P	R^2	F
const	0.789	0.421	1.874	0.061*	within=0.004	F=22.815
Commercial capital	0.066	0.008	7.774	0.000***	between=0.102	P=0.000***
Firm nature	0.004	0.003	1.386	0.166	overall=0.06	
Year of listing	0	0	-1.843	0.066*		
Dependent Variable: Innovation performance						

Table A.32 Time fixed effect model (independent variable: overseas social capital; dependent variable: innovation performance)

Variable	Coefficient	SD	t	P	R^2	F
const	0.975	0.435	2.242	0.025**	within=0.001	F=6.46
Overseas social capital	0.027	0.008	3.422	0.001***	between=0.031 overall=0.018	P=0.000***
Firm nature	0.004	0.003	1.355	0.176		
Year of listing	0	0	-2.173	0.030**		
Dependent Variable: Innovation performance						

Table A.33 Random Effects Model (independent variable: entrepreneur' social capital; dependent variable: dynamic capabilities)

Variable	Coefficient	SD	t	P	R^2	F
const	0.196	0.027	7.327	0.000***	within=0.009 between=0.173	F=16.59 P=0.000***
Entrepreneurs' social capital	0.428	0.057	7.563	0.000***	overall=0.055	
General manager's shareholding ratio	-0.001	0.001	-2.545	0.011**		
Firm nature	0.02	0.014	1.4	0.162		
Dependent Variable: Dynamic Capabilities						

Table A.34 Random Effects Model (Independent variable: professional skill capital; dependent variable: dynamic capability)

Variable	Coefficient	SD	t	P	R^2	F
const	0.251	0.025	9.963	0.000***	within=0.001	F=9.498
Professional skills capital	0.205	0.036	5.691	0.000***	between=0.117	P=0.000***
Firm nature	0.03	0.015	1.984	0.047**	overall=0.034	
General manager's shareholding ratio	-0.002	0.001	-2.887	0.004***		
Dependent Variable: Dynamic Capabilities						

Table A.35 Random Effects Model (independent variable: political social capital; dependent variable: dynamic capabilities)

Variable	Coefficient	SD	t	P	R^2	F
const	0.281	0.028	10.212	0.000***	within=0	F=4.422
Political social capital	0.113	0.045	2.497	0.013**	between=0.059	P=0.004***
					overall=0.017	
Firm nature	0.034	0.015	2.233	0.026**		
General manager's shareholding ratio	-0.001	0.001	-1.035	0.301		
Dependent Variable: Dynamic Capabilities						

Table A.36 Random Effects Model (independent variable: business social capital; dependent variable: dynamic capabilities)

RE Model						
Variable	Coefficient	SD	t	P	R^2	F
const	0.239	0.026	9.197	0.000***	within=0.006	F=11.165
Commercial capital	0.23	0.041	5.605	0.000***	between=0.122	P=0.000***
					overall=0.039	
Firm nature	0.031	0.015	2.036	0.042**		
General manager's shareholding ratio	-0.001	0.001	-2.013	0.044**		
Dependent Variable: Dynamic Capabilities						

Table A.37 Random Effects Model (independent variable: overseas social capital; dependent variable: dynamic capabilities)

Variable	Coefficient	SD	t	P	R^2	F
const	0.279	0.024	11.786	0.000***	within=0.015	F=7.866
Overseas social capital	0.17	0.038	4.507	0.000***	between=0.077	P=0.000***
					overall=0.027	
Firm nature	0.028	0.015	1.8	0.072*		
General manager's	-0.001	0.001	-2.081	0.038**		

shareholding ratio						
Dependent Variable: Dynamic Capabilities						

Table A.38 Time fixed effects model (independent variable: firm dynamic capabilities; dependent variable: innovation performance)

Variable	coefficient	SD	t	P	R^2	F
const	0.535	0.43	1.243	0.214	within=0.014	F=10.667
Dynamic capabilities	0.032	0.007	4.924	0.000***	between=0.048 overall=0.029	P=0.000***
Year of listing	0	0	-1.185	0.236		
Firm nature	0.005	0.003	1.574	0.116		
Dependent Variable: Innovation performance						

Table A.39 Time fixed effect model (independent variable: opportunity perception; dependent variable: innovation performance)

Variable	coefficient	SD	t	P	R^2	F
const	1.456	0.432	3.372	0.001***	within=0.003	F=21.531
Opportunity sensing capability	0.094	0.012	7.524	0.000***	between=0.131 overall=0.059	P=0.000***
Firm nature	0.004	0.003	1.308	0.191		
Year of listing	-0.001	0	-3.341	0.001***		
Dependent Variable: Innovation performance						

Table A.40 Time fixed effect model (independent variable: resource allocation capability; dependent variable: innovation performance)

Variable	coefficient	SD	t	P	R^2	F
const	1.415	0.437	3.236	0.001***	within=0.001	F=15.963
Resource allocation capability	0.095	0.015	6.326	0.000***	between=0.088 overall=0.044	P=0.000***
Firm nature	0.004	0.003	1.263	0.207		
Year of listing	-0.001	0	-3.199	0.001***		
Dependent Variable: Innovation performance						

Table A.41 Time fixed effect model (independent variable: organizational restructuring capability; dependent variable: innovation performance)

Variable	coefficient	SD	t	P	R^2	F
const	0.512	0.437	1.17	0.242	within=0.012	F=5.976
Organizational restructuring capability	0.017	0.005	3.205	0.001***	between=0.02	P=0.000***
Firm nature	0.005	0.003	1.739	0.082*	overall=0.016	

Year of listing	0	0	-1.099	0.272

Dependent Variable: Innovation performance

Table A.42 Coefficients of the mediating effect regression model

	Innovation performance					Dynamic capabilities					Innovation performance				
	coefficient	Standard error	t	P	Standardized coefficient	coefficient	Standard error	t	P	Standardized coefficient	coefficient	Standard error	t	P	Standardized coefficient
Constant	0	0.004	-0.08	0.937	-	0.218	0.021	10.473	0.000***	-	-0.005	0.005	-1.042	0.297	-
Entrepreneurs' social capital	0.132	0.012	10.759	0.000***	0.311	0.425	0.058	7.347	0.000***	0.218	0.123	0.012	9.85	0.000***	0.291
Dynamic capabilities											0.02	0.006	3.179	0.002***	0.094
R^2	0.097					0.048					0.105				
AdjustedR^2	0.096					0.046					0.103				
F	F(1，1078)=115.757，P=0.000***					F(1，1078)=53.972，P=0.000***					F(2，1077)=63.421，P=0.000***				

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively. N=1080

Table A.43 Summary of results of mediation effect test

Item	c Total effect	a	A (p)	b	b(p)	a*b mediation effect	a*b (Boot SE)	a*b (z)	a*b (P)	a*b (95% Boot CI)	c' direct effect	c' (p)	Test Conclusion
Entrepreneurs' social capital=>Dynamic capabilities=>Innovation performance	0.132	0.425	0.000***	0.02	0.002***	0.009	0.003	2.721	0.007***	0.003 - 0.016	0.123	0.000***	Partially mediated

Table A.44 Path model fit indicators

GFI	RMR	CFI	NFI
>0.9	<0.05	>0.9	>0.9
1	0	1	1

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

Table A.45 Model regression coefficient table

X	→	Y	Unstandardized coefficients	Standardized coefficients	S.E.	C.R.	P
Entrepreneurs' social capital	→	Dynamic capabilities	0.425	0.218	0.058	7.356	0.000***
Entrepreneurs' social capital	→	Innovation performance	0.123	0.291	0.012	9.863	0.000***
Dynamic capabilities	→	Innovation performance	0.02	0.094	0.006	3.187	0.001***

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.

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Annex B: Expert Correspondence Form for Entrepreneurial Social Capital, Innovation Performance and Dynamic Capability Evaluation Indicator System (First round)

Dear Prof.:

Hello, we are a research group from the School of Health Management, Southern Medical University!. We are conducting research on "The Impact of Entrepreneurial Social Capital on the Innovation Performance of Biomedical Enterprises —— Based on Dynamic Capabilities". The 21st century is an era of rapid development of high technology, and scientific and technological innovation has become the key variable of national socio-economic development, while biomedicine has been listed as a key area concerning national security and development. Under the background of the global economic downturn and China's economic transformation, the implementation of an innovation-driven development strategy in the field of biomedicine is the key to guaranteeing socio-economic development and enhancing national scientific and technological power, and how biomedicine enterprises can effectively acquire and utilize all kinds of resources to realize innovation by improving and applying their own capabilities has become a key issue to be explored in both the practical and theoretical fields.

Through preliminary theoretical research, literature analysis, and group discussion, this study constructs an evaluation index system of entrepreneurial social capital, innovation performance, and dynamic capability with the support of the resource view theory, high-order ladder theory, and dynamic capability theory, combined with the talent-, technology-, and knowledge-intensive characteristics of the biomedical field and with the accessibility of the evaluation indexes. There are 4 primary indicators of entrepreneurial social capital and 10 secondary indicators; 3 primary indicators of dynamic ability and 6 secondary indicators; 3 primary indicators of innovation performance and 4 secondary indicators; and 2 primary indicators of control variables and 6 secondary indicators, as shown in Table 1.

The questionnaire consisted of four main parts: the first part was a description of the sources of the evaluation indicators; the second part was a questionnaire on the basic information of the experts; the third part was a questionnaire on the evaluation indicators of the entrepreneur's social capital, innovation performance, and dynamic capabilities; and the fourth part was a questionnaire on the experts' familiarity and the basis of judgment.

In view of your attainments and academic reputation in this field, we would like to invite you to be the expert of this research correspondence to rate the preliminary constructed index system. We expect you to respond to the consultation form within two weeks, and if you have any questions in the process of filling out the form, please feel free to contact us. Thank you for your support in this study, and we honor the appropriate consulting fee at the end of the consultation. We sincerely thank you for your enthusiastic support and help in your busy schedule.

(Contact: Qian Zhang; Contact: 13922700333; Email: 9655440@qq.com)

Subject Group, School of Health Management, Southern Medical University

March 23, 2024

Part I. Description of the sources of the system of evaluation indicators

Table 1: Description of the indicator evaluation system and its sources

Variability	Dimension/Level 1 indicator	Secondary indicators	Sources of indicators
Entrepreneurial social capital□Independent Variables□	Professional skills dimension	Professional status	Within the field of biopharmaceuticals, based on the characteristics of biopharmaceutical enterprises, the strength of the entrepreneur's personal expertise may become a key factor in the outcome of the enterprise; Chu, Sugur (2019) pointed out that expertise can encompass such things as professional identity, background, and tenure in higher education, and can also cover a number of facets; and Huang (2022) pointed out that the accumulation of expertise can enable entrepreneurs to better cope with the marketplace and innovate and develop.
		Professional background	
		Work experience in universities or research institutes	
	Political capital	Political profile	Shaheen (2023) and Wu (2023) pointed out that the relationship between entrepreneurs and government departments can obtain government support and resources for enterprises; meanwhile, Liu Jiankun (2020) pointed out that: although entrepreneurs do not serve in the government sector, but through the National People's Congress, CPPCC members and other ways to accumulate a certain amount of relationship resources.
		Political affiliation	
	Business Capital	Entrepreneurial management experience	Peng (2000) pointed out that the skills, knowledge, and interpersonal relationships accumulated by entrepreneurs in the business field can help entrepreneurs to gain an advantage in market competition, and that business connections included the entrepreneur's social network with others or other enterprises□Omar□2022□, the entrepreneur's access to capital and investment□Huang□2023□Onginjo□2021□, and the entrepreneur's visibility and reputation in the field□Junfeng,2022□. The biomedical industry associations are a platform for internal exchanges and cooperation, and serving in the associations can help to understand the industry's dynamics and to build up the industry's relational network; and that the financial experience has an impact on the financing of the enterprise, the investment decisions and the structuring of the capitalization.
		Experience in financial institutions	
		Industry association appointments	
	Overseas social capital	Overseas experience	Guo Shujuan (2019) pointed out that different growth environments and education modes differ in their knowledge structures and thinking choices, etc. Meanwhile, Wang Lin (2021) pointed out that overseas biopharmaceutical companies pay more attention to R&D investment, and that the overseas

			experience has the opportunity to absorb the management mode of foreign enterprises and be more sensitive to the frontiers of new drug R&D.
Dynamic capability□Intermediary Variables□	Ability to perceive opportunities	Ratio of R&D expenditures	Han (2023) pointed out that opportunity perception capability is one of the important components of firms' dynamic capabilities; Tark (2019) suggested that suggested that firms can improve their sensitivity to market opportunities by learning and acquiring new knowledge, have seized new opportunities and identify threats, etc.; Xue-Li Wang & Zhi-Tang Li (2015) pointed out that talent improves the ability to perceive the important opportunities and critical nodes; Jichang Zhang (2022) Indirectly reflect the perceived ability of enterprises through the financial of their R&D investment.
		Percentage of personnel with bachelor's degree or above	
	Ability to integrate resources	Ratio of R&D staff	Resources are divided into internal and external resources of enterprises. Peng (2022) used the ratio of technicians to measure the internal resource capacity; in the field of biomedicine, cooperation with universities/research institutes is an important way to obtain external innovation resources. The studies of Wang Jingyu (2023) and W.Cui (2022) et al. pointed out that the cooperation between industry-university-research institutes is conducive to the use of external resources to break through the transformation of scientific and technological achievements. Xia& Jia (2023) used industry-university-research cooperation programs to measure the ability of enterprises to acquire external resources.
		Industry-University-Research Cooperation	
	Organizational reconfiguration capacity	Changes in senior management	Wajcman (2001) pointed out that in the process of development and growth, enterprises can adjust their organizational structure according to the market changes/demands; existing literature, ChiMaoMao (2020) believed that organizational reconfiguration capability is the reorganization and reengineering of the existing operational capabilities of the enterprise; previous studies mainly take the form of questionnaires, which are mainly aimed at adjusting the organizational structure, the adjustment of the workflow and resources. Scholars Wang Molin (2022) and AiYuhong (2021) measured the firm's ability to reallocate and integrate from the financial aspect, using return on assets to reflect the firm's reconfiguration capability; therefore, this paper obtains objective data from the panel data, reflecting the organizational reconfiguration capability from the non-financial management aspect of the firm's executives and from the financial aspect of the return on resources.
		Return on assets□ROA□	
	Number of patents	Number of patent applications	The biopharmaceutical industry is characterized by a long R&D cycle, high correlation between scientific discoveries and industrial technologies, and

Enterprise innovation performance□Dependent variable□		Number of patents granted	many scholars use the number of patents to measure the innovation performance, such as the number of patent applications, the number of granted patents, etc. (Huang Bo et al. 2023; Liu Guanchen et al. 2022; Liu et al. 2022; Xie 2022); the patent data are open and transparent, standardized in form, easy to collect and comparable. Strong characteristics.
	Number of new product launches	Number of licenses to manufacture drugs or medical devices	Many scholars have used the number of new product launches as a measure of innovation performance, e.g., the number of new product launches/developments (Kong Ting et al. 2013; Yi Yaqun, 2018; Ferreras-Méndez, 2021; Hua & Yuan, 2022), and combined with the products of biopharmaceuticals, which are mainly drugs and medical devices, the number of new product launches in this category is added to the innovation performance measurements, adding richness.
	Number of clinical trial approvals	Number of authorized clinical trial approvals	The State Drug Administration (SDA) stipulates that drugs and medical devices must obtain clinical trial approvals before they are allowed to undergo clinical trials, which is a mandatory stage. Meanwhile, there is literature pointing out that a lot of enterprises have obtained Phase III clinical trial approvals as the time demarcation point for R&D capitalization (Liu, 2022), and that the clinical trial approvals are a stage unique to the field of biomedicine and have the characteristics of the biomedicine industry.
Control Variables	Individual entrepreneurial level	Age of entrepreneurs	Cheng Hong & Han Xiaoxiao (2016) pointed out that the age of entrepreneurs can reflect the experience of entrepreneurs, and the accumulation of experience will have an impact on their decision-making preferences, strategic choices; Sedaghat & Lei (2020) pointed out that the age of entrepreneurs affects motivation. In addition the gender is different, the entrepreneur's ability to perceive the event is different (Ludmila,2017),which from the personal characteristics of entrepreneurs to study whether there is an impact on the innovation performance of biopharmaceutical listed companies.
		Gender of entrepreneurs	
	Enterprise level	Enterprise size	Different enterprise size can reflect the different resource stock of the enterprise, many scholars, such as Yu Jiang (2023), Cui (2022), etc., have studied the impact on performance from the enterprise size, pointing out that the expansion in the appropriate size of the enterprise may enhance the enterprise's R&D strength and efficiency.
		Age of listing of enterprises	In the enterprise life cycle theory, the different age of the company's listing, its popularity, stability goodwill will change, and thus its access to opportunities will also change. (Huang Zhen, 2021; Lei Haimin et al., 2014)

		Nature of enterprise	The nature of property rights is a natural attribute of enterprises, different nature can cause differences in the allocation of enterprise resources, business objectives and policy system and other multiple programs (Tang Hongxiang & Li Yinchang,2020); Zhang Fan (2022) pointed out that the nature of the enterprise's ownership has a moderating effect on technological innovation.
		Size of the Board	The board of directors is a key part of the decision-making of the management of a firm, and Ren Dove & Sun Hui (2019) pointed out that the size of the board of directors has an impact on the decision-making of the firm, especially in firms that are relatively resource-poor.

Part II. Basic information questionnaire for experts

(This part of the information is only used for research and statistical analysis, and will not be disclosed to the public, please rest assured!)

1. Your gender is: (click "□ " in the appropriate box)

Male Female

2. Your age: years

3. Your highest education level is:

Doctoral degree Master's degree

Undergraduate degree College or below

4. The nature of your work unit is:

Governmental administrative department

University or scientific research institution

Enterprise or public institution

Associations/societies or other social organizations

Others (please specify)

5. The location of your work unit: province (autonomous region, municipality directly under the central government) city county (district)

6 Your professional and technical title is:

Senior Associate Senior

Intermediate Junior Other

7. The major fields of specialization in which you are currently engaged and the number of years you have worked:

Specialized field 1: , years of working experience

Specialized field 2: , years of working experience years

--In order to facilitate the payment of the expert consultation fee, please provide the following information together (confidential)

Name: Cell phone number :

E-mail：

Bank card number and account bank (specific to a branch)

ID card number (required to send consulting fees).

Where the unit (please try to be specific):

Part III Expert Correspondence Form on Evaluation Indicators of Entrepreneurs' Social Capital, Dynamic Capabilities and Innovative Performance

Instructions for filling out the form:

1. This study focuses on listed biopharmaceutical firms and examines the impact or relationship between entrepreneurial society, dynamic capabilities, and innovation performance of biopharmaceutical listed firms.

2. Table 2 and Table 3 are about the indicators of entrepreneurial social capital; Table 4 and Table 5 are about the indicators of dynamic capabilities; Table 6 is about the indicators of innovation performance of biopharmaceutical listed companies; Table 7 and Table 8 are about the indicators of control variables.

3. You are asked to rate the importance on a scale of 1-5 according to a 5-point Likert scale. Importance rating: very important = 5, important = 4, fair = 3, unimportant = 2, very unimportant = 1; please make your judgment and click on the "" in the columns as you see fit.

4. If you think there is a need to modify the indicators, please fill in the "Modification Opinion" column. If you think there is a need to add an indicator, please add it in the "New Indicator" column and rate the importance of the new indicator. If you have other suggestions for the indicator system, please add them in the "Other Suggestions" column.

Table 2: Expert Consultation Form for Level 1 Indicators of Social Capital for Entrepreneurs

Variability	Level 1 indicators	Definition of Tier 1 indicators	Degree of importance					Rvised opinion
			Very unimportant.	Unimportant.	General	Important.	Very important	
Entrepreneurial social capital□Independent Variables□	Professional skills dimension	Entrepreneurs' own professionalism and their skills in the biomedical field	□	□	□	□	□	

	Political capital	Networks of entrepreneurs with government departments or agencies	☐	☐	☐	☐	☐	
	Business Capital	The entrepreneur's accumulated experience, knowledge, and relationships in the business world	☐	☐	☐	☐	☐	
	Overseas social capital	Resource capital accumulated by entrepreneurs studying or working abroad	☐	☐	☐	☐	☐	
New indicator column								
Other suggestions column								

Table 3: Expert Consultation Form on Secondary Indicators of Entrepreneurial Social Capital and their Definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	Degree of importance					Revised opinion
				Very unimportant	Unimportant	General	Important	Very important	
Entrepreneurial social capital□Independent Variables□	Professional skills dimension	professional status	professional designation	☐	☐	☐	☐	☐	
			education attainment	☐	☐	☐	☐	☐	
		professional status	Whether graduated from an institution or program related to the	☐	☐	☐	☐	☐	

			biomedical industry						
		Work experience in universities or research institutes	Have you ever worked in a university or research institute	☐	☐	☐	☐	☐	
	Political capital	Political profile	Whether they are members of the Communist Party of China (CPC) or other democratic parties	☐	☐	☐	☐	☐	
		Political affiliation	Whether is a deputy to the National People's Congress or a member of the Chinese People's Political Consultative Conference	☐	☐	☐	☐	☐	
	Business Capital	Entrepreneurial management	Whether they have worked	☐	☐	☐	☐	☐	

		experience	in other enterprises						
		Experience in financial institutions	Have you worked in the financial industry such as banks, securities companies, fund companies, etc.?	☐	☐	☐	☐	☐	
		Industry association appointments	Whether or not they hold positions in trade associations	☐	☐	☐	☐	☐	
	Overseas social capital	Overseas experience	Any overseas study or posting experience	☐	☐	☐	☐	☐	
New indicator column									
Other suggestions column									

Table 4: Expert Consultation Form for Dynamic Capacity Tier 1 Indicators

Variability	Level 1 indicators	Definition of Tier 1 indicators	Degree of importance					Revised opinion
			Very unimportant.	Unimportant.	General	Important.	Very important	
Dynamic capability□Intermediary Variables□	Ability to perceive opportunities	Firms' ability to identify and recognize market opportunities or threats	☐	☐	☐	☐	☐	

	Ability to perceive opportunities	The enterprise's ability to integrate internal and external resources of the enterprise to achieve optimal allocation and efficient utilization	□	□	□	□	□	
	Organizational reconfiguration capacity s	Firms adapted and changed their organizational results to adapt to the changing market environment	□	□	□	□	□	
New indicator column								
Other suggestions column								

Table 5: Expert consultation table on secondary indicators of dynamic capacity and their definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	Degree of importance					Revised opinion
				Very unimportant.	Unimportant.	General	Important.	Very important	
Dynamic capability□Intermediary Variables□	Ability to perceive opportunities	Ratio of R&D expenditures	Ratio of current year's R&D expenditur	□	□	□	□	□	

			e to current year's sales revenue						
		Percentage of personnel with bachelor's degree or above	Ratio of the number of personnel with bachelor's degree or above to the total number of employees in the year	☐	☐	☐	☐	☐	
	Ability to integrate resources	Ratio of R&D staff	Ratio of the number of R&D personnel to the total number of employees in the year	☐	☐	☐	☐	☐	
		Industry-University-Research Cooperation	Whether the year involved cooperation with other enterprises, universitie	☐	☐	☐	☐	☐	

			s and research institutes						
	Organizational reconfiguration capacity	Changes in senior management	Whether the year involved changes in the positions of Chairman and Managing Director	☐	☐	☐	☐	☐	
		Return on assets□ROA□	Ratio of corporate EBIT to average total assets	☐	☐	☐	☐	☐	
New indicator column									
Other suggestions column									

Table 6: Consultation table of evaluation indicators of innovation performance of listed biopharmaceutical companies

Variability	Evaluation indicators	Definition of evaluation indicators	Degree of importance					Revised opinion
			Very unimportant.	Unimportant.	General	Important.	Very important	
Enterprise innovation performance□Dependent variable□	Number of patents	Number of patent applications	☐	☐	☐	☐	☐	
		Number of patents granted	☐	☐	☐	☐	☐	
	Number	Number of	☐	☐	☐	☐	☐	

	of new product launches	licenses to manufacture drugs or medical devices						
	Number of clinical trial approvals	Number of authorized clinical trial approvals	☐	☐	☐	☐	☐	
New indicator column								
Other suggestions column								

Table 7: Expert Consultation Form for Tier 1 Indicators for Control Variables

Variability	Level 1 indicators	Degree of importance					Revised opinion
		Very unimportant.	Unimportant.	General	Important.	Very important	
Control Variables	Individual entrepreneurial level	☐	☐	☐	☐	☐	
	Enterprise level	☐	☐	☐	☐	☐	
New indicator column							
Other suggestions column							

Table 8: Expert consultation form on secondary indicators of control variables and their definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	Degree of importance					Revised opinion
				Very unimportant.	Unimportant.	General	Important.	Very important	
Control Variables	Individual entrepreneurial level	Age of entrepreneurs	Actual age of entrepreneurs	☐	☐	☐	☐	☐	

		Gender of entrepreneurs	Gender of entrepreneurs	☐	☐	☐	☐	☐	
	Individual entrepreneurial level	Enterprise size	Logarithmic value of the number of active employees in the enterprise	☐	☐	☐	☐	☐	
		Age of listing of enterprises	Year of enumeration minus year of listing of the enterprise	☐	☐	☐	☐	☐	
		Nature of enterprise	Nature of the enterprise	☐	☐	☐	☐	☐	
		Size of the Board	Number of members of the Board of Directors	☐	☐	☐	☐	☐	
New indicator column									
Other suggestions column									

Part IV Questionnaire on Expert Familiarity and Basis of Judgement

Instructions for filling in the form: Please make an objective evaluation based on your familiarity with the subject of the correspondence and the basis of your judgment and click on "☐ " in the corresponding column.

Your familiarity with the content of this survey					
degree of familiarity	very familiar	Familiar	General familiarity	Unfamiliar	Very unfamiliar
	☐	☐	☐	☐	☐

The basis of your judgment on the above entries, the degree of influence			
Basis of judgment	Degree of impact		
	great	middle	few
Theoretical analysis	☐	☐	☐
Practical experience	☐	☐	☐
Knowledge of domestic and international counterparts	☐	☐	☐
Intuitive analysis	☐	☐	☐

This concludes this round of consultation, thank you for your participation and guidance!

Annex C: Expert Correspondence Form for Entrepreneurial Social Capital, Innovation Performance and Dynamic Capability Evaluation Indicator System (Second round)

Dear Prof.:

Hello. First of all, I would like to express my sincere gratitude for your positive comments and valuable suggestions in the last round of consultation!

Hello, we are a research group from the School of Health Management, Southern Medical University! We are conducting research on "The Impact of Entrepreneurial Social Capital on the Innovation Performance of Biomedical Enterprises —— Based on Dynamic Capabilities". The 21st century is an era of rapid development of high technology, and scientific and technological innovation has become the key variable of national socio-economic development, while biomedicine has been listed as a key area concerning national security and development. Under the background of the global economic downturn and China's economic transformation, the implementation of an innovation-driven development strategy in the field of biomedicine is the key to guaranteeing socio-economic development and enhancing national scientific and technological power, and **how biomedicine enterprises can effectively acquire and utilize all kinds of resources to realize innovation by improving and applying their own capabilities has become a key issue to be explored in both the practical and theoretical fields.**

Based on the first round, we integrated the valuable opinions of the experts and deleted the indicator system. In this round of consultation, we also listed the indicator modification instructions and the average first-level coefficient of variation of the importance of each indicator in the previous round. Some experts proposed to add or change certain indicators. **After discussion by the research team and combined with the consultation situation of the previous round, we made the second round of evaluation system expert consultation questionnaire, which will be further processed in combination with the results of the second round of expert consultation.**

In view of your attainments and academic reputation in this field, we would like to invite you to be the expert of this research correspondence to rate the preliminary constructed index system. We expect you to respond to the consultation form within two weeks, and if you

have any questions in the process of filling out the form, please feel free to contact us. Thank you for your support in this study, and we honor the appropriate consulting fee at the end of the consultation. We sincerely thank you for your enthusiastic support and help in your busy schedule.

(Contact: Qian Zhang; Contact: 13922700333; Email: 9655440@qq.com)

Subject Group, School of Health Management, Southern Medical University

April 16, 2024

Part I. Results of the first round of expert consultation

1. Index System Modification Notes

Based on the experts' scoring of the importance, familiarity, and judgment basis of the indicators in the first round, we calculated the **mean, full score frequency, and variation coefficient** for each indicator. The inclusion criteria for indicators are shown in Table 1. According to the thresholds of mean score, full score frequency, and variation coefficient for primary and secondary indicators, those above the mean score and full score frequency thresholds are included, while those below the variation coefficient threshold are included. Indicators that do not meet all three inclusion criteria are eliminated. **For indicators that fail to meet one or two points, they will continue to be included in the second round indicator system for expert consultation, and final decisions will be made based on the second round of expert opinions.**

Table 1: Inclusion thresholds for the previous round of indicator importance scores

Index level	Mean	Full score frequency	Coefficient of variation (CV)
First-level index	4.18	32.8%	0.165
Second-level index	3.03	5.0%	0.317

First-level indicators: No changes

Second-level indicators:

Delete "Experience in colleges and universities or research institutes", the mean importance score of this indicator is 2.8, the frequency of full marks is 0%, and the coefficient of variation is 0.319.

Delete "Political status", the mean importance score of this indicator is 2.45, the frequency of full marks is 0%, and the coefficient of variation is 0.362.

2. Detailed description of the results of the first round of expert consultation

Table 2: Description of the indicator evaluation system and its sources

Variability	Dimension/Level 1 indicator	**Mean**	**Full score frequency**	**Coefficient of variation (CV)**	Secondary indicators	**Mean**	**Full score frequency**	**Coefficient of variation (CV)**
Entrepreneurial social capital（Independent Variables）	Professional skills dimension	4.85	85.0%	0.076	Professional status	3.50	10.0%	0.236
					Education	4.15	30.0%	0.162
					Professional background	4.10	35.0%	0.208
					Work experience in universities or research institutes	2.80	0.0%	0.319
	Political capital	4.15	25.0%	0.141	Political profile	2.45	0.0%	0.362
					Political affiliation	2.85	5.0%	0.382
	Business Capital	4.55	55.0%	0.112	Entrepreneurial management experience	3.85	30.0%	0.270
					Experience in financial institutions	3.00	15.0%	0.375
					Industry association appointments	2.90	10.0%	0.369
	Overseas social capital	3.90	10.0%	0.142	Overseas experience	3.80	15.0%	0.202
Dynamic capability（Intermediary Variables）	Ability to perceive opportunities	4.95	95.0%	0.045	Ratio of R&D expenditures	4.30	35.0%	0.133
					Percentage of personnel with bachelor's degree or above	4.00	20.0%	0.162
	Ability to integrate resources	4.95	95.0%	0.045	Ratio of R&D staff	4.00	20.0%	0.162
					Industry-University-Research Cooperation	3.75	25.0%	0.258

	Organizational reconfiguration capacity	4.80	80.0%	0.085	Changes in senior management	3.95	25.0%	0.209
					Return on assets （ROA）	4.00	20.0%	0.162
Enterprise innovation performance （Dependent variable）	Number of patent applications	4.15	35.0%	0.180				
	Number of patents granted	4.20	40.0%	0.183				
	Number of licenses to manufacture drugs or medical devices	4.70	75.0%	0.122				
	Number of authorized clinical trial approvals	4.55	60.0%	0.133				
Control Variables	Individual entrepreneurial level	4.45	55.0%	0.154	Age of entrepreneurs	3.80	15.0%	0.235
					Gender of entrepreneurs	3.05	5.0%	0.249
	Enterprise level	4.40	50.0%	0.155	Enterprise size	3.65	10.0%	0.204
					Age of listing of enterprises	3.35	5.0%	0.175
					Age of establishment	3.25	5.0%	0.197
					Nature of enterprise	3.60	20.0%	0.291
					Size of the Board	3.25	5.0%	0.262

Part II. Description of the sources of the system of evaluation indicators

Table 3: Description of the indicator evaluation system and its sources

Variability	Dimension/Level 1 indicator	Secondary indicators	Sources of indicators
Entrepreneurial social capital（Independent Variables）	Professional skills dimension	Professional status	Within the field of biopharmaceuticals, based on the characteristics of biopharmaceutical enterprises, the strength of the entrepreneur's personal expertise may become a key factor in the outcome of the enterprise; Chu, Sugur (2019) pointed out that expertise can encompass such things as professional identity, background, and tenure in higher education, and can also cover a number of facets; and Huang (2022) pointed out that the accumulation of expertise can enable entrepreneurs to better cope with the marketplace and innovate and develop.
		Professional background	
	Political capital	Political affiliation	Shaheen (2023) and Wu (2023) pointed out that the relationship between entrepreneurs and government departments can obtain government support and resources for enterprises; meanwhile, Liu Jiankun (2020) pointed out that: although entrepreneurs do not serve in the government sector, but through the National People's Congress, CPPCC members and other ways to accumulate a certain amount of relationship resources.
	Business Capital	Entrepreneurial management experience	Peng (2000) pointed out that the skills, knowledge, and interpersonal relationships accumulated by entrepreneurs in the business field can help entrepreneurs to gain an advantage in market competition, and that business connections included the entrepreneur's social network with others or other enterprises（Omar，2022）, the entrepreneur's access to capital and investment（Huang，2023，Onginjo，2021）, and the entrepreneur's visibility and reputation in the field（Junfeng,2022）. The biomedical industry associations are a platform for internal exchanges and cooperation, and serving in the associations can help to understand the industry's dynamics and to build up the industry's relational network; and
		Experience in financial institutions	
		Industry association appointments	

			that the financial experience has an impact on the financing of the enterprise, the investment decisions and the structuring of the capitalization.
	Overseas social capital	Overseas experience	Guo Shujuan (2019) pointed out that different growth environments and education modes differ in their knowledge structures and thinking choices, etc. Meanwhile, Wang Lin (2021) pointed out that overseas biopharmaceutical companies pay more attention to R&D investment, and that the overseas experience has the opportunity to absorb the management mode of foreign enterprises and be more sensitive to the frontiers of new drug R&D.
Dynamic capability（Intermediary Variables）	Ability to perceive opportunities	Ratio of R&D expenditures	Han (2023) pointed out that opportunity perception capability is one of the important components of firms' dynamic capabilities; Tark (2019) suggested that suggested that firms can improve their sensitivity to market opportunities by learning and acquiring new knowledge, have seized new opportunities and identify threats, etc.; Xue-Li Wang & Zhi-Tang Li (2015) pointed out that talent improves the ability to perceive the important opportunities and critical nodes; Jichang Zhang (2022) Indirectly reflect the perceived ability of enterprises through the financial of their R&D investment.
		Percentage of personnel with bachelor's degree or above	
	Ability to integrate resources	Ratio of R&D staff	Resources are divided into internal and external resources of enterprises. Peng (2022) used the ratio of technicians to measure the internal resource capacity; in the field of biomedicine, cooperation with universities/research institutes is an important way to obtain external innovation resources. The studies of Wang Jingyu (2023) and W.Cui (2022) et al. pointed out that the cooperation between industry-university-research institutes is conducive to the use of external resources to break through the transformation of scientific and technological achievements. Xia& Jia (2023) used industry-university-research cooperation programs to measure the ability of enterprises to acquire external resources.
		Industry-University-Research Cooperation	
	Organizational reconfiguration capacity	Changes in senior management	Wajcman (2001) pointed out that in the process of development and growth, enterprises can adjust their organizational structure according to the market changes/demands; existing literature, ChiMaoMao (2020) believed that organizational reconfiguration capability is the reorganization and reengineering of the existing operational capabilities of the enterprise; previous studies mainly take the form of questionnaires,
		Return on assets（ROA）	

			which are mainly aimed at adjusting the organizational structure, the adjustment of the workflow and resources. Scholars Wang Molin (2022) and AiYuhong (2021) measured the firm's ability to reallocate and integrate from the financial aspect, using return on assets to reflect the firm's reconfiguration capability; therefore, this paper obtains objective data from the panel data, reflecting the organizational reconfiguration capability from the non-financial management aspect of the firm's executives and from the financial aspect of the return on resources.
Enterprise innovation performance（Dependent variable）	Number of patents	Number of patent applications	The biopharmaceutical industry is characterized by a long R&D cycle, high correlation between scientific discoveries and industrial technologies, and many scholars use the number of patents to measure the innovation performance, such as the number of patent applications, the number of granted patents, etc. (Huang Bo et al. 2023; Liu Guanchen et al. 2022; Liu et al. 2022; Xie 2022); the patent data are open and transparent, standardized in form, easy to collect and comparable. Strong characteristics.
		Number of patents granted	
	Number of new product launches	Number of licenses to manufacture drugs or medical devices	Many scholars have used the number of new product launches as a measure of innovation performance, e.g., the number of new product launches/developments (Kong Ting et al. 2013; Yi Yaqun, 2018; Ferreras-Méndez, 2021; Hua & Yuan, 2022), and combined with the products of biopharmaceuticals, which are mainly drugs and medical devices, the number of new product launches in this category is added to the innovation performance measurements, adding richness.
	Number of clinical trial approvals	Number of authorized clinical trial approvals	The State Drug Administration (SDA) stipulates that drugs and medical devices must obtain clinical trial approvals before they are allowed to undergo clinical trials, which is a mandatory stage. Meanwhile, there is literature pointing out that a lot of enterprises have obtained Phase III clinical trial approvals as the time demarcation point for R&D capitalization (Liu, 2022), and that the clinical trial approvals are a stage unique to the field of biomedicine and have the characteristics of the biomedicine industry.
Control Variables	Individual entrepreneurial level	Age of entrepreneurs	Cheng Hong & Han Xiaoxiao (2016) pointed out that the age of entrepreneurs can reflect the experience of entrepreneurs, and the accumulation of experience will have an impact on their decision-making preferences, strategic choices; Sedaghat & Lei (2020) pointed out that the
		Gender of entrepreneurs	

			age of entrepreneurs affects motivation. In addition the gender is different, the entrepreneur's ability to perceive the event is different (Ludmila,2017),which from the personal characteristics of entrepreneurs to study whether there is an impact on the innovation performance of biopharmaceutical listed companies.
	Enterprise level	Enterprise size	Different enterprise size can reflect the different resource stock of the enterprise, many scholars, such as Yu Jiang (2023), Cui (2022), etc., have studied the impact on performance from the enterprise size, pointing out that the expansion in the appropriate size of the enterprise may enhance the enterprise's R&D strength and efficiency.
		Age of listing of enterprises	In the enterprise life cycle theory, the different age of the company's listing, its popularity, stability goodwill will change, and thus its access to opportunities will also change. (Huang Zhen, 2021; Lei Haimin et al., 2014)
		Age of establishment	The age of an enterprise is directly proportional to its industry experience. Some studies use the age of an enterprise as a measurement indicator of industry experience (Coad A, 2016). Zheng (2022) pointed out that the older the enterprise, the richer the resources and experience it has, and the stronger its ability to control technological innovation.
		Nature of enterprise	The nature of property rights is a natural attribute of enterprises, different nature can cause differences in the allocation of enterprise resources, business objectives and policy system and other multiple programs (Tang Hongxiang & Li Yinchang,2020); Zhang Fan (2022) pointed out that the nature of the enterprise's ownership has a moderating effect on technological innovation.
		Size of the Board	The board of directors is a key part of the decision-making of the management of a firm, and Ren Dove & Sun Hui (2019) pointed out that the size of the board of directors has an impact on the decision-making of the firm, especially in firms that are relatively resource-poor.

Part III. Basic information questionnaire for experts

(This part of the information is only used for research and statistical analysis, and will not be disclosed to the public, please rest assured!)

1. Your gender is: (click "□ " in the appropriate box)

Male Female

2. Your age: years

3. Your highest education level is:

Doctoral degree Master's degree

Undergraduate degree College or below

4. The nature of your work unit is:

Governmental administrative department

University or scientific research institution

Enterprise or public institution

Associations/societies or other social organizations

Others (please specify)

5. The location of your work unit: province (autonomous region, municipality directly under the central government) city county (district)

6 Your professional and technical title is:

Senior Associate Senior

Intermediate Junior Other

7. The major fields of specialization in which you are currently engaged and the number of years you have worked:

Specialized field 1: , years of working experience

Specialized field 2: , years of working experience years

--In order to facilitate the payment of the expert consultation fee, please provide the following information together (confidential)

Name: Cell phone number :

E-mail：

Bank card number and account bank (specific to a branch)

ID card number (required to send consulting fees).

Where the unit (please try to be specific):

Part III Expert Correspondence Form on Evaluation Indicators of Entrepreneurs' Social Capital, Dynamic Capabilities and Innovative Performance

Instructions for filling out the form:

8. This study focuses on listed biopharmaceutical firms and examines the impact or relationship between entrepreneurial society, dynamic capabilities, and innovation performance of biopharmaceutical listed firms.

9. Table 4 and Table 5 are about the indicators of entrepreneurial social capital; Table 6 and Table 7 are about the indicators of dynamic capabilities; Table 8 is about the indicators of innovation performance of biopharmaceutical listed companies; Table 9 and Table 10 are about the indicators of control variables.

10. You are asked to rate the importance on a scale of 1-5 according to a 5-point Likert scale. Importance rating: very important = 5, important = 4, fair = 3, unimportant = 2, very unimportant = 1; please make your judgment and click on the "" in the columns as you see fit.

11. If you think there is a need to modify the indicators, please fill in the "Modification Opinion" column. If you think there is a need to add an indicator, please add it in the "New Indicator" column and rate the importance of the new indicator. If you have other suggestions for the indicator system, please add them in the "Other Suggestions" column.

Table 4: Expert Consultation Form for Level 1 Indicators of Social Capital for Entrepreneurs

Variability	Level 1 indicators	Definition of Tier 1 indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Rvised opinion
					Very unimportant	Uni-mportant	General	Important.	Very important	
Entrepreneurial social capital	Professional skills dimension	Entrepreneurs' own professionalism and their skills in the	4.85		☐	☐	☐	☐	☐	

（Independent Variables）		biomedical field								
	Political capital	Networks of entrepreneurs with government departments or agencies	4.15		☐	☐	☐	☐	☐	
	Business Capital	The entrepreneur's accumulated experience, knowledge, and relationships in the business world	4.55		☐	☐	☐	☐	☐	
	Overseas social capital	Resource capital accumulated by entrepreneurs studying or working abroad	3.90		☐	☐	☐	☐	☐	
	New indicator column									
	Other suggestions column									

Table 5: Expert Consultation Form on Secondary Indicators of Entrepreneurial Social Capital and their Definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
						Very unimportant.	Unimportant.	General	Important.	Very important	
Entrepreneurial social capital（Independent Variables）	Professional skills dimension	professional status	professional designation	3.50		☐	☐	☐	☐	☐	
			education attainment	4.15		☐	☐	☐	☐	☐	
		professional status	Whether graduated from an institution or program related to the biomedical industry	4.10		☐	☐	☐	☐	☐	
		Political affiliation	Whether is a deputy to the National People's Congress or a member of the Chinese People's Political Consultative Conference	2.85		☐	☐	☐	☐	☐	
	Business Capital	Entrepreneurial	Whether they have	3.85		☐	☐	☐	☐	☐	

		management experience	worked in other enterprises								
		Experience in financial institutions	Have you worked in the financial industry such as banks, securities companies, fund companies, etc.?	3.00		☐	☐	☐	☐	☐	
		Industry association appointments	Whether or not they hold positions in trade associations	2.90		☐	☐	☐	☐	☐	
	Overseas social capital	Overseas experience	Any overseas study or posting experience	3.80		☐	☐	☐	☐	☐	
New indicator column											
Other suggestions column											

Table 6: Expert Consultation Form for Dynamic Capacity Tier 1 Indicators

Variability	Level 1 indicators	Definition of Tier 1 indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
					Very unimportant.	Unimportant.	General	Important.	Very important	
Dynamic capability（Intermediary Variables）	Ability to perceive opportunities	Firms' ability to identify and recognize market opportunities or threats	4.95		□	□	□	□	□	
	Ability to perceive opportunities	The enterprise's ability to integrate internal and external resources of the enterprise to achieve optimal allocation and efficient utilization	4.95		□	□	□	□	□	
	Organizational reconfigura	Firms adapted and	4.80		□	□	□	□	□	

	tion capacity s	changed their organizational results to adapt to the changing market environment								
New indicator column										
Other suggestions column										

Table 7: Expert consultation table on secondary indicators of dynamic capacity and their definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
						Very unimportant.	Unimportant.	General	Important.	Very important	
Dynamic capability（Intermediary Variables）	Ability to perceive opportunities	Ratio of R&D expenditures	Ratio of current year's R&D expenditure to current year's sales revenue	4.30		☐	☐	☐	☐	☐	
		Percentage of	Ratio of the number of	4.00		☐	☐	☐	☐	☐	

		personnel with bachelor's degree or above	personnel with bachelor's degree or above to the total number of employees in the year								
	Ability to integrate resources	Ratio of R&D staff	Ratio of the number of R&D personnel to the total number of employees in the year	4.00		☐	☐	☐	☐	☐	
		Industry-University-Research Cooperation	Whether the year involved cooperation with other enterprises, universities and research institutes	3.75		☐	☐	☐	☐	☐	
	Organizational reconfiguration capacity	Changes in senior management	Whether the year involved changes in the	3.95		☐	☐	☐	☐	☐	

			positions of Chairman and Managing Director								
		Return on assets（ROA）	Ratio of corporate EBIT to average total assets	4.00		☐	☐	☐	☐	☐	
New indicator column											
Other suggestions column											

Table 8: Consultation table of evaluation indicators of innovation performance of listed biopharmaceutical companies

Variability	Evaluation indicators	Definition of evaluation indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
					Very unimportant.	Unimportant.	General	Important.	Very important	
Enterprise innovation performance（Dependent variable	Number of patents	Number of patent applications	4.15		☐	☐	☐	☐	☐	
		Number of patents granted	4.20		☐	☐	☐	☐	☐	
	Number of new product	Number of licenses to manufactur	4.70		☐	☐	☐	☐	☐	

)	launches	e drugs or medical devices									
	Number of clinical trial approvals	Number of authorized clinical trial approvals	4.55		☐	☐	☐	☐	☐		
New indicator column											
Other suggestions column											

Table 9: Expert Consultation Form for Tier 1 Indicators for Control Variables

Variability	Level 1 indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
				Very unimportant.	Unimportant.	General	Important.	Very important	
Control Variables	Individual entrepreneurial level	4.45		☐	☐	☐	☐	☐	
	Enterprise level	4.40		☐	☐	☐	☐	☐	
New indicator column									
Other suggestions column									

Table 10: Expert consultation form on secondary indicators of control variables and their definitions

Variability	Level 1 indicators	Secondary indicators	Definition of secondary indicators	The average of the previous round of expert ratings	Your last rating	Degree of importance					Revised opinion
						Very unimportant.	Unimportant.	General	Important.	Very important	
Control Variables	Individual entrepreneurial level	Age of entrepreneurs	Actual age of entrepreneurs	3.80		☐	☐	☐	☐	☐	
		Gender of entrepreneurs	Gender of entrepreneurs	3.05		☐	☐	☐	☐	☐	
	Individual entrepreneurial level	Enterprise size	Logarithmic value of the number of active employees in the enterprise	3.65		☐	☐	☐	☐	☐	
		Age of listing of enterprises	Year of enumeration minus year of listing of the enterprise	3.35		☐	☐	☐	☐	☐	
		Age of establishment	Statistical year minus the year of	3.25							

			establishment of the enterprise								
		Nature of enterprise	Nature of the enterprise	3.60		☐	☐	☐	☐	☐	
		Size of the Board	Number of members of the Board of Directors	3.25		☐	☐	☐	☐	☐	
New indicator column											
Other suggestions column											

Part V Questionnaire on Expert Familiarity and Basis of Judgement

Instructions for filling in the form: Please make an objective evaluation based on your familiarity with the subject of the correspondence and the basis of your judgment and click on "□ " in Table 13, the relevant assignments are shown in Tables 11 and Table 12.

Table 11: Familiarity level assignment table

Your familiarity with the content of this survey					
degree of familiarity	very familiar	Familiar	General familiarity	Unfamiliar	Very unfamiliar
	1	0.7	0.5	0.3	0

Table 12: Judgment basis assignment table

Basis of judgment	Degree of impact		
	great	middle	few
Theoretical analysis	0.3	0.2	0.1
Practical experience	0.5	0.4	0.3
Knowledge of domestic and international counterparts	0.1	0.1	0.05
Intuitive analysis	0.1	0.1	0.05
Totoal	1	0.8	0.5

Table 13: Familiarity and basis for judgment of inquiry topics

Your familiarity with the content of this survey							
Degree of familiarity	The average of the expert familiarity conversion in the previous round	Your last round familiarity rating	very familiar	Familiar	General familiarity	Unfamiliar	Very unfamiliar
	0.77		☐	☐	☐	☐	☐
The basis of your judgment on the above entries, the degree of influence							
Basis of judgment	The average of the expert familiarity conversion in the previous round	Your last round familiarity rating	Degree of impact				
			great	middle	few		
Theoretical analysis	0.235		☐	☐	☐		
Practical experience	0.47		☐	☐	☐		
Knowledge of domestic and international counterparts	0.0975		☐	☐	☐		
Intuitive analysis	0.09		☐	☐	☐		

This concludes this round of consultation, thank you for your participation and guidance!