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Determinants of Venture Capital Contribution to Small and Medium-Sized Enterprises' Innovation

WANG Tianle

Doctor of Management

Supervisors:
PhD José Paulo Esperança, Professor,
ISCTE University Institute of Lisbon
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April, 2025

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Wang Tianle

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Abstract

Venture capital (VC) plays a pivotal role in driving technological innovation, particularly within small and medium-sized enterprises (SMEs). Drawing on panel data from Chinese SMEs, this study explores how VC influences firms' innovation input and output through four mechanisms: resource spillover, governance, managerial involvement, and financing. An integrated analytical framework is developed, with industry-level variables introduced to assess contextual moderating effects.

Theoretically, this research synthesizes Resource Dependence Theory, Agency Theory, Value-Added Services Theory, and Signaling Theory. It argues that VC's influence extends beyond funding, embedding itself in firms' resource allocation, governance structures, and external signaling strategies. Data sources include the National Equities Exchange and Quotations (NEEQ), the China Patent Database, corporate financials, and VC investment announcements.

Empirical findings show that VC significantly boosts R&D investment and patent output. However, these effects are context-dependent: high industry spillovers reduce VC's effectiveness; industry uncertainty amplifies innovation output; and in highly competitive or financially constrained sectors, certain mechanisms underperform or reverse.

The study also investigates VC heterogeneity, focusing on investment motivation (strategic vs. profit-driven), structure (syndicated vs. standalone), and duration. Syndicated investment and long-term holdings improve innovation outcomes, while strategic labeling and equity stakes show inconsistent effects.

This research reveals the complex dynamics between VC and innovation, offering theoretical and practical insights for firms, VC institutions, and policymakers seeking to strengthen the innovation ecosystem.

Keywords: Venture Capital, Innovation, Small and Medium-Sized Enterprises, Investment Mechanisms

JEL: G24, O31

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Resumo

O capital de risco (venture capital, VC), enquanto força motriz fundamental da inovação tecnológica, tem vindo a atrair uma crescente atenção por parte da academia e dos decisores políticos, sobretudo no que respeita ao seu impacto sobre o comportamento inovador das pequenas e médias empresas (PMEs). Com base em dados em painel de PMEs chinesas, este estudo investiga sistematicamente de que forma o capital de risco impulsiona o investimento e os resultados em inovação, através de quatro mecanismos: o efeito de repercussão dos recursos, o efeito de governação, o efeito de participação na gestão e o efeito de financiamento. Variáveis contextuais ao nível da indústria são introduzidas para testar os efeitos moderadores do ambiente externo.

Do ponto de vista teórico, o estudo integra a Teoria da Dependência de Recursos, a Teoria da Agência, a Teoria dos Serviços de Valor Acrescentado e a Teoria da Sinalização, argumentando que o impacto do capital de risco sobre a inovação não depende apenas da sua função financeira, mas está profundamente enraizado nos processos de alocação de recursos, estrutura de governação e sinalização externa das empresas. Os dados provêm principalmente do Sistema Nacional de Cotações da China (NEEQ), da Base de Dados de Patentes da China, de demonstrações financeiras e anúncios de investimento.

Os resultados empíricos indicam que o capital de risco aumenta significativamente o investimento em I&D e a produção de patentes das PMEs. No entanto, a sua eficácia é moderada por características do setor: em indústrias com elevada repercussão dos recursos, o efeito do capital de risco é atenuado; em contextos de elevada incerteza, o impacto sobre os resultados em inovação é reforçado; e, em setores com forte concorrência ou severas restrições de financiamento, alguns mecanismos não são validados ou revelam efeitos contrários aos esperados.

Adicionalmente, o estudo examina a heterogeneidade do capital de risco, incluindo a motivação do investimento (estratégica vs. orientada para o lucro), a estrutura do investimento (sindicado vs. independente) e o horizonte temporal da participação. Os resultados mostram que o investimento sindicado e a manutenção de participações a longo prazo aumentam significativamente o desempenho em inovação, enquanto as definições estratégicas e os níveis de participação acionista não se traduzem necessariamente num maior estímulo à inovação.

No seu conjunto, este estudo revela a complexa relação entre o comportamento do capital de risco e o desempenho inovador das empresas, fornecendo contributos teóricos e evidência empírica relevantes para orientar as PMEs na escolha racional de parceiros de capital, apoiar as entidades de capital de risco na otimização da gestão pós-investimento, e informar os decisores políticos na melhoria do ecossistema do mercado de capital para a inovação.

Palavras-chave: Capital de Risco, Inovação, Pequenas e Médias Empresas, Mecanismos de Investimento
JEL: G24, O31

摘　要

风险资本作为技术创新的重要推动力量，其对中小企业创新行为的影响机制日益受到学术界和政策实践的关注。本文基于中国中小企业的面板数据，探讨风险资本如何通过资源溢出效应、监督治理效应、管理参与效应与融资效应四种机制，驱动企业创新投入与产出，并引入行业特征变量检验其调节效应。

在理论上，研究融合资源依赖理论、委托代理理论、增值服务理论与信号传递理论，指出风险资本的影响不仅限于资金支持，更深层嵌入企业资源配置、治理结构与外部信号传导。数据主要来自中国中小企业股份转让系统（新三板）、中国专利数据库、企业财务报表及投资公告，构建多维度面板数据集。

实证结果表明，风险资本显著提升中小企业的研发投入与专利产出。但在高资源溢出行业中，其作用被削弱；在行业不确定性较高时，其促进效果增强；而在竞争激烈或融资约束强的行业中，部分机制效应未被验证或出现反向结果。

研究还分析了风险资本的异质性特征，包括投资动机、结构与持股期限。结果显示，联合投资与长期持股能显著提升创新绩效，而战略标签与高持股比例未必带来更强创新效果。

本研究揭示了风险资本行为与创新绩效之间的复杂关系，为企业、投资者与政策制定者提供理论与实证参考。

关键词：风险资本，创新，中小型企业，投资机制

JEL: G24, O31

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List of Abbreviations

VC	venture capital
SME	small and medium-sized enterprise
NEEQ	National Equities Exchange and Quotations

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Chapter 1: Introduction

1.1 Research background

1.1.1 Real context

(1) Deepening the Innovation-Driven Development Strategy

Since entering the new era, the Chinese government has placed innovation at the core of national development, emphasizing that "innovation is the primary driving force for development" and positioning the innovation-driven development strategy as a key pathway toward achieving high-quality growth. From the 13th Five-Year Plan's call for building an "innovative country" to the 14th Five-Year Plan's elevation of "scientific and technological self-reliance and self-strengthening" as a national strategic priority, technological innovation has become a central indicator of national competitiveness. The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China and the report of the 20th National Congress both stressed the need to enhance firms' technological innovation capacity, foster globally competitive and innovative small and medium-sized enterprises (SMEs), deepen the integration of innovation and industrial chains, and establish a technology innovation system led by enterprises, driven by the market, and characterized by in-depth collaboration among industry, academia, and research institutes.

Against this strategic backdrop, SMEs are entrusted with a critical role. As a vital component of China's national innovation system, SMEs possess institutional flexibility and market proximity, positioning them as key actors in the commercialization of scientific achievements and the incubation of emerging industries. However, due to limited research and development (R&D) resources and weak risk resilience, these enterprises frequently face challenges such as insufficient funding, financing constraints, and high innovation risks, which significantly hinder their innovative potential. Consequently, there is an urgent need to leverage external capital—particularly venture capital—to provide comprehensive support in terms of financing, technology, and management, thereby facilitating the transition "from lab to market."

At the national level, a systematic policy framework has gradually been established to support innovation, entrepreneurship, and SME development. The 14th Five-Year National Plan for Science and Technology Innovation explicitly calls for the acceleration of enterprise-

centered innovation mechanisms, the mobilization of financial resources toward early-stage innovation activities, and the cultivation of "specialized, refined, distinctive, and innovative" enterprises with core technological capabilities (State Council, 2021). Simultaneously, the Opinions on Improving the Institutional Mechanism to Support the Development of SMEs (China's State Council, 2020) highlights the importance of developing a multi-tiered capital market, improving venture capital exit mechanisms, and enhancing the efficiency and guidance capability of risk capital. These policy measures reflect the government's proactive efforts to guide social capital toward supporting emerging innovative forces—particularly technology-based SMEs—through institutional innovation and strategic resource allocation.

International organizations have also paid close attention to the implementation pathways of China's innovation strategy and the role of small and medium-sized enterprises (SMEs). The Organisation for Economic Co-operation and Development (OECD, 2021) noted that China has significantly strengthened the systematic nature and implementation capacity of its innovation-driven development strategy in recent years by substantially increasing public R&D investment, prioritizing the development of high-tech SMEs, and enhancing inter-ministerial coordination across innovation, financial, and industrial policies. The World Bank (2020) further emphasized that China's innovation ecosystem is increasingly reliant on diversified financing mechanisms, gradually reducing its dependence on government subsidies and shifting toward more market-oriented instruments—such as venture capital and equity markets—to support the early-stage technological exploration and commercialization efforts of SMEs. The International Monetary Fund (2019) similarly observed that China is transitioning from an investment-driven to an innovation-driven growth model, which places higher demands on the innovation capabilities of SMEs. In this context, venture capital plays an irreplaceable role in supporting SMEs to undertake high-risk technological experimentation.

Therefore, in light of the ongoing deepening of the innovation-driven development strategy and the continued strengthening of policy support, examining how venture capital influences SMEs' innovation input and output within China's distinctive institutional environment and innovation ecosystem is not only aligned with national strategic priorities, but also responds to the concerns of global economic organizations regarding China's innovation model. Such inquiry holds significant theoretical and practical relevance.

(2) Development and Structural Imbalance in China's Venture Capital Market

As China's capital market system continues to mature, venture capital (VC)—as a critical financial instrument for supporting early-stage technological innovation and enterprise growth—has experienced rapid expansion in both scale and activity in recent years. According

to data from Zero2IPO Research Center (2024), the total amount of newly raised VC/PE funds in China exceeded RMB 800 billion in 2023, with a continuous rise in the number of active investment institutions. China has now become the world's second-largest venture capital market, trailing only the United States. The Chinese government has placed strong emphasis on fostering venture investment through initiatives such as the establishment of government guidance funds and the promulgation of regulatory policies including the Interim Measures for the Administration of Venture Capital Enterprises and the Opinions on Promoting the Sustainable and Healthy Development of Venture Capital, which aim to encourage social capital to support SMEs—particularly technology-based startups—through equity investment.

Despite this rapid market expansion, structural imbalances remain in the distribution of venture capital across industries, investment stages, and exit mechanisms, limiting its effectiveness in driving technological innovation among SMEs. In terms of industry distribution, over the past decade, venture capital has disproportionately flowed into sectors with short return cycles and relatively low risk, such as real estate, consumer internet, and platform-based economies, while investments in "hard technologies," advanced manufacturing, and frontier materials—sectors characterized by high R&D intensity and long development cycles—have remained relatively limited. This is partly attributable to the higher uncertainty and exit barriers associated with these industries, which have contributed to a persistent trend of capital flowing into virtual rather than real economies.

In terms of investment stage structure, the proportion of early-stage and seed-round financing remains relatively low, while funding is disproportionately concentrated in mid-to-late-stage investments. This imbalance makes it difficult to meet the urgent capital and resource needs of SMEs during the early phases of research and development. The International Monetary Fund (2019) has noted that despite the large size of China's venture capital market, it has yet to establish a comprehensive support system that spans from the seed stage to initial public offering (IPO). As a result, many technology startups face financing gaps at critical moments when their technologies are still underdeveloped and business models have yet to mature, impeding both technological iteration and commercialization pathways.

Moreover, limited exit options remain a key constraint on the vitality of venture capital. While the recent establishment of the STAR Market and the Beijing Stock Exchange has contributed to diversifying exit channels, challenges such as valuation volatility and uncertain listing review processes continue to undermine exit predictability for VC institutions. According to the World Bank (2020), China's venture capital market, compared to those in developed economies, still lacks a mature exit mechanism and requires improvement in areas

such as intellectual property protection and the dynamism of the mergers and acquisitions (M&A) market. The OECD (2021) also pointed out that China needs to further optimize its legal and institutional frameworks to support IPOs of hard-tech enterprises and foster a robust M&A-based exit ecosystem, thereby attracting long-term, patient capital to back "zero-to-one" technological breakthroughs.

Therefore, while China's venture capital market has undergone rapid expansion, its internal structural imbalances and institutional bottlenecks must be addressed. Under the guidance of China's national strategy to become a technological powerhouse, enhancing the allocation efficiency and support capacity of venture capital in high-risk, high-tech, and high-uncertainty domains is one of the core challenges for promoting SME innovation. This issue also constitutes an important contextual foundation for the present study.

(3) Financing Challenges of SMEs and the Substitutive Role of Venture Capital

Small and medium-sized enterprises (SMEs) occupy a central position in China's economic system. According to statistics from the Ministry of Industry and Information Technology, there are over 48 million SMEs nationwide, contributing more than 60% of GDP, over 70% of technological innovations, and more than 80% of employment. However, this group commonly faces three major structural obstacles in financing: difficulty in access, high cost, and long approval times. These challenges are particularly acute for technology-oriented startups. Traditional financial institutions, driven by risk control frameworks and credit assessment logics, tend to favor large enterprises with collateralizable assets and stable cash flows. In contrast, SMEs often lack sufficient collateral, have shorter credit histories, and exhibit lower transparency in operational data, making it difficult for them to secure bank loans or attract capital market attention.

Against this backdrop, venture capital is viewed as a critical mechanism to fill the "innovation financing gap." Unlike bank credit, venture capital entails equity-based investment and does not demand short-term returns, thereby exhibiting greater tolerance for uncertainty. This enables venture capital to accompany SMEs through key transitional stages such as technology validation, market experimentation, and organizational development—ultimately facilitating their leap "from laboratory to commercialization." For this reason, several national policy documents have emphasized the need to improve venture capital systems and fiscal guidance mechanisms, integrating venture capital into the entire development lifecycle of technology-based SMEs (National Development and Reform Commission [NDRC], 2016).

International experience also supports this approach. The World Bank (2020) notes that during periods of economic transition, traditional credit mechanisms are often inadequate for

supporting innovation-oriented firms. Governments should therefore promote venture capital's discovery and empowerment functions under conditions of information asymmetry—particularly in early-stage, high-risk projects where VC often serves as the sole external financing source. Similarly, the OECD (2021) highlights that venture capital not only provides financial support but also delivers value through governance participation, strategic guidance, and resource integration, helping SMEs overcome the so-called "Valley of Death" and transition from R&D to market scale-up. Furthermore, the International Monetary Fund (2019) argues that for countries like China undergoing institutional transition, shifting from a debt-driven to an equity-driven financing structure is a key strategy for enhancing the financial system's support for innovation.

In this sense, venture capital functions not only as a financial instrument but also as a mechanism for driving innovation. Within an environment where the SME financing structure is distorted and the banking sector exhibits entrenched risk aversion, venture capital assumes a dual role as both an institutional substitute and a resource discoverer. Studying its impact on SMEs' innovation performance thus contributes to a deeper understanding of capital allocation efficiency, firm growth trajectories, and the systemic evolution of national innovation ecosystems.

1.1.2 Theoretical context

Against the backdrop of accelerating technological change and increasing market uncertainty, small and medium-sized enterprises (SMEs) have emerged as a vital force in driving industrial innovation. However, their innovation processes are often constrained by resource shortages and limited governance capacity. To systematically analyze the enabling mechanisms of venture capital in SME innovation, this study draws upon Resource Dependence Theory, Agency Theory, Value Added Service Theory, and Signaling Theory, thereby constructing a multi-dimensional theoretical foundation.

First, Resource Dependence Theory posits that organizations do not operate in isolation but are embedded within an external environment shaped by resources, institutions, and power structures (Pfeffer & Salancik, 2015). Given the limited internal resources of SMEs, their survival and development hinge on acquiring critical external resources such as funding, technology, and market access. SMEs often establish collaborative relationships with external actors to integrate and reconfigure these resources for innovation purposes. This reliance on external support creates resource dependencies. As both a provider of key resources and a participant in governance, venture capital plays a pivotal role in the innovation-driven

development of SMEs. This study explores the critical influence of venture capital within this dynamic and identifies the determinants that shape its effectiveness.

In addition, Agency Theory focuses on governance structures and explains the agency costs arising from the separation of ownership and control (Jensen & Meckling, 2019). Fama and Jensen (1983) proposed that the combination of contractual arrangements, monitoring mechanisms, and incentive structures can effectively mitigate moral hazard and adverse selection. Beyond financial support, venture capital becomes deeply embedded in corporate governance through board participation, staged financing clauses, contingent agreements, and equity-based incentives. In doing so, it not only reduces agency costs but also enhances the firm's strategic execution and innovation capacity under conditions of uncertainty. Therefore, from a governance perspective, Agency Theory provides a valuable lens for this study to examine how venture capital affects SME innovation outcomes.

Furthermore, the Value-Added Services Theory emphasizes that beyond the provision of products or capital, service providers can offer additional knowledge, capabilities, technical support, and relational resources to deeply empower their partners and provide differentiated support (Ulaga & Eggert, 2006). Initially applied in the logistics and telecommunications sectors, this theory has been increasingly extended to the fields of B2B relationship management and inter-organizational collaboration in recent years, becoming a key perspective for explaining co-creative value generation through collaboration. For SMEs with limited resources and weak capability foundations, VC serves not only as a financial investor but also as a critical developmental partner acting in the role of "service-oriented capital." By offering non-financial support—such as strategic consulting, managerial guidance, industry resource integration, and executive referrals—VCs effectively expand the capability boundaries of SMEs and significantly enhance their R&D efficiency and innovation performance. This study incorporates the Value-Added Services Theory to explore how venture capital promotes the development of more competitive innovation capabilities in SMEs through embedded management involvement and capability coordination.

Finally, Signaling Theory provides a theoretical foundation for understanding how venture capital improves SMEs' external perceptions and financing environments (Spence, 1974). According to this theory, in markets characterized by high information asymmetry, information-advantaged actors can send credible and costly signals to influence the judgments of less-informed parties, thereby reducing adverse selection and moral hazard. SMEs often encounter financing difficulties and market skepticism due to their small scale and insufficient information disclosure. In this context, the entry of venture capital serves not only as a capital

infusion but also as a high-credibility market signal. Acting as a form of certification mechanism, venture capital helps firms convey otherwise intangible internal qualities—such as growth potential, technological capability, and governance capacity—to external stakeholders including investors, regulators, and the market. This enhances their market recognition and access to financing. Therefore, from the perspective of information signaling and reputation building, Signaling Theory offers critical support for this study's analysis of how venture capital mitigates financing constraints and activates innovation potential in SMEs.

1.2 Research problem and questions

Despite numerous policy documents emphasizing the critical role of venture capital in supporting SME innovation, there remains significant academic debate and uncertainty regarding its actual impact mechanisms and effectiveness. On one hand, a substantial body of research suggests that venture capital enhances the R&D investment and technological commercialization efficiency of investee firms by providing capital, managerial support, strategic guidance, and resource integration (Chemmanur et al., 2011; Kortum & Lerner, 2000). This effect is particularly pronounced in high-tech industries characterized by substantial technological barriers and market risk, where venture capital is often viewed as a "catalyst for technological innovation." On the other hand, some studies report that the impact of venture capital on innovation outputs may be limited or even negative. For example, some scholars argue that certain venture capital firms exhibit a strong preference for short-term performance and exert excessive influence on the innovation strategies of investee firms, which can lead to frequent changes or premature termination of R&D projects (Bertoni & Colombo et al., 2010; Hellmann & Puri, 2002).

Moreover, venture capital's selection bias may contribute to a "selective investment" phenomenon—favoring firms with pre-existing innovative capabilities—thus reinforcing the "Matthew effect" in innovation rather than genuinely elevating the overall innovation level (Da Rin et al., 2013). In the Chinese context, this dilemma is particularly pronounced. On one hand, the government actively encourages the use of venture capital to foster the development of "specialized, refined, distinctive, and innovative" SMEs and to support breakthroughs in core technologies. On the other hand, structural features of China's venture capital market—such as underdeveloped exit mechanisms, shorter investment horizons, and concentrated industry preferences—have limited the empirical and theoretical understanding of venture capital's true impact on SME innovation (OECD, 2021; WorldBank, 2020). Especially in a complex

institutional environment with frequent policy interventions, whether venture capital can genuinely fulfill its role as an "innovation enabler" remains a critical question worthy of in-depth investigation.

In addition, due to challenges related to data availability, completeness, and consistency, most existing studies have focused on listed or large-scale enterprises, leaving SMEs relatively underexplored. Therefore, this study selects firms listed on the National Equities Exchange and Quotations (NEEQ) as the research sample to examine how venture capital promotes innovation in SMEs through multiple mechanisms. This research not only fills an important theoretical gap but also enriches the intersection of venture capital theory and corporate innovation studies, providing a robust academic foundation for understanding the broader impact of venture capital on SME development.

In summary, whether and how venture capital influences the innovation processes of small and medium-sized enterprises (SMEs) is shaped not only by the interplay between capital attributes and firm-specific conditions but also by the complex interactions among institutional environments, industry characteristics, and policy orientations. This multifaceted research challenge constitutes the central focus of this study and highlights key theoretical gaps and practical difficulties in the current literature on innovation financing.

Accordingly, this study seeks to address the following research questions (RQs):

RQ1: What is the impact of venture capital on SME innovation?

RQ2: Through what mechanisms does venture capital influence SME innovation?

RQ3: How do different types of venture capital affect SME innovation?

RQ4: How do different investment modes influence SME innovation?

1.3 Research method

This study adopts an empirical quantitative research approach, employing multiple regression analysis as the primary analytical technique to systematically examine the effects and mechanisms through which venture capital influences innovation in SMEs. The research aims to construct and estimate multiple regression models to comprehensively test the impact of venture capital on firms' innovation input and output, the underlying mechanisms, and the heterogeneity of moderating effects.

Regarding the research sample, this study selects firms listed on the National Equities Exchange and Quotations (NEEQ)—commonly referred to as the New Third Board—as the primary subjects. This market concentrates a group of innovation-oriented SMEs with relatively

standardized information disclosure practices and active venture capital participation, making it highly representative. The data spans a ten-year period from 2014 to 2023, covering firms' basic financial indicators, R&D investment, patent application data, venture capital involvement, investment characteristics, and industry-level variables.

In terms of data sources, firm-level financial and innovation data are primarily obtained from the Wind database, while venture capital-related information—such as investor type, equity share, and co-investment status—is manually collected and compiled to construct relevant variables. Industry-level variables, including R&D intensity, industry uncertainty, capital dependence, and market competition, are sourced from the Wind industry database and the China Statistical Yearbook.

1.4 Research objectives

This study aims to systematically investigate the impact, mechanisms, and heterogeneous pathways through which venture capital influences innovation behavior in SMEs. It seeks to address ongoing academic debates and theoretical gaps concerning two key questions: whether venture capital genuinely promotes firm-level innovation and how such promotion occurs.

Specifically, the study is structured around three core objectives:

First, the study empirically examines whether venture capital effectively enhances SMEs' innovation input (e.g., R&D intensity) and innovation output (e.g., number of patent applications), thereby clarifying its direct role in strengthening technological capabilities and improving innovation performance.

Second, to address the process-oriented question of how venture capital exerts its influence, the study focuses on four primary mechanisms: resource spillover, supervisory governance, managerial involvement, and financial support. It analyzes how these mechanisms operate under varying industry conditions—such as R&D intensity, environmental uncertainty, market competition, and capital dependence—and explores the differential impacts and marginal effects across contexts.

Third, acknowledging the heterogeneity of venture capital, the study further investigates how different types of VC (e.g., strategic vs. incubative), investment characteristics (e.g., ownership stake, investor reputation, investment duration), and investment approaches (e.g., syndication) contribute to innovation outcomes. The aim is to identify the differentiated effects and moderating roles of these factors in shaping the innovation trajectories of SMEs.

1.5 Research significance

1.5.1 Practical significance

This study carries significant practical implications. First, as China enters a stage of high-quality economic development, innovation has become the core driver for SMEs to overcome growth bottlenecks and achieve transformation and upgrading. By systematically evaluating the actual impact of VC on firms' innovation input and output, this research provides empirical evidence to clarify whether VC truly fulfills its role as a catalyst for innovation. The findings may serve as a reference for policymakers to improve the venture capital system and optimize innovation-oriented policy frameworks.

Second, this study thoroughly investigates the moderating effects of industry-specific characteristics—such as technological intensity, financing constraints, market competition, and environmental uncertainty—on the relationship between venture capital and SME innovation. These analyses enhance the contextual relevance and practical guidance of the study's conclusions. In practice, industries differ substantially in terms of resource endowments, innovation cycles, policy support, and market entry barriers. Consequently, the ways in which VC creates value and delivers support also vary significantly across sectors. By introducing industry-level variables, the study reveals distinct mechanisms of VC influence in "resource-intensive" versus "technology-driven" industries, offering empirical insights for the development of more targeted industrial support policies and capital guidance mechanisms. By uncovering multiple pathways through which VC exerts influence—and the contextual contingencies that shape these mechanisms—the findings can inform VC firms' post-investment management strategies, improving their effectiveness in fostering innovation in SMEs.

Finally, the study further differentiates between various types and attributes of venture capital to explore their marginal contributions to innovation. This enables SMEs to better assess and match suitable capital partners, thereby enhancing the strategic alignment and collaborative efficiency of capital cooperation. In sum, this research not only addresses key theoretical debates but also offers practical pathways and actionable recommendations for policymakers, investors, and entrepreneurial firms aiming to promote technological innovation and cultivate a healthy investment-financing ecosystem.

1.5.2 Theoretical significance

To comprehensively reveal how VC promotes innovation in SMEs through multiple mechanisms, this study integrates four classical theoretical perspectives and further combines them with industry-specific contextual variables. This results in a "theory–mechanism–context" matching analytical framework, which expands the contextual applicability of VC impact mechanisms beyond the boundaries established in existing literature. The theoretical contributions of this study are as follows:

First, Resource Dependence Theory highlights the critical reliance of SMEs on external resources, aligning with the resource spillover effect of VC as an external resource provider. In industries characterized by high barriers to resource access, VC alleviates innovation bottlenecks by injecting capital, technology, and market-related resources, thereby helping SMEs overcome internal capability constraints and sustain innovation activities.

Second, Agency Theory focuses on optimizing corporate governance structures under conditions of ownership–control separation, making it particularly applicable to high-uncertainty industry contexts. In such environments, VC enhances firms' strategic execution by participating in board governance, designing monitoring systems, and establishing incentive contracts—thereby exerting its governance effect to stabilize and regulate the innovation process.

Third, Value-Added Services Theory emphasizes the additional value created by capital providers through capability empowerment and strategic collaboration. In industries facing intense competitive pressure, VC typically extends beyond financial investment to offer management consulting, industry resource integration, and strategic guidance—demonstrating its managerial involvement effect by enhancing firms' differentiation capacity and responsiveness to market changes.

Finally, Signaling Theory provides a theoretical explanation for VC's role in industries characterized by strong financing constraints. SMEs in such sectors often lack credibility and sufficient information disclosure, making it difficult for them to access external funding. The involvement of VC sends a strong positive signal of market validation, enhancing firms' reputation and financing capability—thus demonstrating the financing effect of VC.

In sum, this study systematically constructs four mechanism pathways through which VC influences SME innovation, based on distinct theoretical foundations. By integrating key contextual variables—such as industry resource barriers, environmental uncertainty, market competition intensity, and financing constraints—it proposes a structured and explanatory

theoretical framework. This framework not only strengthens the alignment between theory and practice but also lays a solid foundation for the incorporation of contextual variables and interaction effects in future empirical research.

1.5 Research innovation

To explore the impact of venture capital on enterprise innovation in greater depth, this study constructs a novel analytical framework that aims to enrich and extend existing research from both theoretical and practical perspectives. In line with this objective, the study presents the following three key innovations:

(1) Construction of a multi-level mechanism framework

Building on prior research, this study systematically proposes four core mechanisms through which venture capital influences innovation in small and medium-sized enterprises: resource spillover, supervisory governance, managerial involvement, and financial support. This multi-level framework addresses the limitations of single-perspective approaches by integrating various dimensions of VC involvement to reveal its concrete roles in shaping innovation input, innovation output, and governance structures. By adopting this systematic lens, the study offers a more comprehensive understanding of how venture capital drives SME innovation activities, thereby elucidating its critical function within the broader innovation ecosystem.

(2) Incorporation of moderating factors

The study innovatively incorporates multiple moderating variables—such as industry-level R&D spillovers, industry uncertainty, market competition intensity, and capital dependence—into the analytical model. This allows for an in-depth investigation of how these factors condition the effectiveness of venture capital in fostering innovation. The inclusion of such moderators enhances the study's practical relevance by making clearer the context-dependent nature of venture capital's impact across industries, competitive environments, and enterprise characteristics. This innovation not only strengthens the empirical grounding of the research but also provides theoretical support for the formulation of targeted innovation and investment strategies by policymakers and firms.

(3) Systematic analysis of venture capital heterogeneity and investment mode differences

While existing literature often focuses on the binary question of whether venture capital is present or effective, this study takes a step further by introducing a heterogeneity perspective. It systematically analyzes how different types of venture capital (e.g., strategic vs. incubative),

investment characteristics (e.g., equity stake, investor reputation, investment duration), and investment approaches (e.g., syndicated investment) differentially affect innovation performance. This contribution not only identifies who drives innovation and how to drive it more effectively, but also clarifies the marginal impact mechanisms of capital attributes on innovative behavior. By constructing a comprehensive model of moderating effects, this study broadens the analytical dimensions of venture capital's micro-level effects and provides both theoretical and empirical foundations for the design of more precise innovation support policies and differentiated investment strategies.

1.6 Thesis structure

This study, based on four theories (resource dependency theory, agency theory, value-added service theory, and signaling theory) constructs an analytical framework and empirical model to deeply explore the decisive impact of VC on innovation in SMEs. The study reaches relevant conclusions and provides targeted policy recommendations and feasible insights. The entire research is composed of the following eight parts:

Chapter 1: Introduction

This chapter elaborates on the background, theoretical significance, and practical relevance of the research theme, clearly defining the research content and objectives. It focuses on presenting the core issues and systematically explaining aspects such as framework design, research methods, innovations, and potential research limitations, providing a guiding framework for the entire research.

Chapter 2: Literature Review and Theoretical Analysis

This chapter systematically reviews and briefly evaluates relevant literature from various angles, including the relationship between VC and corporate innovation, the mechanisms through which VC influences corporate innovation, the heterogeneity of VC, and the impact of investment methods on innovation. This chapter lays the groundwork for subsequent theoretical analysis and empirical research. In addition, this chapter delves into how VC influences SMEs' innovation through multidimensional mechanisms such as resource spillover, governance supervision, managerial involvement, and financing support. It also analyzes the specific factors affecting SMEs' innovation from two key perspectives: the heterogeneity of VC and its investment methods, providing ample theoretical support and practical references for the empirical research.

Chapter 3: Origin and Evolution

The symbiotic development of VC and SMEs represents a complex and protracted process that cannot be rapidly realized. This interplay has gradually matured and crystallized within the intricate framework of specific historical, economic, and institutional landscapes. By meticulously retracing the developmental trajectories of VC and SMEs in this chapter, we can achieve a comprehensive understanding of their reciprocal mechanisms. Such an in-depth exploration not only elucidates the historical evolution but also provides a multi-faceted, historically grounded analytical lens. This perspective is crucial for conducting a more nuanced and far-reaching investigation into how VC influences the financing strategies and innovation capabilities of SMEs.

Chapter 4: Research Methods

Chapter 4 presents an empirical analysis of the mechanisms through which VC influences innovation in SMEs. Building on the theoretical framework and variable definitions developed in earlier sections, this chapter first elaborates on the econometric model specification and the operationalization of key variables, including innovation input and output, VC-related characteristics, moderating variables, and firm-level controls. Subsequently, it employs multiple linear regression models to examine the direct effects of VC participation on firm innovation and introduces four moderating mechanisms—resource spillover, supervisory governance, management participation, and financing support—to explore the conditional effects under different contextual environments. In addition, the chapter investigates the heterogeneous impact of VC by analyzing multiple dimensions such as ownership proportion, investment duration, syndication structure, investor type, and reputation. To further enhance the causal inference and address potential sample selection bias, the Heckman two-stage model is applied. Overall, this chapter aims to systematically identify the pathways and boundary conditions through which VC affects SME innovation using rigorous econometric methods and multidimensional variable design, thereby providing a robust empirical foundation for subsequent theoretical development and policy recommendations.

Chapter 5: Research Findings - The Mechanisms and Factors of VC on Innovation

Based on the mechanisms proposed in Chapter 2, this chapter conducts empirical analysis to verify that VC influences SMEs' innovation through four mechanisms: resource spillover, governance supervision, managerial involvement, and financing support. It reveals the effective operational conditions and methods through which VC impacts innovation in SMEs. The, this chapter further empirically tests the factors proposed in Chapter 2, including: descriptive statistical analysis of variables to obtain preliminary conclusions; constructing models to test the impact of VC on SMEs' innovation; a deeper exploration of the heterogeneity of VC and

the differential impacts of various investment methods on innovation in SMEs. The research in this chapter provides specific empirical evidence for understanding the multi-layered effects of VC on SMEs' innovation.

Chapter 6: Discussion and Conclusions

Based on the theoretical analysis, empirical research, this chapter systematically summarizes the research findings, provides policy recommendations and management insights for policymakers and business managers, and finally outlines potential future research directions. It also suggests further study into the relationship between VC and corporate innovation, exploring possible issues and themes for future investigation.

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Chapter 2: Literature Review and Theoretical Analysis

Chapter 2 provides the theoretical foundation and literature background for this study. It begins by clarifying key concepts, including venture capital, technological innovation, and SMEs. The chapter then reviews the major theoretical perspectives underpinning the research, specifically, resource dependence theory, agency theory, value-added service theory, and signaling theory, which collectively offer insights into why firms pursue innovation, how they acquire external resources, and how governance mechanisms influence strategic behavior. Following this, the chapter systematically reviews existing literature on the relationship between venture capital and innovation, identifying both the positive impacts and the contextual contingencies. It further explores the mechanisms through which venture capital promotes innovation—such as resource spillovers, strategic guidance, and financing support—and highlights the role of capital heterogeneity and investment modes in shaping innovation outcomes. Finally, based on the preceding theoretical discussion, the chapter presents the conceptual model and formulates the research hypotheses to be empirically tested in the subsequent chapters.

2.1 Concepts definition

2.1.1 Venture capital

VC originated in the United States and greatly contributed to the development of the U.S. economy and industries. Following this success, many other countries and regions began to replicate this model, especially in the 1980s when China began its own VC boom. There are various interpretations and explanations regarding VC. For instance, Florida and Smith Jr (1993) pointed out that what distinguishes VC from other forms of investment is that, in addition to providing financial support to businesses, it also affects their ownership structure. Scott (1997) argued that VC should focus on small, emerging enterprises with good future potential, which often face funding shortages. Wright and Robbie (1998) further explained that VC involves injecting funds into companies in the form of equity (or associated financial products) with the aim of encouraging talented individuals to explore new business opportunities and secure long-term capital profits. In short, the core of VC is equity investment, complemented by additional management services, and its potential returns are achieved through capital gains and dividends.

According to Gompers and Lerner (2001), VC evolved from financial institutions to provide funding support for small companies that are unable to obtain sufficient financing. These companies are generally small, young, and have relatively low tangible assets, operating in a constantly changing market environment with significant uncertainty. Venture capitalists provide financial support for these high-risk, potentially high-reward projects by purchasing equity in these businesses.

The main target group for VC is early-stage companies with high potential and rapid growth. Berger and Udell (1998) indicated that small and micro-enterprises not only drive domestic economic growth, create new business models, and introduce new products, but also contribute to national tax revenues, becoming one of the key drivers of GDP growth. However, due to their small size and limited financing capabilities, these companies need external support to fund their research and development and technology transfer, in order to achieve their final market commercialization goals.

Generally, venture capitalists are actively involved in the operations and management of the companies in which they invest. Research by Plagge (2007) suggested that VC is often referred to as intellectual capital, meaning that venture capitalists help guide the management of the companies they invest in. This is in stark contrast to traditional business loans, as many small business owners, despite having advanced technical knowledge, often lack basic management skills and thus rely on the guidance of venture capitalists to establish appropriate management systems (Ehrlich et al., 1994). From a risk control perspective, the equity investment nature of VC makes investors particularly attentive to the development of the company. They rigorously evaluate the company before investing and actively engage in management and provide value-added services post-investment.

The core of VC lies in its support for equity rather than debt. According to Durrani and Boocock (2006) this form of VC provides funding to entrepreneurs with commercial potential in exchange for equity stakes or related financial products. This process allows entrepreneurs to utilize their business skills to create new market opportunities and profit from them.

The VC cycle begins with raising funds from investors, referred to as limited partners (LPs), including family offices, asset management firms, and pension funds. The VC manager then decides when to exit the portfolio company (Dittmer et al., 2014). Typically, VC funds set a lifespan of 10 years. During this limited lifecycle, the first 3 to 4 years are generally the active investment phase (J. J. Li et al., 2021).

The holding period for VC investments (from investment completion to exit) varies depending on the financing stage. Robinson (1987) found that the average holding period for

individual venture investments was 6.3 years. Manigart et al. (2002) and Robinson (1987) reached similar conclusions, estimating that the average holding period for early-stage companies in the U.S., U.K., France, Belgium, and the Netherlands was approximately 6.2 years, while the holding period for later-stage investments was about 5.1 years. Additionally, Klingler-Vidra (2016) showed that the holding period for early-stage investments typically ranges from 3 to 5 years, while later-stage investments tend to have shorter duration, typically between 1 to 3 years, as these investments are usually in profitable businesses.

The value-added support provided by VC is not only reflected in the financial capital provided during the investment holding period but also in the social networks it offers. Hellmann (2000) and Hellmann and Puri (2000) described VC fund managers as "coaches" who establish long-term relationships with portfolio companies. These venture capitalists not only guide the founding entrepreneurs in shaping business strategies but also use their networks to promote business development and help establish strategic alliances. Furthermore, during the next round of financing for a portfolio company, venture capitalists can help entrepreneurs raise more funds by certifying the quality of the startup (Denis, 2004).

VC funds significantly increase the likelihood of successful exits by providing both financial and non-financial support to their portfolio companies, enabling the achievement of investment objectives at the end of the investment cycle. Traditionally, VC fund managers plan their exit strategy primarily through an Initial Public Offering (IPO) (Sahlman, 2022). Additionally, VC funds may consider other exit options, such as repurchase by the company's founders or selling their equity stakes to new investors (Cumming & Binti Johan, 2008).

2.1.2 Technological innovation

The two-step theory discusses new concepts and potential future development trends, which is considered a cornerstone in the field of technological innovation (Solow, 1956). Schumpeter (2013) was the first to define the concept of technological innovation, emphasizing that technological innovation involves integrating new resources that have not previously appeared into production systems. This specifically includes five aspects: new products, emerging technologies, entirely new markets, new energy sources, and entirely new business models (Pietronudo et al., 2022).

The concept of corporate technological innovation originates from Schumpeter's "theory of innovation," which posits that innovation is the driving force behind economic growth, development, and social evolution. As research in this area progressed, scholars extensively discussed the concept of a firm's technological innovation capability. According to the OECD

definition, technological innovation refers to the implementation of new and significant improvements in products (including goods and services), processes, marketing strategies, or organizational models in commercial practices, workplace organization, or external relations (Bloch, 2007). Diaconu (2011) proposed that most firms' technological innovations have characteristics of complexity and accumulation. Firms need to be able to gather information, human resources, financial resources, and material resources, and establish a comprehensive functional distribution system to carry out innovation activities. Kline and Rosenberg (2010) argued that technological innovation in firms spans the entire product lifecycle, with the aim of improving the firm's economic efficiency. In general, technological innovation is an ongoing process within firms, existing not only in specific production cycles or stages but also involving all production aspects of the firm. Technological innovation reflects the comprehensive capability of the firm, integrating various capabilities into a complex, creative, open, and multi-factorial system. However, given its nature, the process of technological innovation is often random, irregular, or chaotic, and therefore, research on corporate technological innovation capabilities has not yet formed a complete and systematic theoretical framework. Firms often lack guidance in making technological innovation decisions.

As the core driver of improving a firm's economic performance, technological innovation covers the full cycle of a product, from research and development to market withdrawal. This process is not confined to a specific period or a single stage but permeates all aspects of the firm's operations, showcasing the integration and optimization of the firm's overall strength. The essence of technological innovation is a multi-dimensional composite system, characterized by complexity, creativity, openness, and interaction among multiple factors. Due to its inherent characteristics, technological innovation often presents a non-linear and non-deterministic evolutionary trajectory. Currently, academic exploration of the theoretical aspects of a firm's technological innovation capability is still in the developmental stage, and a systematic theoretical framework has not yet been established. This lag in theoretical research has directly led to the lack of effective theoretical support in firms' innovation decision-making processes, thereby impacting the success rate of innovation practices.

2.1.3 Small and medium-sized enterprises

Schöllhammer and Kuriloff (1979) pointed out that there are certain differences between SMEs and large companies in terms of development models, ownership structures, management styles, and the scale and scope of operations. When formulating support policies, policymakers should consider the unique characteristics of SMEs and provide targeted support measures (North et

al., 2001). During the policy design and implementation process, decision-makers should clearly recognize that SMEs are not simply smaller versions of large companies. As Shuman and Seeger (1986) noted, small businesses not only have different characteristics from large enterprises but also develop unique approaches to dealing with scale-related issues, which often present different features in specific analyses. To accurately identify SMEs, it is necessary to establish clear definition standards; otherwise, inconsistencies in policy implementation may arise, which could impact fair competition between countries.

China's definition of SMEs is similar to that of Europe, using criteria such as the number of employees, total assets, and annual revenue to define SMEs. However, the thresholds for each standard are much broader than those in Europe. Unlike Europe, but similar to the United States, China has also implemented different standards for each industry. Specifically, in 2003, China established provisional standards for SMEs, but these were abolished in 2011. Table 2.1 shows the provisional standards for SMEs in 2003, while Table 2.2 presents the new version of the unified SMEs standards established in 2011.

Table 2.1 Definition of SMEs in China 2003

Size Category	**Industries**	**Employment-based**	**Total assets in million RMB**	**Business revenue in million RMB**
Small	Industry	<300	< 40	< 30
	Construction	<600	< 40	< 30
	Wholesale	<100		< 30
	Retail	<100		< 10
	Transport	<500		< 30
	Post	<400		< 30
	Hotel & Restaurant	<400		< 30
Medium	Industry	300-2000	40 - 390	30 - 290
	Construction	600-3000	40 -390	30- 290
	Wholesale	100-200		30- 290
	Retail	100-500		10- 150
	Transport	500-3000		30- 290
	Post	400-1000		30- 290
	Hotel & Restaurant	400-800		30- 150

Note: SMEs meet one or more of the conditions. ME should meet three conditions, the others are SE.
Source: National People's Congress (2003)

Table 2.2 Definition of SMEs in China 2011

Size Category	Industries	Employment-based	Total assets in million RMB	Business revenue in million RMB
Medium	Agriculture/Fishery/Animal husbandry/Forestry			5-200
	Industry	300-1000		20-400
	Construction		50-90	60-790
	Wholesale	20-200		50-400
	Retail	50-300		5-200
	Transport	300-1000		30-300
	Warehousing	100-200		10-300
	Post	300-1000		20-300
	Hotel & Restaurant	100-300		20-100
	Information transmission	100-2000		10-990
	Software and information service industry	100-300		10-990
	Real estate development and management		50-100	10-1980
	Property management	300-1000		10-50
	Leasing and business service	100-300	85-129	
	Others	100-300		
Small	Agriculture/Fishery/Animal husbandry/Forestry			0.5-5
	Industry	20-300		3-20
	Construction		3-5	3-60
	Wholesale	5-20		10-50
	Retail	10-50		1-5
	Transport	20-300		2-30
	Warehousing	20-100		1-10
	Post	20-300		1-20
	Hotel & Restaurant	10-100		1-20
	Information transmission	10-100		1-10
	Software and information service industry	10-100		0.5-10
	Real estate development and management		20-50	1-10
	Property management	100-300		5-10
	Leasing and business service	10-100	1-85	
	Others	10-100		
Micro	Agriculture/Fishery/Animal husbandry/Forestry			< 0.5
	Industry	<20		< 3
	Construction		< 3	< 3
	Wholesale	<5		< 10
	Retail	<10		< 1
	Transport	<20		< 2
	Warehousing	<20		< 1
	Post	<20		< 1
	Hotel & Restaurant	<10		< 1
	Information transmission	<10		< 1
	Software and information service industry	<10		< 5
	Real estate development and		< 20	< 1

management			
Property management	<100		< 5
Leasing and business service	<10	< 1	
Others	<10		

Note: Others include Scientific research and technical services, Fishery and water conservancy; Environment and public facilities management; Residents service, Repair and other services; Culture, sports and entertainment.
Source: Ministry of Industry and Information Technology (2011)

As seen from the tables, the new version of the unified standards includes more detailed classifications for industries and company sizes, marking the first time China has considered micro-enterprises. Additionally, the standards vary by industry. For example, in the information transmission industry, a company with between 100 and 2000 employees can be classified as a medium-sized company, while in the wholesale industry, a company with 20 to 200 employees can be defined as medium-sized. Moreover, the employment base in 2011 was lower than in 2003, with total assets and business income in China having increased during this period.

Chen and Karami (2010) pointed out that the differences between Eastern and Western standards indeed pose challenges, which may affect the generalizability of research results. However, it is important to note that approximately 70% of employees in SMEs have fewer than 5 employees or are sole proprietors. This suggests that the overall environmental differences between SMEs in Eastern and Western economies are not significantly different. Furthermore, this study focuses on high-tech SMEs, which typically have smaller employment sizes compared to non-tech SMEs. As shown in Table 2.2, except for the information transmission industry, other industries have an employment base of fewer than 300 employees, which is not significantly different from the standards of other countries.

2.2 Theoretical foundations

To systematically analyze how VC drives innovation in SMEs through multiple mechanisms, this study introduces four foundational theories: Resource Dependence Theory, Agency Theory, Value-Added Services Theory, and Signaling Theory. By integrating these classical perspectives, the study constructs a theoretically grounded and explanatory analytical framework. This framework not only helps to identify the key pathways through which VC intervenes in the innovation process but also provides a solid theoretical basis for the design of subsequent empirical models and the specification of relevant variables.

2.2.1 Resource dependence theory

Resource Dependence Theory (RDT) posits that organizations are not autonomous, self-

contained systems but are instead deeply embedded in their external environments (Pfeffer & Salancik, 2015). Their survival and growth depend on the acquisition and integration of critical external resources (Hillman et al., 2009). As these resources are typically controlled by actors outside the organization's boundaries, firms must develop strategies—such as building power structures, forming strategic alliances, or adjusting ownership arrangements—to manage uncertainty and dependency in resource acquisition (Celtekligil, 2020).

The theory centers on several core propositions (Ozturk, 2021):

First, organizations must engage in ongoing interactions with external entities to obtain essential resources for their survival and development. These resources—such as capital, technology, information, talent, and market access—are often held by other organizations or institutions. As such, firms occupy a structurally dependent position and cannot rely solely on internal production to secure the means for sustained operation.

Second, resource dependence compels organizations to make strategic and structural adjustments in order to reduce reliance on specific external parties or enhance their control over key resources. These adaptations may include restructuring governance frameworks, redefining organizational boundaries, or establishing dedicated units to manage relationships with critical resource providers. Through such efforts, firms can improve their bargaining power and strategic flexibility.

Third, the distribution of power among organizations is largely shaped by the scarcity and substitutability of the resources they control. Entities that possess rare, non-substitutable, and strategically vital resources tend to occupy dominant positions in inter-organizational relationships. This asymmetry in resource control influences mutual dependence levels, bargaining dynamics, and the formation and evolution of alliances, partnerships, and governance structures.

From the perspective of RDT, organizational behavior is essentially a strategic response to external resource pressures and environmental uncertainty, often manifested in the form of alliance building, board composition adjustments, equity partnerships, mergers and acquisitions, or the establishment of ties with government agencies and financial institutions—collectively referred to as "resource response mechanisms" (Hillman et al., 2009). These strategies not only help alleviate resource uncertainty but also enhance organizational legitimacy and external support, serving as proactive means for firms to adapt to complex environments and optimize resource allocation.

Accordingly, RDT offers a powerful explanation of the relationship between external resources and firm development. This is particularly relevant for SMEs, which typically suffer

from internal resource constraints and thus rely more heavily on external sources of capital, knowledge, technology, and market access to pursue innovation. As such, SMEs often seek to bring in external shareholders, establish collaborative networks, or accept venture capital investment to improve their capacity for resource integration and enhance strategic flexibility (Katila et al., 2008). In highly uncertain and technologically intensive industries, a firm's ability to access heterogeneous external resources often determines whether it can achieve sustained innovation (Hillman et al., 2009).

Moreover, RDT provides a valuable lens for understanding how firms manage environmental uncertainty. By forming dependencies on organizations that control critical resources, firms can "organize" uncertainty—transforming it into a more manageable structure—and thus secure a relatively stable development trajectory (Casciaro & Piskorski, 2005). Meta-analytic evidence from Drees and Heugens (2013) confirms a significant positive relationship between resource-dependent governance structures (e.g., board restructuring, ownership reconfiguration) and firm performance, with this relationship being moderated by industry structure and institutional context.

Within this framework, VC can be seen as a key power-wielding actor in the resource environment. As an external resource provider, VC not only injects financial capital but also actively participates in corporate governance through board representation, strategic involvement, and executive recruitment. In doing so, it redefines firm boundaries and reshapes innovation trajectories (Wry et al., 2013). Empirical studies have shown that firms backed by venture capital tend to exhibit greater resource allocation efficiency, reflected in faster technology commercialization, shorter time-to-market, and increased patent output (Hellmann & Puri, 2002). Moreover, VC mitigates financial bottlenecks while offering reputational endorsement and network resources, thereby reducing uncertainty and risk exposure in product marketing, market expansion, and subsequent rounds of financing (Gargiulo & Benassi, 2000).

In summary, RDT not only explains why firms must engage with external resource actors, but also clarifies how venture capital promotes SME innovation through governance participation and strategic resource input. In other words, innovation is not solely the product of internal firm activity, but rather the outcome of dynamic interactions between firms and their external resource environments.

2.2.2 Agency theory

Agency Theory offers a theoretical framework that conceptualizes the firm as a nexus of

contracts. Drawing from property rights, financial economics, and organizational behavior, the theory aims to explain the problems of information asymmetry and interest misalignment that arise under modern corporate structures, particularly due to the separation of ownership and control (Jensen & Meckling, 2019).

According to Agency Theory, principals (e.g., shareholders or investors) and agents (e.g., professional managers or entrepreneurs) inherently differ in their objectives, risk preferences, time horizons, and access to information. These differences give rise to agency costs, which refer to the additional economic and organizational expenses incurred in monitoring, incentivizing, and aligning the behavior of agents with the interests of principals (Panda & Leepsa, 2017).

Agency costs manifest primarily in two classic problems—moral hazard and adverse selection—which together constitute the core mechanisms of conflict in principal–agent relationships (Panda & Leepsa, 2017).

Moral hazard occurs when agents, motivated by self-interest and operating under conditions of incomplete transparency, may engage in behaviors that are difficult for principals to observe and potentially harmful to their interests (Fama & Jensen, 1983). This typically arises during the contract execution phase. For example, a manager may forgo high-potential but risky long-term innovation projects in favor of short-term performance gains or personal reputation enhancement. Alternatively, agents may misallocate resources toward excessive expansion or unproductive investments. Given that agents often possess superior operational information, and that principals lack the capacity for real-time oversight, this information asymmetry increases the risk of moral hazard, which can undermine long-term strategic objectives and impair the efficiency of resource utilization.

Adverse selection, in contrast, typically arises prior to contract formation. It refers to the principal's inability to accurately assess the agent's true capabilities, intentions, or integrity due to information asymmetry at the initial decision-making stage. In the context of venture capital, for instance, early-stage investors often face significant challenges in evaluating the technical feasibility of a startup's innovation or the credibility of its strategic commitments. As a result, capital may be allocated to firms that lack substantive innovation capacity or are driven by opportunistic motives, creating a "lemons market" where inferior ventures crowd out superior ones (Eisenhardt, 1989). Such misallocations reduce the efficiency of capital deployment and may undermine the long-term sustainability of entrepreneurial ecosystems.

Both moral hazard and adverse selection are particularly pronounced in high-risk, high-uncertainty domains such as technological innovation and venture investment. These problems

represent key constraints on organizational efficiency and investment performance (Bessonova & Gonchar, 2017). On one hand, startups often operate in early-stage environments marked by high technical uncertainty and underdeveloped disclosure mechanisms, making it difficult for external investors to accurately assess operational viability or founder intentions—thereby heightening adverse selection risk. On the other hand, innovation projects inherently involve large investments, long development cycles, and high failure rates, granting entrepreneurs considerable discretion in resource allocation and strategic decision-making. This discretion increases the likelihood of moral hazard behaviors (Shahzad et al., 2023).

Agency Theory has laid the conceptual foundation for subsequent developments in "separation of control rights" and has become one of the most influential theoretical pillars in corporate governance research. Fama and Jensen (1983) expanded the theory by emphasizing the role of institutionalized mechanisms in mitigating agency conflicts and protecting the interests of principals. They proposed a framework encompassing three core governance mechanisms:

a). Contractual mechanisms: These include well-defined equity structures, performance evaluation criteria, and profit-sharing agreements that regulate agent behavior and clarify decision boundaries.

b). Monitoring mechanisms: These involve the establishment of boards of directors, the implementation of external audits, and the enhancement of information disclosure to improve transparency and organizational accountability.

c). Incentive mechanisms: Such as compensation plans, stock options, and co-investment arrangements that align the interests of agents with those of principals and motivate diligent performance.

This governance framework not only provides a foundational basis for modern corporate governance, but also offers theoretical justification for the application of external governance models such as venture capital. Through active involvement in decision-making, performance monitoring, and incentive structuring, venture capitalists help mitigate agency risks and enhance the governance efficiency of innovation-driven firms—especially SMEs.

In addition, Agency Theory has become a critical theoretical lens for understanding the governance structures and behavioral interactions between entrepreneurial firms and external capital providers. Colombo et al. (2016) argue that the quality of collaboration between venture capitalists and entrepreneurs depends on goal alignment, information symmetry, and mutual trust—all of which must be reinforced through institutionalized governance arrangements. Compared to traditional financial institutions, venture capitalists tend to adopt more proactive

and structured engagement strategies to mitigate agency risks. For example, they often employ mechanisms such as staged financing agreements, contingent contractual clauses (e.g., performance-based ratchets), exit provisions (e.g., repurchase rights or IPO options), and board participation or veto power over critical decisions to exert substantive influence over a firm's strategic direction and resource allocation (Gompers & Lerner, 2004; Kaplan & Strömberg, 2003).

Moreover, many venture capitalists complement formal governance mechanisms with informal approaches, such as technical guidance, managerial consulting, and resource brokering, thereby forming a hybrid governance model that integrates "soft monitoring" and "reputational incentives." This mixed model is particularly effective in motivating entrepreneurs to stay focused on long-term innovation.

As entrepreneurial ecosystems continue to evolve, agency mechanisms have also become more diversified and staged in nature. On the one hand, in the early stages of a startup, balancing agency risk and cooperative trust is especially critical. Wasserman (2003) found that retaining founder control during the early phase of a venture helps preserve strategic coherence and innovation continuity. However, as the firm enters the expansion and scaling phase, the introduction of professional managers and institutional governance mechanisms becomes essential for improving governance efficiency and capital utilization.

On the other hand, in industries characterized by high technological barriers and knowledge intensity—such as hard technology or biopharmaceuticals—agency risks are even more salient. In such contexts, venture capitalists often adopt highly detailed governance designs, including the establishment of strategic advisory committees, the implementation of frequent information reporting systems, and the intervention in key executive appointments. These measures enhance the VCs' ability to both constrain and support innovation strategies (Hellmann & Puri, 2002; Shahzad et al., 2023).

In summary, Agency Theory not only offers a systematic framework for analyzing the power dynamics, control arrangements, and trust mechanisms involved in venture capital's engagement with corporate innovation, but also helps explain how VCs minimize agency costs and maximize innovation efficiency through an integrated system of contracts, monitoring, and incentives. As one of the key theoretical foundations of this study, Agency Theory provides a structured analytical lens and explanatory pathway for examining how venture capital affects the innovation performance of SMEs through governance mechanisms.

2.2.3 Value-added service theory

In today's economy, where services increasingly dominate value creation, Value-Added Services (VAS) theory has emerged as one of the key frameworks for understanding how firms gain competitive advantage through non-core but differentiated service offerings. Originating in the logistics and telecommunications sectors, value-added services refer to supplementary offerings beyond core products and basic services that enhance customer experience, increase satisfaction, and foster loyalty (Anderson & Narus, 1995; Mathwick et al., 2001).

Rather than constituting a single unified theory, VAS theory represents a convergence of multiple conceptual perspectives centered on the enhancement of service value. Its theoretical foundations can be traced to two core frameworks: Customer Perceived Value (CPV) and Service-Dominant Logic (SDL). Zeithaml (1988) defines CPV as "the consumer's overall assessment of the utility of a product based on what is received and what is given," offering a quantifiable basis for value-added design. Building on this, Vargo and Lusch (2004) propose SDL, which emphasizes that "service is the fundamental basis of exchange." This view shifts the firm's role from being a product provider to a co-creator of value, establishing a foundation for differentiated advantage through service interaction.

As the concept has evolved, VAS has extended far beyond the realm of after-sales service or product add-ons to encompass more strategic domains such as customer relationship management, customized solutions, technical support, and data analytics (Ulaga & Eggert, 2006). For instance, in B2B contexts, firms frequently adopt service bundling strategies that integrate products and value-added services to deliver more attractive and comprehensive solutions (Tuli et al., 2007).

With the advancement of SDL and relationship marketing theory, scholars have extended the application of VAS from traditional business-to-consumer (B2C) models to inter-organizational contexts such as business-to-business (B2B) relationships and collaborative ecosystems. Within this framework, value-added services are no longer viewed merely as functional complements to products; instead, they are understood as proactive contributions of resources, knowledge, and capabilities by one party to enhance the value-creation potential of the other (Ulaga & Eggert, 2006). This interpretation is particularly relevant in platform ecosystems, B2B collaborations, and venture capital relationships. For example, in VC contexts, investors often provide strategic consulting, executive referrals, and network access—forms of "service-oriented value" that go far beyond financial investment and help build enduring partnerships and mechanisms for joint growth (Gompers & Lerner, 2001). From this

perspective, Value-Added Services theory not only explains how service enhancements improve customer satisfaction but also offers a robust conceptual lens for understanding inter-organizational collaboration, capital empowerment, and co-creation of value.

2.2.4 Signaling theory

Signaling Theory was first proposed by Nobel laureate Michael Spence in 1973 to explain the issue of information asymmetry in the labor market. In his seminal model, employers are unable to directly assess job applicants' capabilities; hence, applicants engage in costly behaviors—such as obtaining higher education—to signal their competence to potential employers (Spence, 1974). The theory posits a key assumption: in markets characterized by information asymmetry, informed parties can convey credible information about their quality to uninformed parties through costly and difficult-to-imitate signals, thereby influencing the latter's judgments and decisions.

The core structure of signaling theory involves three main components: the signaler, the receiver, and the signal itself. In market settings, firms, job seekers, or other actors often function as signalers who possess private information about their own quality. Meanwhile, investors, employers, or consumers serve as receivers who must infer the signaler's quality based on observable cues. The effectiveness of a signal hinges on its separating and costly nature—that is, high-quality actors find it easier or more advantageous to send the signal, while low-quality actors find it prohibitively expensive or difficult to mimic, thus achieving differentiation.

Signaling theory has since been widely applied and expanded in fields such as organizational studies, strategic management, and finance. Connelly et al. (2011) conducted a comprehensive review of its development in management research, noting the persistent cognitive gaps between firms and external stakeholders. To bridge these gaps, firms frequently rely on observable but imperfectly verifiable signals—such as technology patents, product certifications, executive appointments, CSR disclosures, or the introduction of venture capital—to communicate their capabilities, reliability, or growth potential to the market.

The theoretical significance of signaling theory lies in its challenge to the traditional rational-choice assumption of "perfect information." It emphasizes that organizational and individual behaviors are not only driven by internal motives but are also shaped by strategic considerations of external perception and signaling. Especially in contexts of high uncertainty or pronounced information asymmetry—such as startup financing, IPO pricing, mergers and acquisitions, green finance, and ESG disclosures—signaling mechanisms play a critical role in

shaping resource flows and market valuations. For instance, startups lacking stable cash flow or historical performance often attract reputable venture capital investors, publicly disclose R&D progress, or highlight top executive credentials to build trust with the market (Janney & Folta, 2003). Similarly, in capital markets, earnings forecasts, innovation announcements, and CSR reports are frequently interpreted by investors as forward-looking indicators of firm performance.

Nonetheless, signaling theory is not without criticism and refinement. Its explanatory power may vary across different market contexts, and the interpretation of signals by receivers can be influenced by prior beliefs, market sentiment, or institutional settings. As research has evolved, scholars have introduced concepts such as multi-signaling and signaling clutter to describe more complex scenarios in which multiple signals are emitted simultaneously, potentially leading to information overload and diminished signal clarity (Highhouse et al., 2009).

In summary, signaling theory provides a robust theoretical tool for analyzing how firms influence external perceptions and shape market cognition under conditions of information asymmetry. It underscores the symbolic function of behavior and the strategic role of information disclosure in resource acquisition, reputation building, and strategic communication—offering a powerful lens for understanding modern corporate behavior.

2.3 The relationship between VC and corporate innovation

The relationship between VC and corporate innovation has always been a core topic in the field of VC theory. Scholars have approached this issue from multiple perspectives, utilizing data from various countries, regions, and levels, and employing a variety of analytical methods, leading to numerous important discoveries. These research findings have not only enriched the content of VC theory but also provided valuable insights for a deeper understanding of how companies can achieve innovation through VC.

2.3.1 Criteria for selection of companies for investment by venture capitalists

VC firms typically conduct comprehensive screenings and due diligence on potential target companies when selecting investment recipients. However, this preliminary investigation process may have a negative impact on the target company's subsequent innovation activities. Therefore, it is essential to explore the decision-making criteria used by VC firms when choosing target companies, including the core characteristics of the companies they focus on,

to better understand the mechanisms through which VC influences the innovation performance of invested companies.

In research at the corporate and industry levels, studies by Kelly and Kim (2018) and Puri and Zarutskie (2012) highlight that firm size and growth potential are the primary factors attracting VC firms' attention, while innovation ability is not the main focus. Meanwhile, Gompers et al. (2020) further emphasize that VC firms place particular importance on the management team when selecting investment targets. The quality and capabilities of the management team are often the key determinants of investment success, especially in startups, where the importance of the management team often outweighs that of the business model or technological innovation. Additionally, VC firms also carefully consider the management of their investment portfolios during the decision-making process. Different firms, based on their investment philosophies and strategies, adopt diverse investment approaches. Some firms prefer to build diversified portfolios to reduce risk, even if this results in sacrificing some returns due to the dispersion of investments. Other firms focus on specific industries, investing in multiple competing companies within the same field to explore high-potential opportunities, thus aiming for higher investment returns.

At the cross-national level, Jeng and Wells (2000) conducted a study about VC cases from 21 countries and regions, concluding that the objective of VC is not to directly drive corporate innovation but simply to invest in companies to gain investment returns. Romain and Van Pottelsberghe (2003) conducted an empirical analysis of the determinants of VC using panel data from 16 OECD countries and found that factors such as a company's knowledge stock, innovation output, R&D activities, tax demands, and short-term interest rates played a key role in its role as an innovation subject. At the same time, the rigidity of the labor market and the level of entrepreneurship also significantly impacted the behavior of VC firms. Häussler et al. (2012) analyzed VC cases in the UK and Germany and found a positive correlation between patent applications by firms and VC. Patent information alleviates information asymmetry to some extent and provides important reference points for VC firms' decision-making. Hoenig and Henkel (2015) conducted a joint survey of 187 venture capitalists from Europe and the United States, discovering that these investors highly rely on the number of alliance agreements signed by startups when making decisions. Strategic alliances are seen as an important means of acquiring complementary resources, which not only strengthen the firm's overall capabilities but also enhance the startup's market credibility and attractiveness through certification and assurance mechanisms.

Overall, while a firm's innovation capability does attract VC to some extent, it is not the

core factor that VC firms focus on when making investment decisions. VC firms are more focused on achieving indirect returns by enhancing a company's long-term profitability or driving its expansion. Due to the differences in objectives between the firm and the VC firm, contractual arrangements and effective incentive mechanisms play a key role in aligning the interests of both parties. By optimizing the benefit structure for both sides, these mechanisms help establish stable cooperation and promote a win-win situation for both.

2.3.2 Can VC promote innovation in investee companies?

The role of VC firms in promoting the innovation and development of the invested companies has been widely debated. Some viewpoints suggest that VC firms only select innovative companies with strong growth potential, and even without VC involvement, these companies would continue to innovate and reap rewards. To address this issue, a substantial body of literature has explored the relationship between VC and key innovation indicators such as R&D investments, patent activity, and other critical innovation metrics, providing relevant explanations.

Regarding the positive impact of VC on corporate innovation, existing research has been conducted at the corporate, industry, and national levels. At the corporate level, Mann and Sager (2007) found a significant positive correlation between patent rights and VC in U.S. software companies. Bertoni and Croce et al. (2010) and Bertoni and Colombo et al. (2010) further discovered that the involvement of VC in new technology companies in Italy led to a significant increase in patent activity. Although no clear difference in patent application tendencies existed between supported and unsupported companies before VC involvement, after the VC injection, the supported companies exhibited a marked increase in patent activities. Kortum and Lerner (2000) emphasized that VC-backed companies exhibit stronger innovation capabilities, higher patent rates, and better patent quality, enabling them to grow more quickly during the initial development stages compared to those without VC support. Akcigit et al. (2022) similarly corroborated this finding. Furthermore, Celikyurt et al. (2014) emphasized that VC not only promotes the development of small startups but also accelerates the R&D and innovation processes of mature, large, publicly listed companies. Greenwood et al. (2022) found that VC-backed companies received higher valuations during their IPOs compared to those without such support. After going public, these companies outperformed others in terms of R&D expenditure, revenue growth, and employment growth. Akcigit et al. (2022) quantified the impact of VC and discovered that about 26% of venture-backed startups entered the industry's top 10 within 10 years of receiving their first-round funding, compared to only 3.5% of non-venture-backed

startups. Additionally, these companies had significantly higher patent levels, further confirming the positive impact of VC on innovation.

At the industry level, Kortum and Lerner (2000) conducted an empirical study of 20 industries in the U.S. and found that industries receiving more VC had a significant increase in research expenditures and patent numbers, thereby advancing technological progress in those industries. Aghion et al. (2013) from the perspective of institutional investors, explored the impact of institutional investors on corporate innovation. The study showed that a higher percentage of institutional ownership in listed companies stimulated innovation, which was verified by indicators like patent numbers. At the national level, Schertler (2007) conducted a panel data analysis of 15 European countries over 10 years, using patent numbers and research staff as indicators, and concluded that VC could promote corporate innovation. Popov and Roosenboom (2012) examined the impact of VC on innovation across 21 European countries from 1991 to 2005. Their research revealed significant differences in this impact between countries, especially in nations with low entrepreneurial barriers, favorable tax policies, and relaxed regulatory environments, where VC had a more pronounced effect on innovation.

While research on the positive effects of VC on corporate technological innovation is abundant, discussions on its potential negative impacts remain relatively scarce. VC firms engage in early-stage investments by assuming high risks and uncertainties, aiming to achieve high returns through exit strategies such as IPOs or mergers and acquisitions. However, contrary to common belief, Caselli et al. (2009) in their analysis of IPO data from 37 Italian companies, revealed an unusual phenomenon: despite innovation capability being an important criterion for VC firms in selecting investment targets, these firms did not continue to drive innovation activities post-investment. Instead, their focus shifted toward improving the company's profitability and management. The results showed that after receiving VC, the number of patents registered by these invested companies was even lower than that of companies that did not receive investment. Gilbert and Newbery (1982) found a negative correlation between VC and product patent quality, suggesting that VC might, in some cases, hinder technological advancement. Similarly, Zucker et al. (1994) found a similar outcome in their analysis of the VC market's effect on biotechnology innovation. With all other conditions remaining the same, VC might inhibit the innovation process. Gompers and Lerner (2001) based on data from 20 U.S. manufacturers, further confirmed that during periods of economic development, VC might actually weaken a company's technological innovation capabilities. Additionally, Geronikolaou and Papachristou (2008) provided evidence that newly established startups showed a decline in overall patent numbers after receiving VC support. Peneder (2010)

showed that after eliminating selection effects, the positive effect of VC on corporate innovation was no longer significant, but it had a positive impact on company growth. Similar to these findings, Engel and Keilbach (2007) in their study of German startups, found that although venture-backed companies initially filed more patents than their non-venture-backed counterparts, most of these patents were filed before VC investment. After VC involvement, the patent number gap between the two groups gradually narrowed. However, the venture-backed companies exhibited a clear advantage in terms of growth speed. This suggests that the higher innovation capability shown by venture-backed companies is more attributed to the venture capitalists' strict selection mechanisms rather than direct funding driving innovation activities. VC tends to focus more on the commercialization of existing innovations and driving the speed of company development.

Arvanitis and Stucki (2014) analyzed all new companies founded in Switzerland in 1996-1997 to study the impact of VC on product development capabilities and long-term product quality improvements. They found that VC did not significantly enhance either the R&D capabilities or product quality levels of companies, whether in the early or later stages. In other words, both early and later-stage financed companies did not see improvements in their technological innovation and growth due to VC support.

Although VC has a significant role in promoting business growth and commercialization processes, its effect on technological innovation is not always positive. In many cases, compared to long-term innovation investments, VC may focus more on a company's profitability and short-term growth. This phenomenon reflects the inconsistency in VC's resource allocation and innovation activity goals, and it also indicates that its impact on innovation largely depends on the selection preferences and incentive mechanisms of the investment firms.

In addition to linear relationships, there are also non-linear links between corporate innovation and VC. Arqué-Castells (2012) took a sample of 233 Spanish companies with VC support, finding that these companies' patent applications increased year by year after receiving VC support, showing an inverted U-shape trend. That is, VC significantly enhanced innovation in the early stages, but its marginal effect gradually weakened over time. Additionally, Manigart and Van Hyfte (1999) pointed out that although VC alone cannot directly drive technological progress in companies, it can help them make strategic decisions conducive to technological innovation by providing advice and guidance on day-to-day operations. Moreover, the introduction of VC helps control operational risks and enables companies to conduct R&D more effectively, while reducing concerns about technological innovation during the development

process, thus reinforcing companies' investments and exploration in science and technology.

Furthermore, there is a bi-directional causal relationship between VC and corporate innovation. A common academic discussion is whether it is the company's inherent innovation capabilities that attract VC or whether the involvement of VC leads to more innovative outcomes. Some scholars lean toward the "Innovation-first" theory, which holds that technological innovation is the primary driver of increased VC demand. Hirukawa and Ueda (2011) through an in-depth analysis of U.S. manufacturing panel data from 1963 to 2002, found that patent results were the key factor attracting VC inflows, not the VC itself increasing patent numbers. On the other hand, Hellmann and Puri (2000), based on a comparative analysis of 149 Silicon Valley companies from 1994 to 1997, found that VC-backed companies performed significantly better than those without VC in terms of marketing strategies and financing models, revealing the close link between VC and technological innovation in startups. VC can provide innovative companies with convenient access to financing, and companies with technological innovation are more effective at attracting the attention of investors. This complementary relationship indicates that technological innovation attracts VC, and the intervention of VC in turn promotes technological innovation. Isolated studies of either party fail to fully demonstrate their mutually reinforcing role. Chemmanur et al. (2011) further revealed that, compared to non-venture-backed companies, those favored by VC already had higher total factor productivity (TFP) before securing funding, and their TFP growth rate was more pronounced after receiving VC funding. This phenomenon strongly supports the notion of a close interdependent and mutually reinforcing relationship between VC and corporate innovation.

In conclusion, the research on the relationship between VC and corporate innovation presents significant variability and even divergence in findings. This difference is mainly due to the establishment of proxy variables, sample selection, country or regional characteristics, and industry differences in the research. For example, the core goal of VC institutions is to pursue high investment returns, while corporate innovation is more often viewed as an indirect means to achieve this goal. As VC is a highly specialized investment activity, its incentive effects on innovation are greatly influenced by multiple factors such as industry, region, and institutional environment. Therefore, for theoretical scholars, the focus should be on studying "how VC promotes corporate innovation" rather than simply discussing "whether VC drives corporate innovation." Greater attention should be paid to exploring the key factors in this process, particularly those that may lead to differences across industries or regions, such as contract terms, policy support, and industry characteristics. Ultimately, this approach can minimize the negative impact of VC on innovation and enhance its positive contribution to

innovation, thereby achieving high returns for VC while promoting corporate innovation and sustainable development.

2.4 The role of VC in promoting corporate innovation

Based on numerous theoretical studies, VC has a positive impact on corporate innovation. So, how does VC exert this positive influence? Related research has analyzed the mechanisms through which VC operates, summarizing its main effects in three key areas: financing effects, non-capital value-added services, and oversight and involvement effects.

2.4.1 The financing effect increases investment in R&D

Entrepreneurial founders lay the foundation for innovation by conceptualizing groundbreaking new products and service ideas. VC firms, in turn, support the realization and market promotion of these advanced concepts through financial backing, thereby obtaining investment returns. Although VC firms do not directly participate in innovation activities, they play a crucial role in the national innovation system (Barkoczy & Wilkinson, 2019). The most direct contribution of VC is providing financial support to the invested companies. This support effectively alleviates the funding shortages that firms often face in the early stages of development, enabling them to focus more on research and development activities, increase investments in R&D capital and human resources, and thus drive innovation and enhance innovation output.

In empirical studies, R&D investment is often used as a proxy for measuring innovation input, while patent quantity and quality are considered representative variables for innovation output. Research results show that increased R&D investment significantly promotes the enhancement of patent quantity and the optimization of patent quality.

2.4.2 Non-capital value-added services

The value-added benefits that VC brings to innovative companies far exceed its financial support. It not only provides critical support to the company's cash flow but also offers valuable resources in operations management and strategic development. Through providing comprehensive, beyond-capital value-added services, VC has a profound impact on the invested companies. Research by Stevenson et al. (1987) indicates that assisting companies in formulating sound development strategies and making key decisions is the core way VC firms enhance the value of the companies they invest in.

In the collaboration with entrepreneurs, VC firms play three critical roles: First, as strategic leaders, they help create long-term development plans for the company; second, as operational facilitators, they assist companies in market positioning, building management teams, introducing professional service providers, and securing key customer resources; and third, as close partners, they provide emotional support and intellectual inspiration to entrepreneurs, acting as friends, mentors, and advisors (Manigart & Wright, 2013).

From the perspective of corporate innovation strategy, VC firms play a unique role in enhancing the innovation capabilities of invested companies. They not only alleviate financial pressures through capital support but also drive companies to build strong and sustainable R&D foundations, thereby enhancing their ability to absorb external knowledge and significantly improving innovation levels. In comparison, although public financial funds can ease financial pressure and create space for corporate innovation activities, they lack direct strategic guidance and cannot effectively promote the accumulation and enhancement of a company's internal absorption capabilities. As a result, their potential to stimulate long-term innovation in enterprises is relatively limited. Furthermore, VC firms also strengthen innovation effects by promoting the formation of new R&D alliances among their portfolio companies. Especially when competitors are in the same industry or when there are connections between portfolio companies and other firms, VC firms can drive the formation of R&D alliances (Lindsey, 2008). This alliance strategy helps companies share R&D resources and technological expertise, reduce the uncertainty and risks of technological development, and accelerate technological innovation and breakthroughs.

In high-technology risk environments, venture-backed companies tend to achieve technological sharing through R&D alliances to accelerate the innovation process. In high-market-risk environments, these companies are more likely to engage in commercial alliances, sharing marketing and distribution channels to jointly address market uncertainties, enhance market penetration, and competitiveness, and ultimately achieve commercialization goals (L. Wang & Wang, 2012a, 2012b). This cooperative strategy not only broadens resource channels but also promotes the rapid integration of technology and markets, laying a solid foundation for the long-term development of the company (Hsu, 2006).

Ates (2018) developed a model that further distinguishes the relative impact of financing channels (i.e., capital support) and non-capital value-added services (such as professional management knowledge) on corporate performance. The model's analysis shows that financing channels mainly affect the profit levels of companies, while non-capital value-added services contribute more significantly to the company's growth rate. The research indicates that non-

capital value-added services, such as professional management knowledge, account for one-third of the total contribution to business development, highlighting the critical role VC plays in providing support beyond capital.

In summary, VC firms not only provide necessary financial support but also offer multidimensional support for innovation and growth through strategic guidance, operational assistance, resource sharing, and management optimization. This all-encompassing support significantly enhances the market competitiveness and sustainable development capabilities of companies, distinguishing VC from other forms of financing.

2.4.3 Monitoring and involvement effects of VCs

VC firms' active supervision and deep involvement play a crucial role in the innovation process and ultimate success of invested companies. This supervisory and participatory behavior stems from potential goal differences and information asymmetry between VC firms and the companies they invest in. By implementing effective supervision and participation mechanisms, these issues of information asymmetry can be significantly reduced, promoting communication and cooperation between the two parties and laying a solid foundation for the company's innovation and development.

Research by Celikyurt et al. (2014) shows that when VC firms actively engage in the governance of invested companies and deepen their involvement in management by appointing board members, the intensity of the company's R&D activities significantly increases, leading to greater innovation output. This positive change further drives improvements in business performance. In regions with relatively low VC density, the positive impact of supervision and involvement by VC firms is even more pronounced, providing more noticeable innovation momentum and performance growth for these companies.

Bernstein et al. (2016) utilized external factors, such as the opening of new airline routes, as an entry point for studying VC involvement, effectively eliminating the influence of selection bias. The study found that the opening of new airline routes reduced the time and costs associated with VC firms fulfilling their regulatory responsibilities, making it easier for them to monitor their portfolio companies. Under these conditions, the overall performance of the invested companies often improved, further confirming the importance of VC supervision and participation in company development.

However, like any other aspect, VC also has its downsides. Excessive supervisory pressure and short-term performance expectations can negatively affect companies, especially their innovation capacity. When VC firms place too much short-term pressure on the performance

of invested companies or intervene excessively in their daily operations, it can undermine the company's innovation drive and long-term development potential. Therefore, VC firms need to find a balance between supervision and support when participating in company management to promote sustainable and healthy development.

While most research highlights the positive role of VC, its potential costs should not be overlooked. Atanasov et al. (2006) show that VC firms, in some cases, may use their control over a company to harm the interests of entrepreneurs and other common shareholders. To maximize the positive impact of VC while minimizing potential harm, VC firms and policymakers need to adopt a series of strategies to balance the benefits and risks.

VC firms should optimize investment approaches, such as through phased investments and setting reasonable performance targets, to maintain effective supervision without over-intervening in the company's innovation process. Contract arrangements should clearly define the rights and obligations of both parties, ensuring that VC firms respect and protect the legal rights of entrepreneurs and other shareholders when exercising control. Policymakers should introduce relevant policies to guide the healthy development of the VC industry, such as establishing behavioral norms, strengthening industry regulation, and offering tax incentives to encourage long-term investment.

By implementing these measures, the positive impact of VC on corporate innovation can be strengthened while minimizing its potential negative effects, ultimately creating a more fair, efficient, and innovation-friendly VC ecosystem.

2.4.4 The spillover effects of VC

VC not only brings external benefits to the invested companies themselves but also plays an important role in economic development, employment, industrial structure, and technological innovation. Its significance lies not only in creating capital returns for investors but also in driving the development of emerging enterprises, creating job opportunities, and generating wealth, thereby contributing to the overall economy.

Research by Engel and Keilbach (2007) found that companies receiving VC support have higher employment growth rates and sales growth rates. Arqué-Castells (2012) pointed out that the most important impact of VC on the economy is providing funding support for technological innovation, encouraging startups to innovate and create value. VC plays a key role in the early stages of company development. For example, companies like Microsoft received VC support during their startup phase, and high-tech enterprises such as Apple, Google, and Facebook also relied on VC to boost their growth. These companies have played an indispensable role in

shaping modern economic models.

Dessi and Yin (2015) conducted a study of the knowledge spillover effects of VC and found that VC-funded projects achieve knowledge transfer in two ways: before the project begins, venture capitalists transfer useful knowledge from other companies to entrepreneurs, and this internal knowledge transfer helps entrepreneurs create valuable innovations. After the entrepreneur successfully implements innovation, venture capitalists then spread this innovative knowledge to other companies, promoting broader knowledge spillovers and sharing.

In summary, VC's influence extends beyond the invested enterprises to stimulate economic growth, job creation, and knowledge sharing, ultimately contributing to the development of the broader economy and technological advancements.

2.5 The impact of VC heterogeneity on corporate innovation

Not all VC firms provide both financial support and professional knowledge services simultaneously. In some cases, the non-financial services offered by VC can be more valuable than the financial backing itself. Moreover, different VC firms exhibit varying potential and differences in the value they add to companies (Hsu, 2004). Existing research has explored the impact of the diversity of VC on corporate innovation ability from multiple dimensions, revealing the complex and multifaceted roles that VC plays in supporting corporate innovation.

2.5.1 The establishment age of VC firms

Generally, new VC firms have limited capabilities in providing post-investment value-added services. This is mainly due to two reasons: first, their own operational expertise is not yet mature, and their social networks have not been fully established; second, they typically tend to adopt a "short-cycle, low-risk, quick-return" investment strategy, with the aim of profiting as quickly as possible. Therefore, for value-added services such as professional business knowledge, new VC firms often lack the willingness to provide them, or due to limitations in capabilities and resources, they find it difficult to do so. In contrast to emerging or newly established VC firms, senior firms with rich industry experience are able to effectively deploy specialized teams to carry out post-investment capital value-added services, leveraging their broad social networks, deep operational expertise, mature management experience, and efficient internal organizational structures.

2.5.2 Types of VC firms

In the field of VC, there are three main forms: Independent Venture Capital (IVC), Corporate Venture Capital (CVC), and Government Venture Capital (GVC). The uniqueness of CVC lies in its innovative integration mechanism, which combines the traditional R&D framework of companies with the selection process for innovative projects that VC institutions seek. CVC not only provides necessary capital injections to invested companies, but it also achieves synergies in industrial technologies. At the same time, with its professional capabilities, it conducts in-depth analyses of market development trends and policy directions. Compared to IVC, CVC focuses more on achieving strategic goals rather than purely pursuing financial returns. Additionally, CVC, with its deep industry knowledge, also tends to have a higher degree of alignment with the invested companies in terms of technology (Chemmanur et al., 2014). Furthermore, CVC demonstrates significant advantages in capital raising and timeline planning, helping invested companies achieve outstanding long-term innovation results, increasing the likelihood of successful exits, and obtaining higher market valuations. CVC's investment focus typically concentrates on earlier stages of companies, such as providing critical support to companies in the seed and startup stages.

At the same time, an increasing number of countries and local governments around the world are actively setting up government-guided funds and GVCs to address the capital shortages faced by startups in the early stages of financing. Compared to other types of venture capital institutions, GVC places more emphasis on serving the strategic development goals of national and local governments. Its investment focus is typically concentrated in high-tech fields, such as information technology, semiconductors, biopharmaceuticals, and high-end equipment manufacturing. The investment goals of GVC are not purely profit-driven; instead, they emphasize the guiding role, aiming to expand investment impact through the leverage effect of government funds. However, this non-profit-driven investment strategy is also accompanied by longer investment cycles and higher uncertainty and risks. Additionally, some studies have shown that GVCs may produce "crowding-out effects" due to their investment methods, potentially threatening the balance of other venture capital activities in the market (Colombo et al., 2016).

2.5.3 Reputation-driven and profit-driven venture capital

Piacentino (2019) found that venture capitalists' motivation to pursue reputation in the primary market can have a positive effect. Reputation in the VC field is seen as a certification

mechanism that effectively reduces the risks of information asymmetry during the investment process. When VC institutions collaborate with investors who have a strong reputation, the market recognition and trust of the company usually increase, which paves the way for the company's future development, especially in the processes of going public and securing additional financing. However, some studies have also pointed out that the reputation of VC can have adverse effects on startups. Some entrepreneurs, in order to gain the support of high-reputation VC firms, might be willing to sacrifice the initial valuation of their company in exchange for the opportunity to collaborate with a highly reputable VC firm to secure funding support (Hsu, 2004).

Meanwhile, due to the time pressures faced by VC institutions, some firms may use their reputation as a compensatory measure, resulting in limited actual value-added services being provided to the invested companies (Kanniainen & Keuschnigg, 2003).

2.5.4 Coordination between VC institutions and invested companies

VC firms often focus on specific industry sectors or technological innovations. This specialization allows them to accumulate rich experience and resources in these areas, providing more precise support to innovative companies. Research by Aghion et al. (2019) shows that, in the U.S. economy, further enhancing the degree of coordination matching based on existing levels can significantly boost economic growth. Conversely, using a random matching model could hinder economic growth.

Additionally, a study by De Clercq and Sapienza (2006) found that the frequency of interactions between venture capitalists and entrepreneurs in social settings is positively correlated with VC performance. When venture capitalists and entrepreneurs possess knowledge that enhances each other's professional abilities and skills, their cooperation is more likely to achieve optimal outcomes. The specialization of VC further helps investors obtain information specific to a given field, allowing them to make more efficient investment decisions and providing stronger support for the company's innovation and development.

2.5.5 VC firms' tolerance for failure

Innovation activities are typically characterized by long cycles, high uncertainty, and a greater risk of failure. To stimulate and nurture a company's innovation capabilities, it is essential to face failure head-on. Innovation incentive policies provide a different approach from traditional incentive methods like performance evaluations, adopting a more tolerant attitude toward early-

stage failures and even offering greater rewards for them (Manso, 2011). Since the concept of failure tolerance was introduced, numerous scholars have approached its quantification and evaluation from various dimensions, including compensation contracts, top management, corporate strategic planning, and VC. These studies offer new theoretical tools and perspectives to explore how VC can better assist technological innovation by tolerating innovation risks.

Tian and Wang (2014) empirically tested the role of venture capitalists' failure tolerance in promoting technological innovation within companies. They calculated the weighted average of the duration of investments in failed projects as a measure of venture capitalists' tolerance for failure. The study found that companies supported by venture capitalists with high failure tolerance exhibited more significant innovation outcomes. In contrast, new VC firms are often constrained by factors such as funding limitations and career development, leading to lower failure tolerance and, consequently, weaker innovation incentives for the invested companies.

Additionally, when comparing IVC with CVC, a study by Chemmanur et al. (2014) found that CVC demonstrated a higher tolerance for failure. This characteristic of the mechanism encouraged startups funded by CVC to achieve outstanding innovation results at different stages of development, with their innovation levels significantly surpassing those of similar companies supported by IVC. These results further indicate that failure tolerance, as a key feature of VC, not only affects the quantity and quality of a company's innovation output but also plays a critical role in the long-term success of high-risk projects.

2.6 Impact of VC investment strategies on corporate innovation

The innovation outcomes of companies invested in by VC are also influenced by the VC strategies employed, such as staged investments, investment methods, and the length of the post-investment holding period. These factors can affect the level of support provided to the invested companies, the timing of resource allocation, and the overall approach to risk management, all of which contribute to the effectiveness of the innovation process.

2.6.1 Staged investment

In the field of VC, as market environments evolve and competition intensifies, optimizing resource allocation and effectively reducing monitoring costs have become significant challenges for investors. To optimize resource allocation and lower supervision costs, the staged investment strategy has become an important tool in VC (Tian, 2011). Greenwood et al. (2022) pointed out that the dynamic contractual relationship built between entrepreneurial companies

and investors is a core element for their sustained development. Within this cooperation framework, investors first inject startup capital into early-stage projects, then provide multiple rounds of financing support. At each stage of financing, VC institutions conduct thorough reviews and evaluations of the company's operations, market prospects, and financial status. Only projects that meet the investor's standards can receive subsequent funding, effectively avoiding the risks of over-investment or capital loss.

Additionally, staged investment allows for continuous assessment and adjustments, enabling investors to intervene in or optimize the company's development direction at each stage. This flexibility not only improves resource allocation efficiency but also ensures that funds are directed to the most suitable areas. Furthermore, the staged investment mechanism aids in the optimization of corporate strategy and the continuous enhancement of execution capabilities. With each round of financing, companies not only gain financial support but also benefit from the resources, market experience, and strategic guidance provided by investors. These factors positively impact the company's strategy formulation and execution. The project evaluation and feedback after each financing round provide clear direction, helping the company continuously adjust and optimize its strategy in practice and improve its execution ability.

2.6.2 Independent investment v.s. syndicated investment

In the modern VC field, syndicated investment has become an important investment strategy, providing innovative companies with more resources and support. Through syndicated investment, different investment institutions can combine their respective strengths to inject diversified expertise, management experience, and market resources into a company, helping it gain a competitive advantage in a complex market environment. The greater the number of syndicated investors, the more significant the innovation capabilities of the invested companies (Tian, 2012). However, syndicated investment is not without its challenges. Research by Gompers et al. (2016) suggests that if there are differences among syndicate members unrelated to their capabilities, it could negatively affect the investment's outcomes. For example, substantial differences in investment strategies, risk preferences, and decision-making processes between institutions could cause issues. If not properly managed, these disagreements could lead to poor investment performance. In particular, excessive collaboration or lack of coordination during the decision-making process could delay the investment process and even lead to resource wastage and reduced efficiency.

Compared to syndicated investment, Independent investment avoids coordination issues

between multiple institutions but has relatively limited resources and professional support. A single investor's investment may lack diversified industry perspectives and a broad market network, which could limit the growth potential and innovation capabilities of the invested company. Additionally, companies backed by single investors often face more isolation risks, and if the VC firm fails to provide timely and effective strategic support, the company may fall into difficulty.

2.6.3 Duration of equity holding

Research by Puri and Zarutskie (2012) found that, compared to similar companies that did not receive VC funding, companies that obtained VC demonstrated a lower risk of bankruptcy within the first five years following initial financing. During this critical stage, VC firms maintained a tolerance for the invested companies. The comparison data showed that the operational stability of venture-backed companies was significantly better than that of non-venture-backed companies. However, after the company's lifespan exceeded five years, bankruptcy rates reversed, with venture-backed companies having a higher probability of bankruptcy compared to non-venture-backed companies. This suggests that while VC firms are willing to provide time and patience during the early growth stages of a company, this time window is limited. Once it surpasses this period, venture capitalists often quickly exit their investments.

Additionally, as the collaboration period between VC firms and companies lengthens, the operational management experience provided by the venture capitalists tends to significantly enhance the company's innovation effectiveness (Ates, 2018). Of course, the impact of VC on corporate innovation may also be constrained by macroeconomic conditions and regional institutional differences. For example, in areas with strong economic growth, investment institutions may be more inclined to promote technology-driven innovation, while in economic downturns, more investments may focus on cost control and efficiency improvements. Furthermore, the institutional environment in different countries and regions, such as policy support, laws and regulations, and the degree of market openness, can directly affect the effectiveness of VC.

2.7 Critical summary of existing literature

Overall, no conclusive conclusions have been reached regarding the different relationships between VC and corporate technological innovation. After reviewing the existing literature,

this study identifies the following gaps:

(1) Lack of unified standard in evaluating innovation: In assessing the technological innovation capabilities of SMEs, the indicator systems used often lack a unified standard. Scholars have different evaluation methods, such as using the number of patents or registered trademarks to measure technological innovation, while others use company performance as a reference. The diversity of measurement methods directly leads to significant differences in the evaluation of innovation potential, which in turn affects the reliability of the research conclusions.

(2) Limited focus on VC firm characteristics and mechanisms: Most existing studies focus on the impact of VC on corporate technological innovation or performance, yet few have thoroughly analyzed the specific mechanisms through which factors such as the background characteristics of VC firms, fund size, management effectiveness, and the unique attributes of the invested companies influence technological innovation.

(3) Lack of unified research conclusion and case studies: Despite many scholars employing empirical research methods and quantitative statistical data to analyze the relationship between VC and corporate technological innovation, a unified research conclusion has not yet emerged.

(4) Focus on foreign data and lack of Chinese context: The significant achievements of some high-tech U.S. companies under the support of VC have led to global imitation and learning, prompting academic discussions on the relationship between innovation, performance, and VC. However, most existing research is based on overseas data, with less focus on the specific situation in China and the particularities of Chinese SMEs in technological innovation.

Given the above points, future research could delve deeper into the following areas:

(1) Clarification of innovation measurement indicators: The uncertainty in the indicators used to measure corporate technological innovation suggests that there is no consensus on the criteria for assessing innovation capabilities. Future research should focus on identifying more definitive and widely recognized indicators for measuring corporate technological innovation, thus creating a more accurate understanding of the relationship between VC and technological innovation.

(2) The mechanisms of VC's impact on innovation: The impact of VC on technological innovation can be studied from various theoretical perspectives, such as resource-based theory, signaling theory, and agency theory. Additionally, it is essential to explore the factors that influence VC, including its heterogeneity and investment methods. Future research should consider these factors comprehensively and explore how they influence the innovation mechanisms within companies. For instance, research could examine how different types of

VC impact technological innovation and how the investment strategies of VC firms shape a company's innovation capabilities.

(3) Focus on determinants of VC: While existing studies often focus on the impact of VC institutions' involvement in corporate technological innovation, the critical factors that determine VC itself have received insufficient attention. On a macro level, the VC industry's scale, policy environment, and industry development trends are closely linked to technological innovation. On a micro level, further research into the governance capabilities, investment size, and influence of VC firms will help provide a more comprehensive understanding of their role in the innovation process. This would allow for a deeper exploration of the inherent connection between VC and technological innovation.

(4) Consideration of Chinese context and characteristics: Much of the existing literature is based on foreign data and overlooks the specific conditions in China and the unique characteristics of Chinese technological innovation companies. Future research should focus more on the practical situations of Chinese enterprises and explore how Chinese companies leverage VC to enhance their technological innovation. For example, studies could examine the investment preferences and strategies of Chinese VC institutions and how these impact Chinese innovation companies.

In conclusion, future research could explore the following areas: constructing definitive indicators for measuring corporate technological innovation, investigating the deeper driving factors of VC, and conducting in-depth analyses based on the unique characteristics of Chinese enterprises. Such research will help provide a more comprehensive understanding of the inherent relationship between VC and corporate technological innovation, offering more targeted decision-making guidance for companies and policymaker.

2.8 Theoretical framework and hypotheses development

As discussed in Section 2.3, existing literature presents divergent and often contradictory conclusions regarding the relationship between venture capital and innovation activities. Some studies highlight the positive impact of venture capital on innovation, while others report limited or even negative effects. In response to these inconsistencies, the present study proposes the following baseline hypothesis:

- H1: VC has a positive effect on both the innovation input and innovation output of SMEs.

2.8.1 Moderation effect

2.8.1.1 Resource spillover effect

In the innovation process of enterprises, the external spillover effect of R&D resources plays a crucial role (F. Hu et al., 2021). This effect refers to the fact that enterprises benefit not only from their own R&D activities but also from the indirect benefits derived from the R&D achievements of other enterprises. Particularly in highly competitive industries, the R&D activities of various enterprises often generate a demonstration effect and competitive effect, driving the overall technological advancement of the industry. For SMEs, fully utilizing the R&D resource spillover effect within the industry can effectively enhance their innovation capabilities and market competitiveness (Davcik et al., 2021; Sher & Yang, 2005).

However, despite the valuable resource support and strategic collaboration that VC offers to SMEs, its enabling effect may not be as significant as expected in industries characterized by a high degree of R&D resource spillovers. According to Resource Dependence Theory, the scarcity and substitutability of external resources directly influence an organization's level of dependence on resource providers (Celtekligil, 2020; Ozturk, 2021). When an industry exhibits widespread R&D spillovers—meaning that firms can access others' technological outcomes, experiential knowledge, or innovation pathways at relatively low cost—their reliance on specific external actors such as VC firms tends to diminish. In such contexts, the knowledge networks, technical channels, or industry-specific resources provided by venture capital become less scarce and therefore less strategically valuable, weakening the associated resource advantages and spillover effects.

Moreover, in industries with intense knowledge diffusion mechanisms, SMEs often opt for "imitative follow-up" strategies rather than original innovation (Cowan, 2005). This reduces their need for high-risk, high-return innovation investments—one of VC's primary value propositions. Some firms may also leverage public innovation resources or industry platforms to acquire technological know-how, further diminishing their dependence on the differentiated resources offered by VC (Braunerhjelm et al., 2010; Dasgupta, 2012). This type of "free-riding" innovation behavior undermines the marginal incentive effect of venture capital.

Accordingly, it can be inferred that in industries with a high degree of R&D resource spillovers, the innovation-promoting effect of venture capital is significantly constrained. The positive impact of VC tends to exhibit diminishing marginal returns as the external availability of innovation resources increases. In other words, the greater the level of spillovers in the industry, the more diluted VC's resource advantage becomes, and the weaker its capacity to

drive enterprise innovation.

Based on the above theoretical reasoning and the empirical evidence presented in Section 2.3, this study proposes the following hypothesis:

- H2: In industries with extensive R&D resource spillovers, the positive effect of venture capital on firm innovation will be weakened.

2.8.1.2 Supervisory governance effect

In the process of development, enterprises often face various uncertainties, including fluctuations in market demand, changes in the macroeconomy, intensified industry competition, and the risks associated with technological innovation. These uncertainties increase the difficulty of management and decision-making, which can lead to failure in innovation and market operations. SMEs, in particular, face greater uncertainty due to imperfect internal organization, lack of investment management experience, and limited social networks.

VC institutions play a crucial role in reducing these uncertainties. According to the supervisory governance theory, VC institutions alleviate the principal-agent problem between internal controllers and external investors by supervising the management of the invested enterprises and improving corporate governance structures. Furthermore, their supervisory role ensures that management effectively implements innovation strategies, thereby enhancing the level of innovation investment in the enterprise (Corsi & Prencipe, 2019). Specifically, VC's governance role on SMEs is reflected in the following areas:

(1) Long-term cooperation and information symmetry: According to the supervisory governance theory, VC, as a form of long-term equity investment, is unique in establishing a lasting partnership with the invested company. In this process, VC not only provides financial support but also tracks and supervises the company's development, obtaining detailed information about its operations. This long-term monitoring and the establishment of information symmetry help VC strictly monitor the use of funds, preventing misuse and ensuring that the company's strategic decisions and operations are more effective (Zider, 1998). This mechanism significantly alleviates the principal-agent problem caused by information asymmetry, as highlighted in supervisory governance theory.

(2) Unified goals and shared equity: Unlike ordinary equity distribution, supervisory governance theory emphasizes the shared equity characteristic between venture capitalists and entrepreneurs. Venture capitalists are not only providers of funds but also actively participate in the company's equity distribution, co-owning the company with the entrepreneur, thus creating an alignment of interests. This structure ensures that the venture capitalist and the

entrepreneur share common goals, overcoming the weakening of management control that comes from the dispersion of ownership (Atanasov et al., 2006; Smolarski & Kut, 2011). It fosters the healthy development of the enterprise. Additionally, VC institutions bring expertise in investment and rich management experience, helping the enterprise develop clear development directions in its early stages.

(3) Implementation of constraint and incentive mechanisms: Supervisory governance theory emphasizes that VC promotes the healthy development of invested enterprises through flexible constraint and incentive mechanisms. These mechanisms include staged investments, threats of investment suspension, incentives for additional investments, and joint investments, among other financial contract designs. Through these mechanisms, VC can dynamically adjust the depth and breadth of its management participation at different stages of the enterprise's development (Robinson, 1987). When the enterprise operates well, venture capitalists usually intervene less in daily management, providing only strategic support. However, when the enterprise faces a crisis, venture capitalists increase their intervention, actively participating in daily management to help the company overcome difficulties.

Building on the theoretical foundation and empirical evidence presented in Section 2.3, this study proposes the following hypothesis:

- H3: When firms operate in industries characterized by high environmental uncertainty, the supervisory governance effect of venture capital has a stronger positive impact on SME innovation.

2.8.1.3 Management involvement effect

Market competition is one of the core challenges for enterprises' survival and development. Especially in highly competitive industries, companies must continuously innovate to maintain their competitive advantage. While mature enterprises typically have rich technological accumulation and market experience, allowing them to better cope with market competition, SMEs often find themselves in a disadvantaged position due to weak technological foundations and limited social capital. To secure a place in a fiercely competitive market, SMEs must rely on innovation to achieve sustainable competitive advantages (Kato, 2021; Smolarski & Kut, 2011).

According to the value-added service theory, VC institutions provide more than just financial support; they also participate in management and offer value-added services to nurture the development of SMEs, promoting their rapid growth (Granz et al., 2021). Specifically, the mechanisms through which VC supports SMEs can be observed in the following aspects:

(1) VC collaborates with enterprises: According to the value-added service theory, the interests of VC institutions are closely linked to the success of SMEs. As venture capitalists hold equity in the companies they invest in for the long term and cannot easily liquidate their investment, they cannot simply exit when difficulties arise. Therefore, venture capitalists, in supporting the development of the enterprise, focus on using value-added services to enhance the company's competitiveness and ensure that it achieves long-term growth. This interest-alignment mechanism forces venture capitalists to be more than just providers of funds; they become active drivers of enterprise growth (Brander et al., 2002; Davcik et al., 2021).

(2) Dual support: Intellectual and Financial: The value-added service theory emphasizes that VC provides not just financial capital but also intellectual support (Brander et al., 2002). Venture capitalists are often experts with rich industry experience, management knowledge, and market insights. They offer SMEs not only capital but also management experience, consulting advice, and industry information. By combining "intellectual" and "financial" support, venture capitalists help SMEs optimize critical areas such as strategic planning, product development, and marketing, significantly improving business efficiency and management standards (Branzei & Vertinsky, 2006; Madill et al., 2005). This intellectual support is particularly crucial for early-stage entrepreneurial companies, as it effectively compensates for their lack of management and operational experience.

(3) Introduction of market resources: In addition to providing capital and management advice, venture capitalists help SMEs access valuable market resources, such as suppliers, customers, and other market stakeholders, through their extensive market networks. Venture capitalists, with their reputation in the capital markets, can attract high-quality partners, such as institutional investors, brokers, and analysts, to help SMEs expand their market influence and enhance their market position (Ferrary, 2010).

Based on the above theoretical analysis and the empirical studies reviewed in Section 2.3, this study proposes the following hypothesis:

- H4: In industries with more intense market competition, the managerial involvement effect of venture capital has a stronger positive impact on SME innovation.

2.8.1.4 Financing effect

External financing constraints refer to the difficulties and limitations that enterprises face when accessing external funds, such as bank loans or equity financing (Kurt et al., 2024). This issue is particularly prominent among SMEs and can severely limit their investment and development capabilities in R&D and innovation. According to signaling theory, in a market with

information asymmetry, the party with the information advantage communicates this information to the party with the information disadvantage through a signaling mechanism. SMEs, due to their small scale, opaque financial information, lack of sufficient collateral, and unstable cash flow, often encounter financing difficulties resulting from information asymmetry when seeking external capital. These external financing constraints limit the liquidity of funds, which in turn affects their R&D and innovation capabilities. Specifically, the mechanisms through which VC affects the financing of SMEs can be seen in the following aspects:

(1) Financial support and innovation assurance: Product R&D requires financial support, and VC involvement provides SMEs with the necessary funding and other potential resources. It also helps companies gain more policy support and resource integration opportunities, thereby alleviating potential funding and resource bottlenecks in the innovation process (Davila et al., 2003). This is particularly critical for SMEs in sectors like biotechnology, pharmaceuticals, and artificial intelligence, where traditional financing channels often cannot meet their funding needs due to the high costs of R&D and technological risks. VC's financial support ensures continuous R&D, preventing the interruption of innovation projects due to cash flow problems, thus enhancing the company's overall innovation capacity and market competitiveness.

(2) Signaling and establishing market trust: VC institutions, as professional investors, send a high-quality signal to the market simply by investing in a company. Through VC's equity involvement, enterprises can showcase their potential in technology, management, and market prospects, thus alleviating the concerns of external investors who may be skeptical due to information asymmetry (Chemmanur et al., 2011). This signaling effect not only increases the company's market recognition but also attracts more institutional investors and financial support. Through collaboration with VC, SMEs can establish a strong financing track record and market reputation, which is crucial for future fundraising.

(3) Optimizing financing structure and enhancing sustainable financing capacity: VC not only alleviates short-term financing constraints through capital injection but also helps optimize the company's financing structure, laying a solid foundation for its long-term development. VC institutions typically assist companies in establishing a reasonable capital structure, enabling them to respond more flexibly to changes in funding needs during their growth (Davila et al., 2003; Häussler et al., 2012).

Drawing on the preceding theoretical analysis and the empirical evidence discussed in Section 2.3, this study proposes the following hypothesis:

- H5: In industries with a high degree of capital dependence, the financing support effect of

venture capital significantly enhances SME innovation capability.

2.8.3 Factors affecting the impact of VC on SMEs' innovation

2.8.3.1 Heterogeneity of VC

The heterogeneity of VC manifests in various dimensions, including institutional type, reputation, and profit orientation (Zacharakis et al., 2007). These heterogeneous factors influence VC's approach to resource allocation, level of management involvement, and risk preferences, ultimately affecting SMEs' innovation investment, output, and efficiency.

(1) VC ratio

The equity share held by venture capitalists often reflects their assessment of a firm's future growth potential. As a long-term form of equity investment, venture capital primarily targets early-stage firms with high growth prospects, despite the inherent risks associated with such investments. The ultimate objective of venture capitalists is to generate value appreciation and substantial returns, and technological innovation is widely regarded as the most effective pathway to achieving this goal. As a result, venture capital firms actively encourage and finance R&D activities, especially among technology-based entrepreneurs (Félix et al., 2013).

Technological innovation projects typically require significant financial investment, yet early-stage tech firms often face severe financing constraints due to limited collateral and short credit histories. Traditional banks, seeking to minimize risk exposure, are reluctant to lend to such firms—partly because high-risk lending entails greater monitoring costs and the potential for financial losses. Moreover, regulatory interest rate ceilings prevent banks from offsetting high risks through elevated returns. In contrast, venture capitalists can mitigate these risks by holding equity stakes, participating in business decisions, and conducting staged, multi-round investments, thereby providing both financial support and strategic supervision throughout the firm's development (Gompers, 2022).

Furthermore, high-tech firms in their early stages often suffer from limited managerial experience, which can constrain the efficiency of innovation activities. Venture capital institutions, equipped with extensive management expertise, broad professional networks, and technical resources, can offer value-added services such as management consulting, business development support, and technical guidance. This resource integration not only enhances the overall capabilities of the investee firm but also significantly improves the likelihood of innovation success. Additionally, VC networks facilitate inter-firm knowledge exchange and talent mobility, creating synergies and clustering effects that further accelerate technological

innovation (Ates, 2018; Kortum & Lerner, 2000).

In summary, venture capital plays an instrumental role in alleviating financing constraints, enhancing governance, and integrating strategic resources for tech-oriented SMEs. This model not only advances firm-level innovation but also contributes to the broader development of high-tech industries. Accordingly, this study proposes the following hypothesis:

- H6: A higher VC ratio is associated with better innovation capability in SMEs.

(2) Types of VC institutions

Based on different motivations, VC in the market can be divided into two types: one is "incubation-type VC", which seeks to exit quickly after the company goes public to achieve profits, and the other is "strategic-type VC", which chooses to hold onto its shares long-term after the company goes public to continuously create value (Hackett & Dilts, 2004; Peters et al., 2004).

Firstly, incubation-type VC primarily focuses on short-term gains, with the goal of nurturing technology companies and aiming to promote rapid growth and early listing. These investors often seek to quickly liquidate their shares once the lock-up period expires after the company goes public, realizing short-term returns. With the support of incubation-type investments, SMEs are able to secure sufficient funding in the early stages to drive technological R&D and market expansion. However, since incubation-type investors prioritize quick returns, they may lack long-term management support after the company's listing, potentially limiting the sustainability of the company's innovation. In this case, the company may focus more on short-term innovation results and neglect more in-depth and long-term technological accumulation and innovation planning (Chandra et al., 2003).

Secondly, strategic-type VC places greater emphasis on the long-term development of the company. These investors typically choose to continue holding shares after the company goes public, focusing on the company's ongoing innovation and value creation. Strategic investors not only provide financial support but also participate deeply in the company's management and optimize resource allocation to drive long-term innovation and sustainable development. Because they have a more positive outlook on the company's future, strategic investors can help the company establish a long-term technological innovation strategy, enhancing the company's competitiveness in the market. Additionally, the long-term holding behavior of strategic investors sends a signal to the outside world that the company is operating well, enhancing the company's ability to raise funds and further supporting its innovation input and output (Barkoczy & Wilkinson, 2019; Shahzad et al., 2023).

Overall, incubation-type VC can provide momentum for early-stage innovation in SMEs,

but its short-term nature may limit the company's ability to sustain innovation. In contrast, strategic-type VC can promote continuous innovation and technological breakthroughs through long-term resource and management support. Therefore, the different types of VC significantly influence SMEs' innovation in different ways and lead to different outcomes.

Compared to incubative investors, strategic investors are generally more effective in promoting innovation within SMEs. Strategic investors are typically focused on the long-term development of the firms they invest in, whereas incubative investors tend to prioritize short-term profit realization. Incubative investors often aim to exit swiftly—usually after a successful IPO—seeking to achieve capital returns as early as possible. As a result, SMEs under the guidance of incubative investors may focus their innovation efforts on short-term R&D activities and rapid market expansion, while neglecting long-term innovation planning and deep technological accumulation.

In contrast, strategic investors are more concerned with sustainable growth and often retain their equity positions even after a company goes public. Their long-term involvement provides both stable funding and strategic guidance that supports sustained innovation efforts. While incubative investors do offer critical funding during the early stages, their short-term exit strategies may leave firms without ongoing capital and resource integration post-IPO. Strategic investors, on the other hand, contribute not only financial resources but also long-term managerial engagement, optimization of organizational structures, and enhanced resource allocation efficiency. Their commitment enables SMEs to adopt a long-term perspective on innovation strategy, fostering more sustained and impactful technological breakthroughs.

In summary, strategic investors are more capable of driving long-term innovation in SMEs through continued capital support, active managerial involvement, and technical guidance. Therefore, this study proposes the following hypothesis 7:

- H7: Strategic investors are more effective than incubative investors in enhancing the innovation capabilities of SMEs.

(2) Reputation or profit orientation

The investment behavior and management strategies of VC institutions are often significantly influenced by their reputation and profit orientation. Institutions with a strong reputation tend to focus on long-term strategic investments, emphasizing the sustainable development and innovation outcomes of the companies they invest in. In contrast, institutions with a short-term profit focus are more likely to prioritize quick returns and short-term financial performance (Nahata, 2008). These two orientations create distinct differences in investment choices, management models, and exit strategies, which have a profound impact on the

innovation capabilities and growth paths of SMEs.

Reputation-oriented VC institutions typically adopt long-term investment strategies, placing more emphasis on a company's sustainable innovation capability and long-term development. They are willing to invest time and resources to accompany the company through various stages of innovation, helping to build a solid R&D system and innovation culture. This long-term support can effectively mitigate the issues of insufficient funds and resources that companies often face during the innovation process, allowing them to maintain continuous technological leadership and product innovation capabilities in a competitive market environment (Park & LiPuma, 2020).

Profit-oriented VC institutions, on the other hand, are more focused on high returns and rapid exits. They often choose companies with high growth potential that can achieve financial returns in a short period. However, this pressure may encourage companies to adopt aggressive strategies in R&D and market promotion, quickly launching new products or entering new markets to enhance short-term financial performance. While this short-term innovation stimulus can, to some extent, stimulate a company's innovative energy, it may also lead to a focus on short-term gains at the expense of long-term innovation planning and technological accumulation (Mahto et al., 2018).

The impact of the reputation and profit orientation of VC institutions on SMEs' innovation is multifaceted. Reputation-oriented institutions tend to provide long-term support and resource integration, helping companies build solid innovation capabilities and market competitiveness. In contrast, profit-oriented institutions are more focused on short-term returns, which may stimulate rapid innovation in the company but also pose greater operational risks (Atanasov et al., 2012).

High-reputation VC firms play a critical role in supporting enterprises through capital provision, value-added services, and governance oversight. First, reputable VC firms help reduce information asymmetry in the investment process, thereby minimizing misjudgments by other investors in the secondary market. By taking equity positions, these firms signal their confidence in the future growth prospects of the investee companies, thereby conveying to the financial markets that the firm possesses strong development potential. This signaling effect not only enhances the firm's credibility in capital markets but also improves its future fundraising capacity. The deep due diligence and valuation expertise of well-known VC firms further increase the likelihood of sustained access to external financing, strengthening the financial foundation for innovation and growth (Atanasov et al., 2012).

Moreover, high-reputation VCs provide extensive value-added services based on their

industry experience and broad professional networks. These services include follow-on financing, access to market intelligence, and managerial support. Leveraging their social capital, these firms can connect portfolio companies with high-quality clients and suppliers, foster partnerships with specialized institutions, and facilitate knowledge and technology sharing. Such relationships contribute to more diverse and effective value creation, enhancing firms' performance in areas such as R&D, market expansion, and organizational capability development (Nahata, 2008).

In addition, reputable VC firms often engage deeply in firm management to safeguard their reputation and ensure the success of their investments. They apply professional expertise to select high-potential ventures and frequently participate in governance by appointing board members or senior executives. This active monitoring of innovation activities helps ensure alignment with long-term strategic goals, strengthens internal governance structures, and improves management efficiency.

In sum, high-reputation VC firms significantly enhance enterprise value through multi-dimensional support, including financial investment, expert knowledge, industry resources, and strategic involvement. Their status and influence in the industry allow them to deliver holistic support from fundraising to management, thereby improving firms' capacity for sustainable development in competitive environments.

Accordingly, this study proposes the following hypothesis 8:

- H8: Reputation-oriented venture capitals are more effective than profit-oriented investors in enhancing the innovation capabilities of SMEs.

2.8.2.2 VC investment methods

VC investment methods, including syndicated or independent investments, duration, and other approaches, influence the innovation behaviors of SMEs through different resource allocation and risk management strategies (Hopp & Rieder, 2011; Peneder, 2010). These investment methods not only directly affect the company's cash flow and risk exposure but also profoundly impact the company's innovation input, output, and efficiency by altering its strategic direction and innovation environment.

(1) Syndicated investment vs. independent investment

Syndicated and Independent investments are two common investment methods used by VC institutions to support the innovation of SMEs. Syndicated investment refers to multiple VC institutions jointly investing in a project, sharing risks and returns, while independent investment involves a single VC institution providing full funding and assuming the risks and

management responsibilities alone. Both investment methods have their advantages and disadvantages, and they impact SMEs' innovation activities in different ways (Ferrary, 2010).

Syndicated investment typically involves multiple VC institutions, each providing different levels of support based on their strengths and expertise. This model not only disperses risks but also introduces diversified resources and professional support to the enterprise (Lu et al., 2017). On one hand, syndicated investment effectively reduces the risks for individual VC institutions. If a project fails, the losses can be shared among multiple investors, thus lowering the financial pressure on any single institution. This risk diversification makes investors more willing to invest in high-risk, high-potential innovation projects, increasing the chances for SMEs to secure funding (Lerner, 2022). On the other hand, syndicated investment often involves institutions with different backgrounds and expertise, bringing in various types of resources and support. The integration of these diverse resources helps SMEs receive comprehensive support across multiple dimensions such as technological R&D, market expansion, and management improvements, thereby increasing the success rate and market competitiveness of innovation projects (Brander et al., 2002). In syndicated investments, the portfolio may include companies with synergistic potential, creating opportunities for collaboration and resource sharing among them. This cooperation can drive collaborative innovation, especially in areas like technology, markets, or supply chains (Hopp & Rieder, 2011). Moreover, the joint endorsement of multiple investors enhances the company's market credibility and brand image, making it easier to attract external resources and collaboration opportunities (Lu et al., 2017).

However, the involvement of multiple parties in syndicated investment can lead to more complex decision-making processes. If the various investors have disagreements over the company's strategy, innovation direction, or resource allocation, it can result in delayed decisions or wasted resources. This coordination cost may affect the timeliness and flexibility of the company's innovation decisions, especially in fast-changing market environments. Additionally, differences in investment goals, exit strategies, and risk tolerance among the investors may lead to internal conflicts, impacting the company's innovation strategy and long-term development. To coordinate the interests of all parties, the management team may need to invest significant time and effort in communication and mediation, which could affect innovation efficiency.

Independent investment is provided by a single VC institution that offers full funding and support. This method has unique advantages in decision-making speed and management efficiency but also presents certain challenges. The primary advantage of independent investment is the ability of a single institution to make decisions quickly without the need for

complex coordination among multiple parties (Brinkmann & Kanbach, 2023; Maula et al., 2005). When the company needs to rapidly adjust its innovation strategy, R&D direction, or market plan, independent investment can provide faster financial support and resource allocation. This flexibility is particularly crucial for SMEs in rapidly changing and highly competitive industries such as technology and the internet (Gu et al., 2016). However, the limitation of independent investment lies in the relative lack of resource diversity compared to syndicated investment. If the VC institution itself has a limited resource network and industry experience, the company may not receive sufficient support in certain areas, such as international market expansion or cutting-edge technological development, which can affect the breadth and depth of innovation projects.

Moreover, since only one institution bears the full investment risk in independent investment, investors typically have higher expectations for the company's performance and innovation outcomes (Cumming et al., 2017). If the company's innovation projects do not meet expected goals in the short term, the institution may quickly tighten funding or even halt subsequent investments. This financial pressure can lead the company to adopt a more conservative approach in its innovation process, making it less willing to undertake bold technological explorations or market trials.

Based on this, this study proposes the following hypothesis 9:

- H9: Syndicated venture capitals are more effective than independent investors in enhancing the innovation capabilities of SMEs.

(2) Duration

The duration refers to the length of time that a VC institution holds equity in an invested company. The length of this period significantly influences the level of support, strategic guidance, and exit strategies employed by the VC institution, thus affecting the innovation behavior and development path of SMEs (B. Guo et al., 2015). Generally, duration can be categorized as short-term, mid-term, and long-term, each having different effects on a company's innovation direction, risk-taking, and resource allocation (Cumming & MacIntosh, 2001; Momtaz, 2021; Sethuram et al., 2021).

Short-term holding typically refers to the situation where a VC institution intervenes in a company for a short period (usually 1 to 3 years) with the aim of achieving a rapid exit, often through the company's high-speed growth or an initial public offering (IPO). The impact of short-term holding on innovation in SMEs is as follows.

The first impact is short-term innovation pressure. Since investors aim to exit within a short period and achieve high returns, companies are encouraged to focus on achieving visible

innovation results in the short term, such as quickly launching new products or expanding market share (Sethuram et al., 2021). In this case, the company's innovation activities tend to be short-sighted, focusing on projects that can quickly generate market returns and possibly neglecting long-term technological accumulation and deep R&D. VC institutions with short-term duration may impose significant financial performance pressure on the company, requiring significant revenue and profit growth in a short time (Y. Li, 2008). This pressure may lead the company to adopt aggressive strategies or even reduce innovation investment and R&D budgets to quickly improve financial performance, negatively impacting long-term innovation capabilities.

The second impact is the limitations in resource support and strategic decision-making. Due to the shorter holding period, VC institutions typically do not invest much effort in resource integration and strategic guidance (Cumming & Johan, 2010; Momtaz, 2021; Wong, 2024). As a result, companies may struggle to obtain deep strategic guidance, management improvements, and market expansion support, which can be disadvantageous for innovation projects that require long-term investment and resource coordination. In the short term, companies might make decisions that are harmful to long-term development in order to meet the exit targets of investors, such as excessively cutting R&D investments or neglecting talent development. This short-term profit-maximization behavior may have adverse effects on the company's future innovation.

Mid-term holding generally refers to a situation where a VC institution holds equity in a company for 3 to 5 years. This holding period allows for a longer duration of financial and resource support and gives VC institutions sufficient time to accompany companies through critical innovation and growth stages. The impact of mid-term holding on innovation in SMEs includes the following.

The first impact is steady growth and innovation support. SMEs can obtain continuous financial support over a longer period, which helps them conduct in-depth R&D and technological breakthroughs in innovation projects. VC institutions typically work closely with companies to develop detailed innovation plans, including medium- and long-term strategies for technology R&D, product iteration, and market expansion. Such planning helps companies allocate resources effectively, balancing short-term returns with long-term risks and laying a solid foundation for sustainable innovation (Sethuram et al., 2021; Wong, 2024).

The second impact is strategic guidance and resource integration. During mid-term holding, VC institutions usually participate deeply in corporate governance and management optimization, assisting companies in integrating resources and making strategic adjustments in

key innovation areas (Cumming & Johan, 2010). This deeper involvement helps improve management efficiency and optimize resource allocation, enhancing the company's ability to execute innovation strategies. Investors typically leverage their industry resources and networks to introduce technical experts, partners, and market resources, thereby enhancing the company's resource integration capabilities. This multi-dimensional support helps companies achieve synergies in technology development and market promotion, improving the success rate of innovation projects.

Long-term holding typically refers to a situation where a VC institution holds equity in a company for more than 5 years. VC institutions with long-term holdings focus more on the company's long-term value and strategic development, which has a profound impact on the company's innovation activities. The effects of long-term holding are as follows.

The first impact is long-term innovation and technological accumulation. VC institutions with long-term holdings are not only concerned with short-term and mid-term performance but also with the long-term technological accumulation and improvement of the company's core competitiveness (B. Guo et al., 2015; Momtaz, 2021; Wong, 2024). This long-term perspective allows companies to conduct long-term R&D in key technological areas, focusing on achieving disruptive and breakthrough innovations to maintain a competitive edge in the market.

The second impact is innovation culture and talent development. Long-term investors typically help companies establish an innovation culture and support long-term investment in technology R&D and management innovation. They are also more willing to invest in talent development and organizational capacity building, encouraging companies to establish sustainable innovation mechanisms (Cumming & MacIntosh, 2001). These cultural and talent investments help companies significantly enhance their innovation capabilities, ensuring that they maintain continuous innovation in future competition.

The third impact is strategic patience and risk tolerance. Long-term investors usually exhibit higher strategic patience and are willing to support companies in incubating long-term innovation projects and building technological reserves, even if these projects do not generate immediate economic benefits (B. Guo et al., 2015; Sethuram et al., 2021). This strategic patience effectively supports companies in exploring and innovating in high-uncertainty areas, such as frontier technologies and basic research, opening new growth opportunities for the company's future development.

In conclusion, the holding period of a VC institution has a profound impact on the innovation behavior of SMEs. While short-term holdings can drive rapid innovation results, they may lead to short-sighted behavior and long-term development pressures. Mid-term

holdings provide more stable funding and resource integration, supporting continuous innovation and risk balancing. Long-term holdings encourage deep technological R&D and long-term strategic planning, helping to establish core competitiveness and sustainable innovation capabilities.

Through a detailed analysis of VC heterogeneity and investment methods, it is evident that VC plays a multi-dimensional role in driving innovation in SMEs. These factors collectively reveal how VC, through capital attributes, resource allocation, and strategic guidance, helps mitigate innovation uncertainty, optimize resource efficiency, and ultimately drive SMEs to achieve technological iteration and enhanced competitiveness in a dynamic market environment.

Accordingly, this study proposes the following hypothesis 10:

- H10: A longer duration by venture capital investors enhances SME innovation capability.

2.9 Conceptual model

The impact of VC on the innovation of SMEs is primarily reflected in two aspects: innovation input and innovation output. From a mechanism perspective, VC supports enterprises through several mechanisms:

(1) Resource spillover mechanism: Although VC is expected to enhance firms' innovation by providing external resources such as funding, technology, and talent, this effect weakens in industries with high R&D spillover, where firms can access knowledge more freely without relying heavily on VC support.

(2) Supervisory governance mechanism: Through increased oversight of business operations, VC helps reduce internal management issues and inefficiencies.

(3) Management participation Mechanism: VC firms deepen their involvement in company decision-making processes, helping to optimize management workflows and decisions.

(4) Financing effect mechanism: VC alleviates the financing pressures faced by SMEs, enabling smoother progress in innovation activities.

In terms of influencing factors, the heterogeneity of VC, such as the type of institution, reputation, or profit orientation, leads to significant differences in the impact on corporate innovation. Additionally, the investment method (such as syndicated or independent investment) and the length of the holding period also influence the intensity of innovation input and the final innovation output. These mechanisms and factors interplay to determine the overall effect of VC on the innovation activities of SMEs. The conceptual model of this study is shown in Figure

2.1, and all hypotheses are summarized in Table 2.3.

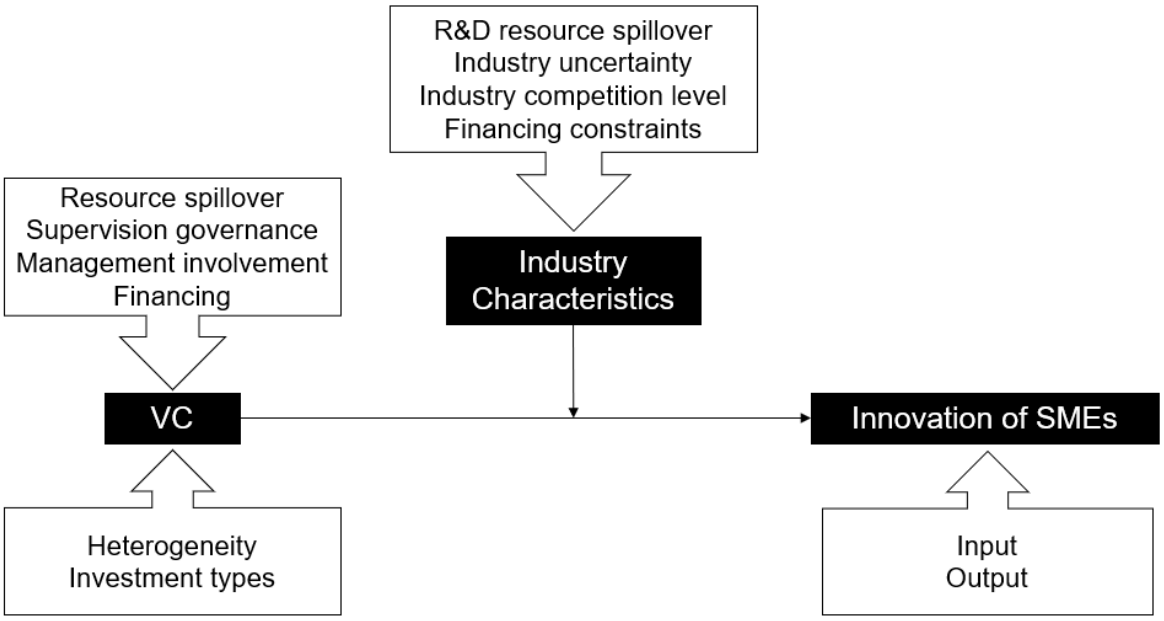


Figure 2.1 Conceptual model of this study

Table 2.3 Hypotheses summary

No.	Hypothesis
H1	VC has a positive effect on both the innovation input and innovation output of SMEs.
H2	In industries with extensive R&D resource spillovers, the positive effect of venture capital on firm innovation will be weakened.
H3	When firms operate in industries characterized by high environmental uncertainty, the supervisory governance effect of venture capital has a stronger positive impact on SME innovation.
H4	In industries with more intense market competition, the managerial involvement effect of venture capital has a stronger positive impact on SME innovation.
H5	In industries with a high degree of capital dependence, the financing support effect of venture capital significantly enhances SME innovation capability.
H6	A higher VC ratio is associated with better innovation capability in SMEs
H7	Strategic investors are more effective than incubative investors in enhancing the innovation capabilities of SMEs.
H8	Reputation-oriented venture capitals are more effective than profit-oriented investors in enhancing the innovation capabilities of SMEs.
H9	Syndicated venture capitals are more effective than independent investors in enhancing the innovation capabilities of SMEs.
H10	A longer duration by venture capital investors enhances SME innovation capability.

The conceptual model systematically elaborates on how VC promotes the innovation capabilities of enterprises through multi-dimensional and multi-level pathways, particularly in terms of innovation input and innovation output, such as R&D investment, patent numbers, starting from two core aspects: mechanisms of action and influencing factors.

Chapter 3: Origin and Evolution of Chinese Venture Capital

3.1 The emergence of VC in China

Since the late 20th century, VC in the United States has become a critical avenue for early-stage financing of innovative enterprises, with its origins dating back to the founding of the American Research and Development Corporation (ARD) in 1946. This groundbreaking initiative not only laid the foundation for modern VC but also fostered innovation within the financial sector. The development of the U.S. VC model has contributed significantly to the growth of the U.S. economy and the advancement of scientific research, leading to the emergence of global industry leaders like Intel and Microsoft, which have long remained at the forefront of their respective sectors while driving progress in scientific research.

In contrast, China's VC industry began much later. It was not until September 1985 that the first state-owned VC fund, Zhongke ChaoShang Equity Investment Co., Ltd., was established, marking the official onset of the Chinese VC sector. However, due to the underdeveloped market mechanisms, lack of practical experience, conservative thinking, and outdated laws and regulations at that time, the early stages of China's VC industry did not yield the expected outcomes, and its contributions to national economic growth and breakthroughs in high-tech sectors were limited (Ates, 2018).

Over the past 40 years, however, China's VC industry has gradually matured. There have been notable improvements in the number of investment institutions, the scale of capital, investment strategies, and the quality of talent. Simultaneously, with the ongoing development of markets such as the SME Board, ChiNext, and the New Third Board, the capital market has introduced more diversified and standardized exit mechanisms for VC. These developments have facilitated the emergence of investors with strong financial foundations and exceptional investment expertise, propelling China's VC industry into a dynamic new phase.

The development of China's VC industry can be broadly divided into four stages (Fan et al., 2001; Hua & Huang, 2021; Y. L. Li & Li, 2010; Sun et al., 2024):

(1) Emerging stage (1985–1997)

During this stage, VC in China began to take shape, although its development was relatively slow. Driven by government support and incentives, the VC industry gradually started and grew

steadily, but progress remained sluggish overall. The main players in VC at this time were primarily government-led financial institutions, with a few foreign early-stage investors making attempts to enter the market. However, although foreign capital brought new opportunities, its scale and influence were limited, and the industry was still in an exploratory phase.

The emergence of domestic VC in China was closely tied to national policy support. For example, the establishment of China New Technology VC Company in 1985 marked the founding of the first VC institution in China, laying a solid foundation for industry development. In 1986, the State Science and Technology Commission issued the "White Paper on Science and Technology," which outlined strategic policies to foster entrepreneurial VC, emphasizing the promotion of new economic forms, particularly the "emerging high-end industry development model." Subsequently, high-tech development zones and various VC funds began to emerge, creating favorable conditions for the development of China's VC industry. At the same time, international VC firms began injecting capital into China, focusing on relatively mature sectors. However, due to underdeveloped capital markets and weak intellectual property protection, foreign capital participation remained at the experimental stage. These limitations, coupled with an immature domestic market mechanism, posed several challenges for the industry.

By the mid-1990s, the overheating of the Chinese economy caused severe speculation in the stock market and soaring prices. In the second half of 1994, the central government intervened to curb informal financial activities, leading to a downturn in the securities market. This deterioration of the financial environment directly impacted the pace of VC development, creating a bottleneck. Despite this, by the end of 1994, more than 20 VC institutions had been established, and by 1996, five additional VC firms were founded. During this time, the government played a dominant role in investments. However, the lack of effective exit mechanisms made it difficult for VC activities to achieve successful capital exits, limiting further industry growth. Thus, although the VC industry completed its initial institutional setup and exploration during this stage, its development remained slow, with limited market scale and influence.

(2) Exploration stage (1998–2008)

During a period of external complexity and uncertainty, China's VC industry entered a stage of fluctuating growth. Influenced by global market changes and domestic regulatory adjustments, the industry began to accelerate, showing a clear upward trajectory.

In the early 21st century, strong support for U.S. tech startups led to major successes in the NASDAQ market, providing Chinese VC firms with opportunities to learn from these

international successes. As a result, VC activity in China saw rapid growth. By 2000, over 100 financial institutions were participating in VC in China, and by the end of that year, the total assets of these institutions reached approximately 8 billion RMB (ZeroIPOResearchCenter, 2008), as shown in Figure 3.1.

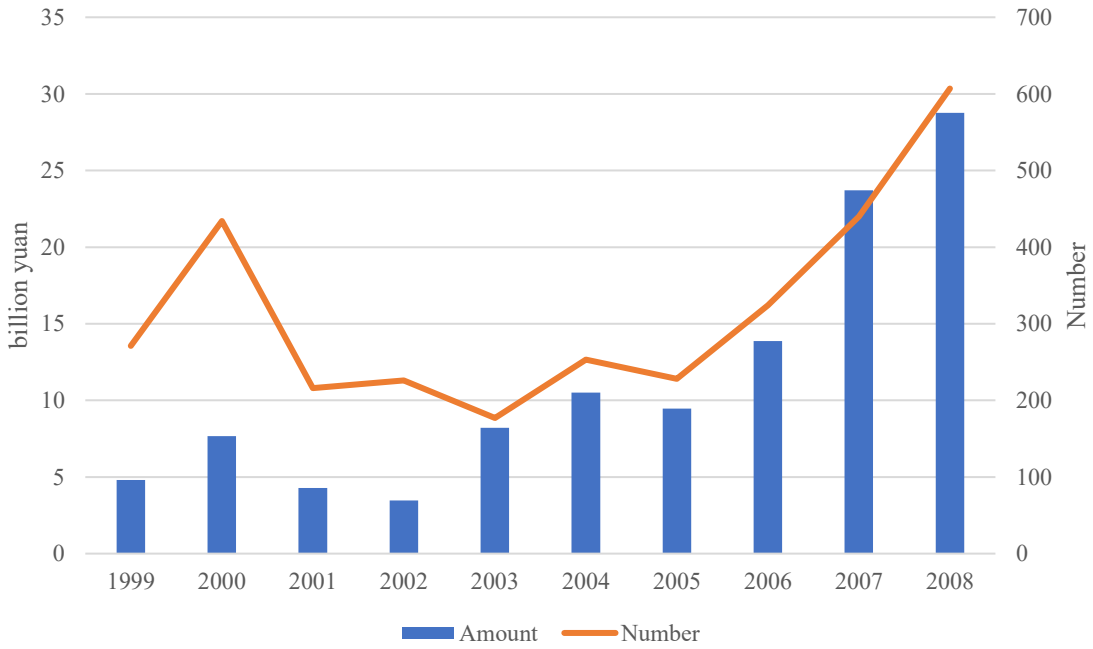


Figure 3.1 Annual VC amount and number of cases (in billion yuan) (1999-2008)

Source: Zero2IPO Research Center (2008)

However, the rapid expansion during this period, however, also sowed the seeds for later volatility, especially after the "dot-com bubble" burst. The large amounts of capital invested earlier were trapped, and many investors found themselves in financial difficulties, making it difficult for VC to exit. As a result, the VC industry entered a "winter" period, characterized by a significant decline in the number of new projects and a continuous shrinking of total investment, leading to an adjustment phase for the industry.

Despite the brief downturn, since 2004, the exit mechanism of the SME Board provided a new exit channel for VC, greatly driving the industry's development. The introduction of the "Interim Measures for the Management of Venture Capital Enterprises" in 2006 marked a significant progress in the construction of VC systems. This policy clarified the exit methods for VC funds and improved China's multi-level capital market system. In the same year, the "Notice on Promoting the Development of Venture Capital Enterprises and Related Taxation" was also issued, providing tax incentives for VC. The formulation and improvement of these regulations laid the institutional foundation for the long-term and stable development of the VC industry (PeDaily, 2024).

The Chinese VC industry rapidly developed under the strong promotion of the government

and the gradual improvement of the domestic economic environment. Especially after 2007, domestic stock market activities became increasingly active, providing high-quality investment targets for VC (L. Y. Zhang et al., 2007). Additionally, during this period, the market was mainly dominated by U.S. dollar capital, with foreign VC institutions showing strong strength in the Chinese market, driving the further opening and internationalization of the industry.

In summary, the exploration stage was a key transition period for China's VC industry, moving from its early stages to a more established form. Despite facing global economic fluctuations and internal developmental imbalances, China's policy support and improving market environment during this period led to significant breakthroughs, laying a solid foundation for subsequent rapid development.

(3) Growth stage (2009–2014)

However, the financial crisis severely impacted global stock market valuations, and China's stock market saw a sharp decline in its market value. Additionally, U.S. dollar funds in the domestic equity investment market faced difficulties, once again presenting significant challenges to the VC industry. In response to these challenges, the central government implemented a series of policy measures to maintain the smooth operation of equity financing, effectively promoting the healthy development of the VC industry. Following the 2008 global financial crisis, China's VC industry gradually recovered and experienced steady growth.

The promulgation of the new "Fund Law" in December 2012 marked an important milestone in the development of the industry. This law was the first to include the concept of "private placement funds" within the legal framework, laying the foundation for the legalization of private equity investment funds and bringing a significant turning point to the industry. It provided clear regulatory guidelines and enhanced investors' trust in the VC sector. Subsequently, on January 16, 2013, the New Third Board (National Equities Exchange and Quotations) was officially launched, signaling that China had begun to form a multi-level capital market system, including the main board, SME board, ChiNext, New Third Board, and regional equity markets, which provided more exit channels for various types of VC.

During this stage, RMB funds became the main driving force of VC. The active promotion of national policies injected new momentum into VC institutions and funds, significantly boosting industry confidence. As shown in Figure 3.2, from 2009 to the end of 2011, the number of various VC events in China maintained steady growth. However, there was a brief decline in 2012 and 2013, which was due to the suspension of the approval process for IPOs on China's A-share market, directly leading to a decline in VC activity and impacting the industry's short-term downturn.

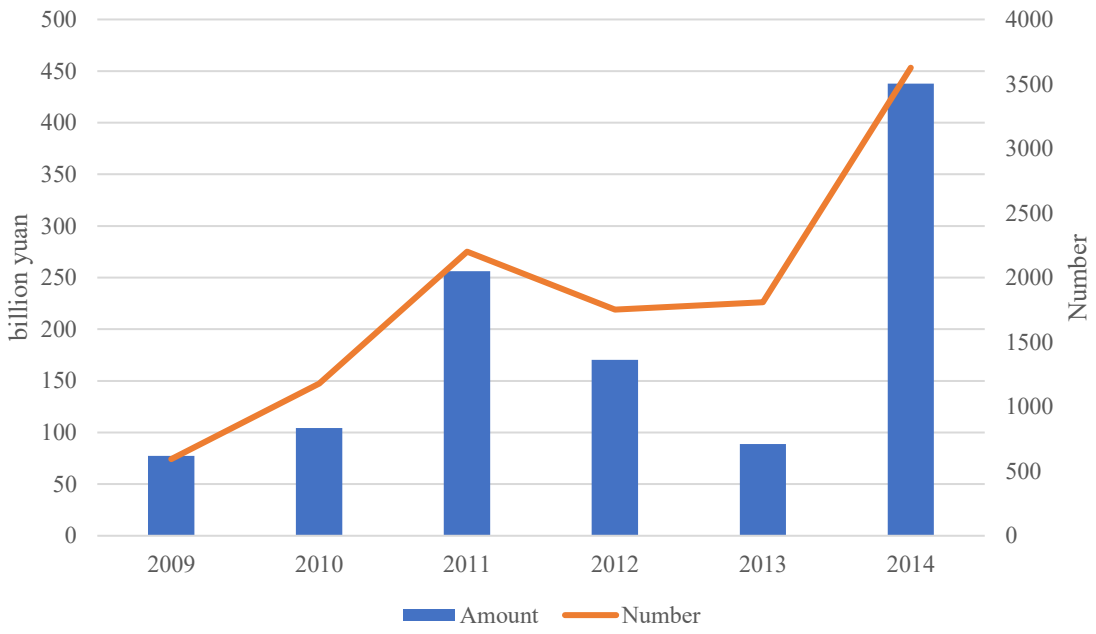


Figure 3.2 Annual VC amount and number of cases (in billion yuan) (2009-2014)

Source: Zero2IPO Research Center (2024)

Nevertheless, since the resumption of IPO approvals in January 2014, the VC market quickly regained momentum, showing strong development. During this period, many mobile internet companies such as Meituan, Tencent, Kuaishou, Dianping, and Pinduoduo, benefiting from the support of VC and private equity, achieved rapid growth and became exemplary cases in the industry, further enhancing market confidence in VC.

In 2010, Meituan secured investments from IDG Capital and Sequoia Capital, followed by funding from Tencent and other investors. In 2015, Meituan successfully merged with Dianping, a process that relied heavily on risk capital and strategic guidance. Within just a few years, Meituan evolved into one of China's largest lifestyle service platforms, yielding substantial returns for its investors through the company's success.

Didi Chuxing stands as a prominent player in China's sharing economy, significantly propelled by risk capital that has fueled its growth. Since its inception, Didi has garnered support from international investors, including Tencent, Alibaba, SoftBank, and Uber. In 2012, Didi secured early-stage investments from IDG Capital and Sequoia Capital, enabling the company to rapidly establish a foothold in the highly competitive market.

In summary, from 2009 to 2014, China's VC industry entered an important development phase. Despite the fluctuations in the external economic environment, the industry gradually recovered and achieved steady growth during this stage through policy support and the improvement of the multi-level capital market. Particularly, investment activities led by RMB funds significantly drove technological innovation and the rise of emerging economies, laying

a solid foundation for the future development of the VC industry.

(4) Stability stage (2015–2019)

Since 2015, China has entered a phase of medium-to-low-speed development, and the initial boom in internet startups has waned. Under the new economic normal, a new trend driven by core technological innovation marked China's entry into the fourth wave of entrepreneurship. The distinctive feature of this stage is that the technological content of projects is higher, with deeper innovation, and the entry threshold has been significantly raised. Cutting-edge fields such as 5G technology, semiconductors, high-end manufacturing, artificial intelligence (AI), and "Internet Plus" innovation projects have become the key focus and support targets of VC.

During this stage, China's economy was undergoing a key period of transformation and upgrading. The deepening reform of state-owned enterprises and the emergence of new consumption models had a profound impact on the investment field. Especially with the demand growth brought about by demographic changes, sectors such as elderly care, retail, children, automobiles, and healthcare gradually became investment hotspots, further fueling the enthusiasm and vitality of VC. In this process, the types of participants in the VC market became more diversified, and competition in the market intensified. Many well-known investors set up their own investment firms, while large strategic investors, such as BAT (Baidu, Alibaba, Tencent), also widely intervened across multiple industries, gradually becoming an important force in the market. Meanwhile, VC institutions backed by national capital maintained a strong competitive advantage in the market. Government-led investment funds quickly grew and became one of the most important limited partners (LPs). Especially between 2015 and 2016, government investment funds showed explosive growth, with funding mainly coming from national and provincial funds, injecting ample capital into the VC industry and further promoting its development. In 2015, NIO secured initial funding, with Tencent and Sequoia Capital as key investors, providing the essential capital for its research and development, as well as production. In 2016, Didi Chuxing raised $6 billion in a round led by SoftBank, which enabled Didi to acquire Uber China and accelerate its global expansion. In 2017, Pinduoduo completed a $500 million Series D funding round led by Tencent, which allowed the company to stand out in the highly competitive e-commerce market.

As shown in Figure 3.3, since this stage, the VC industry has gradually entered a phase of consolidation. The government implemented strict regulatory policies to clean up non-compliant entities and optimized resource allocation, improving the industry environment. However, external uncertainties, such as the China-U.S. trade conflict and the impact of the COVID-19 pandemic, limited the attraction of new equity investment funds.

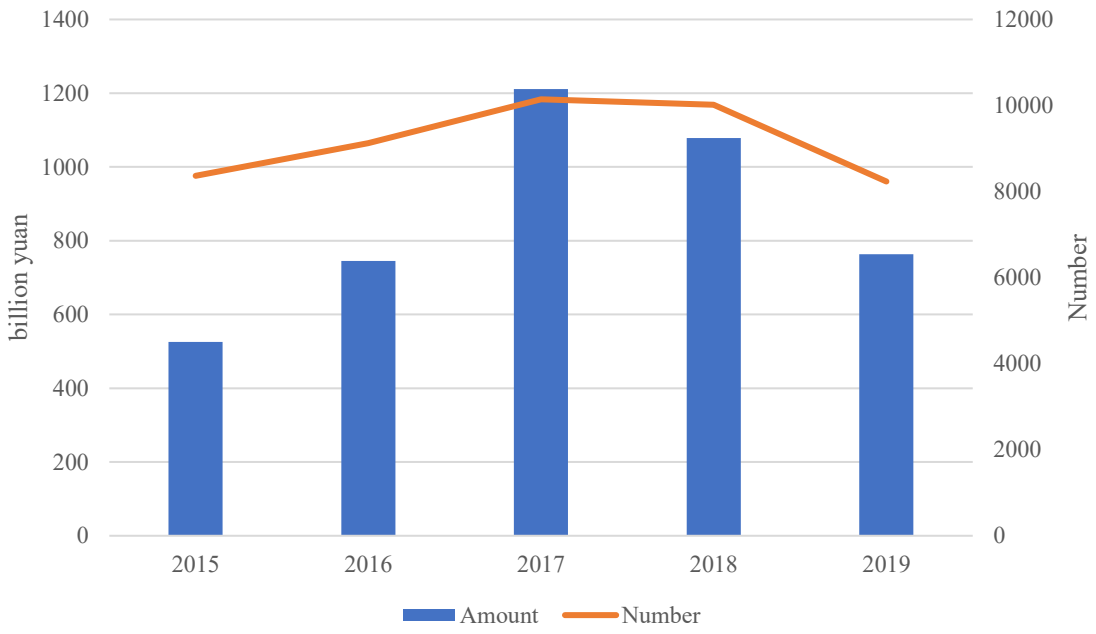


Figure 3.3 Annual VC amount and number of cases (in billion yuan) (2015-2019)

Source: Zero2IPO Research Center (2024)

Despite facing challenges, the VC industry still had a good performance. In 2019, China's VC industry achieved 1,152 exit transactions, a 17.8% increase compared to the previous year. Among them, initial public offerings (IPOs) remained the most common exit method, accounting for 50.4%. During this stage, VC not only showed outstanding growth in quantity but also demonstrated greater efficiency in supporting the development of the real economy. China's VC industry reached a new historical milestone, driven by both government policy support and market demand. Industry participants became more focused on high-tech, high-value-added innovative projects. Investment activities gradually integrated into national strategies, supporting the development of the real economy and laying a solid foundation for future economic transformation and technological progress.

The continuous development of global capital markets has made VC increasingly important in driving the transformation of scientific and technological achievements, promoting the growth of innovative enterprises, and cultivating emerging industries (Rui et al., 2021). Figure 3.4 shows the trends in the number and transaction amounts of investments by Chinese VC institutions in A-share listed companies from August 2004 to December 2020. The data indicates that VC generally exhibited sustained growth over time, with two notable peaks in 2010 and 2016. This suggests that the capital market environment and policy support at those times may have contributed to the surge in VC activities.

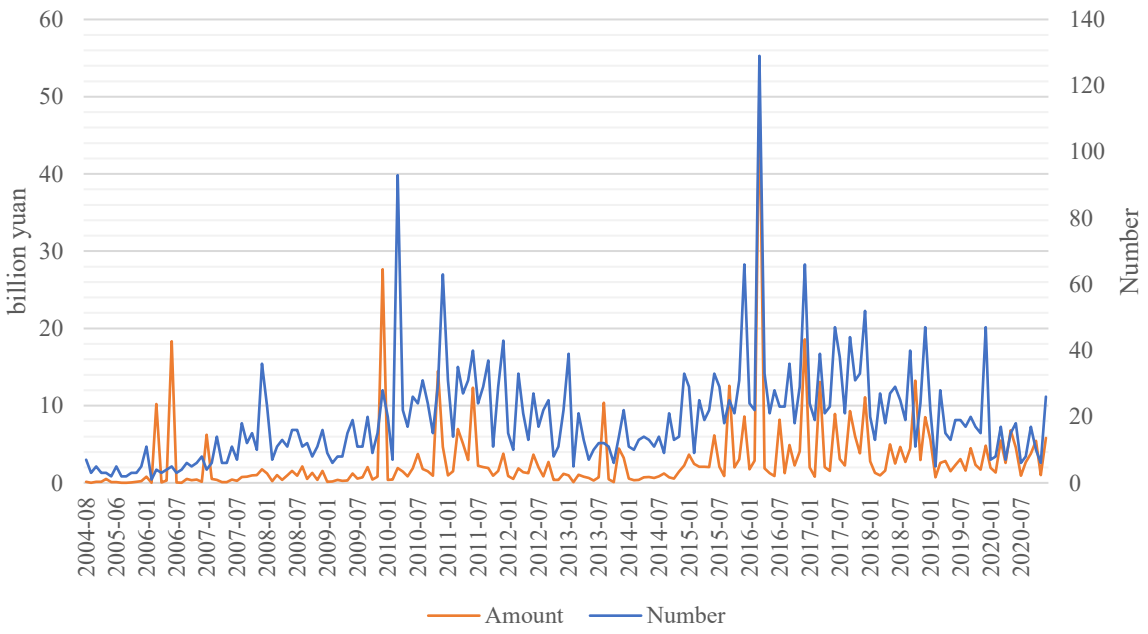


Figure 3.4 Investment quantity and transaction amount (in billion yuan) of VC investments in A-share listed companies (August 2004 - December 2020)

Source: Zero2IPO Research Center (2024)

In 2010, the peak in investment growth occurred when the impact of the global financial crisis gradually weakened. As China's economy recovered, national policies began to increasingly support high-tech industries, actively promoting innovation and entrepreneurial activities. Against this backdrop, VC institutions increased their investments in emerging enterprises, providing strong support for the commercialization of scientific and technological achievements while also promoting the rapid development of entrepreneurial companies. The investment boom during this period not only injected new vitality into China's capital markets but also helped many emerging industries gain prominence in the market, making high-tech enterprises an important driving force for economic growth.

The investment peak in 2016 was closely tied to the national promotion of the "Internet Plus" strategy. The goal of the "Internet Plus" strategy was to use the popularization and application of internet technologies to facilitate the transformation and upgrading of traditional industries while exploring the potential applications of new technologies in various sectors. In response to this policy direction, VC institutions significantly increased their investments in technology and internet companies. The investment activities during this stage not only supported the growth of technology start-ups but also further created strong innovation-driven forces in emerging industries.

As the scale of VC continued to expand, the industry distribution of Chinese VC projects gradually became more rational. Figure 3.5 illustrates the distribution of Chinese VC projects

across various industries in 2020. From the figure, it is evident that the number of investments and the amount of capital in different industries exhibit distinct characteristics, reflecting the strategic objectives of VC institutions in their industry selection.

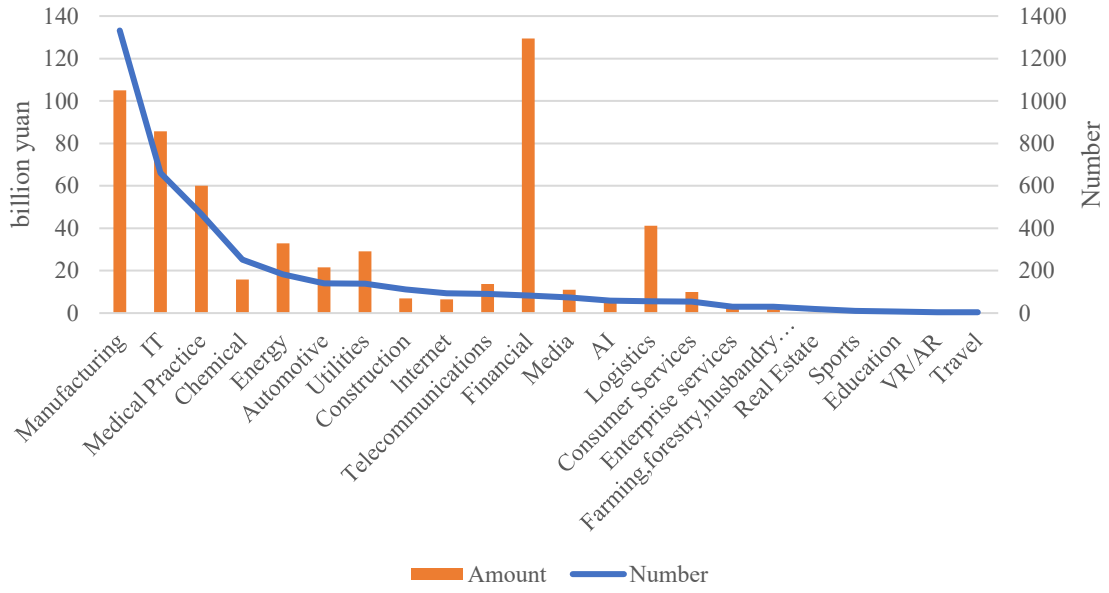


Figure 3.5 Industry distribution of VC projects (2020)

Source: Zero2IPO Research Center (2024)

As seen in Figure 3.5, the financial industry leads in transaction amounts, far surpassing other sectors, showcasing its vital position as a core pillar of the economy. Although it has the highest transaction value, the number of events is relatively low, indicating that transactions in the financial sector are concentrated in a few high-value projects, such as large investments, mergers and acquisitions, or capital market operations. This highlights the capital intensity of the financial industry and its critical role in economic operations.

In contrast, industries such as manufacturing, information technology, and healthcare also exhibit strong competitiveness in both transaction amounts and event numbers. These industries have a higher number of events, reflecting their widespread penetration and deep collaboration in economic activities. These sectors generally possess higher technological content and innovation potential and align closely with the national policy direction of promoting technological innovation and industrial upgrading. In particular, in the healthcare industry, influenced by the COVID-19 pandemic, there has been a significant increase in VC's focus on biopharmaceuticals and health management. The growth in healthcare investments not only meets society's demand for health services but also aligns with the capital market's long-term expectations for the health industry's development.

While industries like artificial intelligence and the Internet of Things (IoT) have a large number of transaction events, the transaction value is relatively low, indicating that these

sectors are in their early stages. There is significant investment, but the scale is smaller, showing a trend of high growth. In contrast, traditional industries like energy and automobiles generally have larger transaction amounts with fewer events, likely due to business being concentrated in a few large projects.

Overall, manufacturing, information technology, and healthcare industries attract the bulk of funds, while emerging industries show active development and significant future potential. These industry differences provide important reference points for policy-making, resource allocation, and investment decisions.

3.2 Current development status of SMEs

SMEs have shown strong vitality in the global economy, gradually becoming an important part of the economic system and attracting active attention and particular emphasis from governments around the world. The development of SMEs is currently a hot topic of global concern (Z. Zhang et al., 2022). However, the definition of SMEs, and whether there is a unified or authoritative standard, remains a question worthy of in-depth discussion.

In theory, SMEs are typically defined as businesses with small production and trading scales and low labor intensity (Laforet, 2013). Although both developed and developing countries have attempted to classify businesses, the criteria for classification often differ due to factors such as region, industry, and time. In the United States and the United Kingdom, a combination of qualitative and quantitative methods is commonly used to define SMEs, while countries like Japan, Germany, and Italy rely more on quantitative analysis. International comparative studies show that there are significant differences in SMEs classification by government departments, particularly in the context of different levels of economic development, social structures, and institutional frameworks, making it even more challenging to unify the definition of SMEs. Some countries define SMEs based on business size, such as the number of employees or annual turnover, which is also the primary basis for defining SMEs by international organizations like the European Union (EU) and the Organization for Economic Cooperation and Development (2022).

Although there is no final consensus on the definition of SMEs, they are generally regarded as businesses with fewer employees than a specified threshold. In the EU, the upper limit for SMEs employees is 250, with some countries setting the standard at 200. In the United States, businesses with fewer than 500 employees can be considered SMEs. Typically, small businesses have fewer than 50 employees, micro-enterprises have about 10 employees, and

medium-sized enterprises fall between 50 and 249 employees. In addition, annual revenue and asset conditions are also important criteria for distinguishing SMEs. For example, according to EU standards, the annual revenue of an SMEs should be less than 50 million euros, and the total assets should not exceed 43 million euros (OECD, 2006).

This study focuses on SMEs traded on the SME Board, emphasizing the decisive impact of VC on SMEs' innovation. Figure 3.6 illustrates the changes in capital market financing activities and stock issuance from 2013 to 2022. The data shows that 2015 to 2017 was a period of rapid growth in the capital market, with both financing amounts and the number of stock issuances reaching their peak. However, after 2017, the market began to show a reversal trend, with financing activities significantly decreasing.

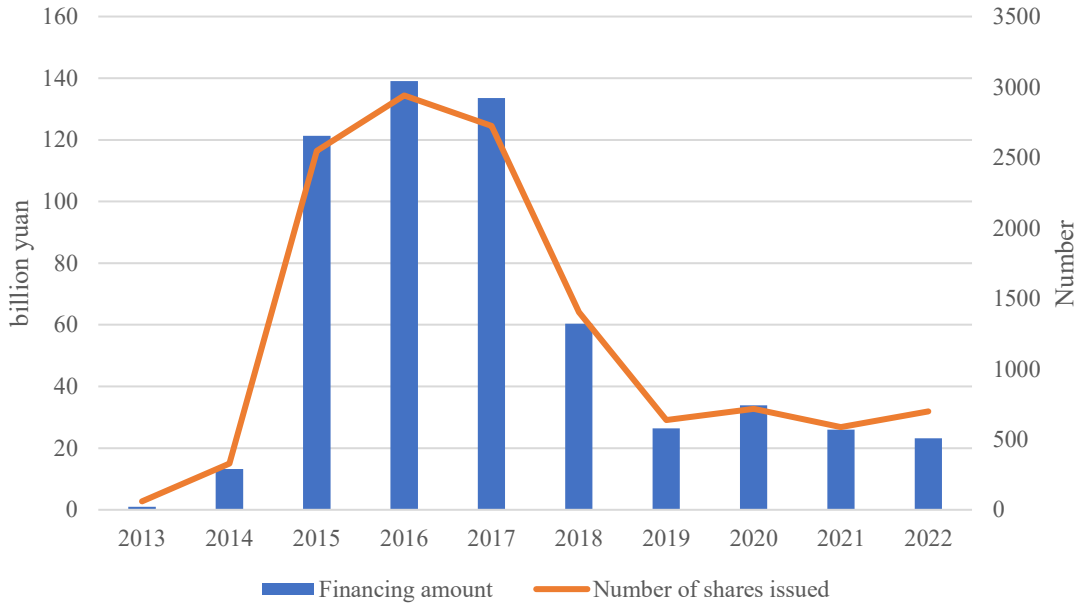


Figure 3.6 Statistics on the amount and number of stock issuances in the NEEQ

Source: NEEQ (2023)

Specifically, in 2016, the financing amount reached a peak of 139.1 billion yuan, but it slightly decreased to 133.6 billion yuan in 2017, showing signs of a slowdown. In 2018, the financing amount sharply dropped to 60.4 billion yuan, a 54.8% year-on-year decline. The number of stock issuances also significantly decreased to 1,402, a 48.3% year-on-year drop. This downward trend further intensified in 2019, with the financing amount dropping to 26.46 billion yuan and the number of stock issuances reducing to 637, representing year-on-year declines of 56.2% and 54.6%, respectively. Although financing amounts rebounded in 2020 and 2021, by 2022, the financing amount again dropped to 23.23 billion yuan, reflecting that the market was still in a sluggish state. The number of stock issuances in 2022 was 697, which, while higher than in 2021, represented a 76.3% decrease compared to the peak period in 2016.

These data indicate that after a brief period of prosperity, the capital market, influenced by changes in the macroeconomic environment, market sentiment fluctuations, and policy adjustments, experienced a notable reduction in investment activity, leading the market into a phase of calm adjustment. The fluctuations in capital market financing activities and stock issuances also reflect the difficulties faced by SMEs in obtaining capital support, while highlighting the need for more stable and optimized policy support for sustainable development in the sector.

In terms of industry distribution, as shown in Figure 3.7, the manufacturing and information technology sectors are significantly leading in the number of listed companies and financing amounts in the SME Board. The manufacturing sector ranks first with 431 listed companies and a financing amount of 13.37 billion yuan, reflecting the industry's huge demand for capital in technology upgrades, capacity expansion, and market development. Following closely is the information technology sector, with 136 listed companies and a financing amount of 3.14 billion yuan, showcasing its continued technological innovation drive and strong capital demand.

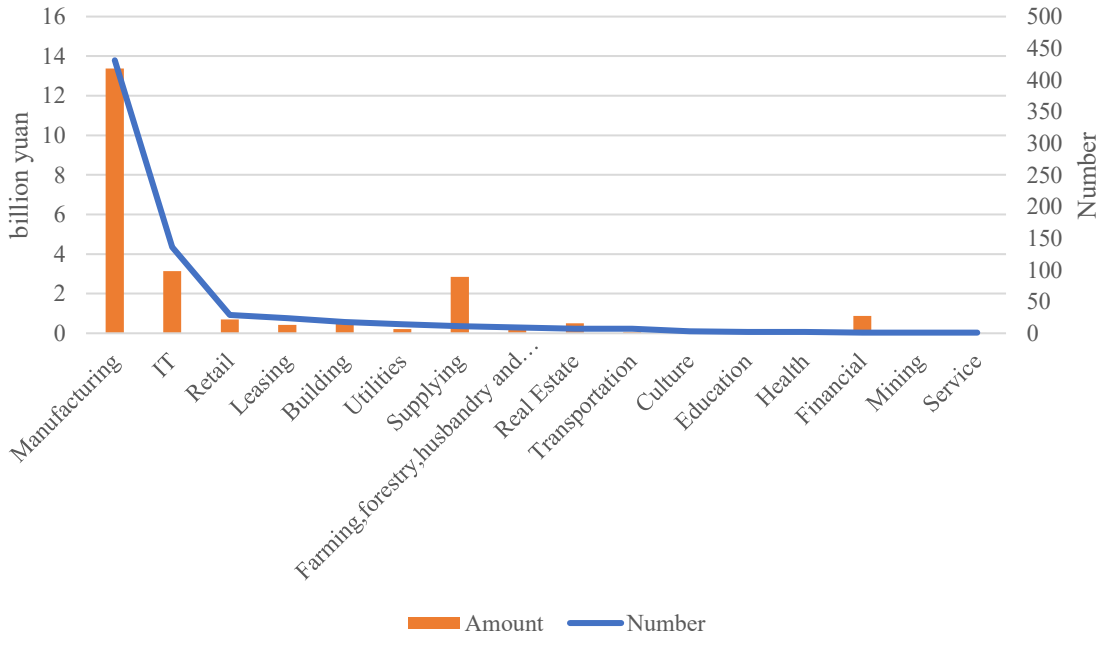


Figure 3.7 Industry distribution of stock issuances in the NEEQ

Source: NEEQ (2023)

In addition, despite the relatively small number of listed companies in the retail and leasing service industries, these sectors have shown considerable financing activity within their respective fields. Specifically, the retail industry has 29 listed companies with a financing amount of 702 million yuan, while the leasing service industry has 24 listed companies with a financing amount of 419 million yuan. This indicates that although these industries are smaller

in scale, their participation and influence in the capital market cannot be overlooked.

For industries such as construction, public utilities, supply chain, agriculture, forestry, animal husbandry and fishery, real estate, and transportation, although the number of listed companies and the financing amounts are not as high as in the manufacturing and information technology sectors, they still play an important role in maintaining industry operations and market competition. The construction and public utilities sectors have 18 and 14 listed companies, respectively, reflecting the stable investment demand in infrastructure-related industries. Notably, although the supply chain industry has relatively few listed companies, it has a financing amount of 2.856 billion yuan, highlighting its capital demand in optimizing production and distribution processes. While the number of listed companies in the real estate sector is limited, the financing amount is still significant, demonstrating its crucial position within the economic system.

The data above clearly reflect the result of the dispersed industry distribution of SMEs and the changing development patterns across different sectors in the market economy. Overall, the industry distribution of stock issuance within the SME Board aligns closely with the distribution of VC projects by industry, suggesting that the funding direction of VC and the distribution of listed companies in the capital market are interconnected. This distribution pattern reflects the diversified roles of SMEs across various economic sectors and the varying degrees of dependence each sector has on capital market support. Moving forward, the activity and financing capabilities of different industries in the capital market will continue to be influenced by industrial policies, technological innovation, and market demand, thereby promoting the further development and upgrading of SMEs.

There exists a close relationship between the SME Board and VC, particularly in terms of development characteristics, policy objectives, and development trends.

Firstly, there are many similarities in the development characteristics of VC and the SME Board. VC is a long-term investment approach with low liquidity, typically seeking growth opportunities in relatively inactive markets and focusing on innovative, high-growth enterprises. Therefore, VC is often referred to as "patient and brave capital." The majority of enterprises listed on the SME Board are at lower stages of development, attracting long-term investors, primarily institutional investors. The market characteristics of the SME Board are mainly dominated by long-term investments, value investments, and early-stage investments. These characteristics make the SME Board an ideal platform for screening quality projects and connecting with VC.

Secondly, VC and the SME Board align in their policy objectives. VC not only seeks high

returns but also focuses on nurturing and supporting innovative start-ups. The core goal of the SME Board is to promote the growth and innovation of SMEs. Both share a common mission in serving the real economy, advancing technological progress, and supporting the development of entrepreneurial enterprises, which results in highly consistent operational and developmental goals.

Furthermore, in the context of the new era, VC and the SME Board market exhibit similar development trends. China has become the second-largest VC market in the world. With the arrival of a new wave of entrepreneurship, VC has ushered in historic opportunities. Fields such as 5G technology, semiconductors, biomedicine, advanced manufacturing, artificial intelligence, and "Internet Plus" offer abundant potential investment opportunities for VC. At the same time, the VC industry is undergoing a shift from rapid expansion to consolidation. Similarly, after a period of rapid growth, the SME Board market has entered a phase of rational adjustment, with the current strategic focus on improving market quality and liquidity. This suggests that, over the long term, the interaction between VC and the SME Board market will become more frequent, and they will form a synergistic effect in supporting the development of SMEs.

3.3 Chapter summary

This chapter serves as the foundational section of the study, providing an overview of the background, significance, and research framework regarding the role of VC in promoting innovation in SMEs. First, the chapter reviews the development of the VC industry, from its nascent stages in the late 19th century to its recent rapid growth in China. Key milestones, such as the founding of the American Research and Development Corporation in 1946 and the establishment of China's first state-owned VC firm in 1985, are highlighted as pivotal events marking the gradual maturation of VC both globally and within China. The development of the Chinese VC industry is categorized into four stages: the inception stage, the exploratory stage, the growth stage, and the stabilization stage. Each stage is analyzed in terms of the characteristics of the market's gradual maturity and the diversification of investment strategies.

In this historical context, the chapter also delves into the importance of SMEs, emphasizing their central position and irreplaceable role in the global economic system. By analyzing the differing definitions and classifications of SMEs across countries, the chapter illustrates their critical role in economic development. Specifically, using data from the NEEQ, this chapter provides a detailed presentation of the financing activities of SMEs within the capital markets

and the trends in stock issuance. These data not only reflect the dynamic nature of capital markets but also highlight the crucial role of SMEs in driving innovation-based economic development.

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Chapter 4: Research Methods

Current research has insufficiently explored the impact of VC on SMEs' innovation, particularly in examining the specific mechanisms through which VC influences innovation in SMEs. To address this gap, this chapter uses an empirical approach to analyze the impact of VC on SMEs' innovation, drawing on a sample of companies listed on the NEEQ from 2014 to 2023. This chapter investigates the mechanisms of VC's impact on SMEs' innovation at a micro level, providing an empirical examination of the theoretical framework developed in Chapter 4. The main components of this chapter are as follows:

(1) Sample selection, variable definition, and descriptive statistical analysis: This section explains the sample selection criteria, defines key variables, and presents descriptive statistics to derive preliminary statistical conclusions.

(2) Moderation effect model and mechanism testing: The chapter develops a moderation effect model to test the four key mechanisms—resource spillover effect, supervisory governance effect, management participation effect, and financing effect—by which VC impacts SMEs' innovation. Additionally, robustness tests are conducted to verify the reliability of the empirical findings.

This empirical analysis will provide a comprehensive understanding of how VC facilitates innovation within SMEs, validating and extending the theoretical mechanisms proposed in Chapter 2. Through this analysis, the study aims to offer concrete insights into the role of VC in promoting technological advancement among SMEs in China.

4.1 Statistical analysis

4.1.1 Statistical methods and rationale

This study aims to systematically evaluate the effect of venture capital on the innovation performance of SMEs, with a particular focus on its underlying mechanisms under varying external environmental conditions and capital heterogeneity. To this end, the study first adopts a multiple linear regression model, estimated using the ordinary least squares (OLS) method, to examine the direct effects of venture capital participation on firms' innovation input and output. In addition, firm-level characteristics are included as control variables, and interaction

terms are introduced to test the moderating effects of external environmental factors. Capital-related attributes are also incorporated to explore the heterogeneity of venture capital's influence on innovation.

The multiple linear regression approach is appropriate for this study due to its conceptual simplicity and estimation efficiency, making it well-suited for large-sample analyses involving multiple explanatory, control, and interaction variables. Given the research framework—which encompasses variations in industry environments and multidimensional attributes of venture capital—this method is capable of effectively identifying the mechanisms through which various factors impact innovation activities. All regression analyses were conducted using SPSS 24.0.

It is important to note, however, that a potential issue must be addressed to more accurately estimate the true impact of venture capital on SME innovation. Specifically, venture capitalists may engage in non-random selection, showing a preference for investing in firms that already demonstrate stronger innovation capabilities. As a result, the variable indicating the presence of venture capital may partially reflect firms' endogenous innovation advantages. If this sample selection bias is not accounted for, the analysis may systematically overestimate the true effect of venture capital on innovation.

To address this concern, the study employs the Heckman two-stage correction model, originally proposed by Heckman (1979), which is designed for scenarios where non-random sample selection may cause correlation between the error term and the explanatory variables. The model consists of two steps. In the first stage, a Probit selection equation is estimated based on the full sample (including firms with and without venture capital) to calculate the probability of receiving venture capital. This estimated probability reflects the likelihood of a firm being selected for investment—i.e., the firm's propensity to be chosen by venture capital. Based on this, the Inverse Mills Ratio (IMR) is calculated to capture the potential bias resulting from non-random sample selection.

In the second stage, the IMR is included as an additional control variable in the main regression model to correct for the selection bias arising from the fact that firms receiving venture capital may be inherently more innovative. This two-step approach enhances the model's causal inference and improves the robustness and credibility of the estimation results. The Heckman two-stage regression analysis was conducted using Stata 17.0.

4.1.2 Regression model specification

To test the mechanisms through which VC affects innovation investment in SMEs, this chapter

constructs the following multiple regression model (see Formula 4.1), drawing on the research method of D. Guo and Jiang (2022):

$$\boldsymbol{RDD = \alpha_1 + \beta_1 VC_D + \beta_2 \sum Control + YEAR + IND + \varepsilon} \quad (4.1)$$

Where, the dependent variable, RDD, represents firms' innovation investment, while the independent variable, VC_D, indicates VC involvement. $Control$ denotes control variables, $YEAR$ represents year fixed effects, IND denotes industry fixed effects, and ε is the random error term.

To examine the impact of VC on the innovation output of SMEs, this chapter constructs the following multivariate regression model, as shown in Formula 4.2:

$$\boldsymbol{Patent = \alpha_2 + \beta_3 VC_D + \beta_4 \sum Control + YEAR + IND + \varepsilon} \quad (4.2)$$

Where, the dependent variable, $Patent$ represents the innovation output of firms.

To examine four potential mechanisms through which VC support may influence firm innovation, this chapter further establishes the following model, as shown in Formula 4.3 and 4.4:

$$\boldsymbol{RDD = \alpha_3 + \beta_5 VC_D + \beta_6 X + \beta_7 VC_D * X + \beta_8 \sum Control + YEAR + IND + \varepsilon} \quad (4.3)$$

$$\boldsymbol{Patent = \alpha_4 + \beta_9 VC_D + \beta_{10} X + \beta_{11} VC_D * X + \beta_{12} \sum Control + YEAR + IND + \varepsilon} \quad (4.4)$$

Where, X represents each of the four mechanisms being examined: Spill, Uncertain, Compete, and Constrain.

To operationalize the four mechanisms affecting VC's impact on SMEs' innovation, we adopt the following approaches based on prior studies:

Mechanism 1: Resource Spillover Effect (Spill)

Following the method of C. Wu and Tang (2016), we measure the resource spillover intensity in an industry by estimating the contribution of R&D intensity from other companies within the same industry to the focal company's revenue. Specifically, if the R&D resource spillover level in the company's industry is above the 75th percentile across all industries, we assign the variable Spill a value of 1; otherwise, it is set to 0.

Mechanism 2: Supervisory Governance Effect (Uncertain)

Based on Carpenter and Fredrickson (2001), we measure the uncertainty in a company's industry by calculating the volatility in industry performance. This is done by regressing industry sales revenue on time within the sample period and dividing the standard deviation of the regression coefficients by the mean sales revenue of the industry. If the uncertainty level in the company's industry exceeds the 75th percentile of uncertainty across all industries, the

variable Uncertain is set to 1; otherwise, it is set to 0.

Mechanism 3: Management Involvement Effect (Compete)

For market competition, we use the Herfindahl-Hirschman Index (HHI), as suggested by Shi and Gu (2013), which represents the level of industry concentration. The HHI is calculated as the sum of the squared market share of each firm within the industry. If the HHI in a company's industry for a given year is below the median HHI across all industries, indicating a more competitive market, we assign the variable Compete a value of 1; otherwise, it is set to 0.

Mechanism 4: Financing Effect (Constrain)

To measure the company's dependency on external financing, we adopt the KZ index (Kaplan & Zingales, 1995), which reflects financing constraints. If a company's KZ index is above the 75th percentile among all sampled firms, indicating higher financing constraints and greater reliance on external funds, we set the variable Constrain to 1; otherwise, it is set to 0.

These variables—Spill, Uncertain, Compete, and Constrain—are incorporated into the empirical model to capture the specific effects of each mechanism, enabling a detailed analysis of how VC influences SMEs' innovation through different pathways.

To examine the impact of VC heterogeneity and investment type on innovation in SMEs, this chapter establishes the following multiple regression model, as shown in Formula 4.5:

$$\boldsymbol{RDD_{it} = \alpha + \sum_{k=1}^{K} \beta_k Factor_{it}^{k} + \sum_{k=1}^{K} \gamma_k Control_{it}^{k} + \mu_i + \theta_t + \varepsilon_{it}} \quad (4.5)$$

The dependent variable, RDD_{it}, represents the innovation investment. The explanatory variable, $Factor_{it}^{k}$, denotes the heterogeneity and investment type of VC. $Control_{it}^{k}$ includes firm-level control variables that influence innovation investment. μ_i represents firm-specific fixed effects, which help eliminate interference from firm-level individual factors. θ_t captures time fixed effects, removing macro-level disturbances. ε_{it} is the random error term. This setup allows for a detailed analysis of how VC characteristics and investment types influence SMEs' innovation while accounting for firm and time-specific effects.

To examine the impact of VC on innovation output in SMEs, this chapter establishes the following multiple regression model, as shown in Formula 4.6:

$$\boldsymbol{Patent_{it} = \alpha + \sum_{k=1}^{K} \beta_k Factor_{it}^{k} + \sum_{k=1}^{K} \gamma_k Control_{it}^{k} + \mu_i + \theta_t + \varepsilon_{it}} \quad (4.6)$$

The dependent variable, $Patent_{it}$, represents the innovation output of the firm, with other variables defined as above.

4.2 Variable definition

4.2.1 Dependent variables

The study includes a comprehensive set of variables to analyze the relationship between VC involvement and SMEs' innovation. These variables encompass dependent variables, independent variables, and moderating variables, which are defined as follows.

Regarding the dependent variables, SMEs' innovation input and output are the primary focus.

SMEs' Innovation Input: This is measured by the natural logarithm of R&D expenditure plus one, denoted as RDD.

SMEs' Innovation Output: This is represented by the number of patents filed by the company in the given year, labeled as Patent.

4.2.2 Independent variables

As for the independent variable, the presence of VC in SMEs is examined.

VC: To determine VC involvement, we consider both VC and private equity (PE) due to the lack of clear distinctions in China. Firms with names containing terms like "venture investment," "innovation investment," "high-tech industry investment," and "investment company" are categorized as VC companies. We use three proxy variables to measure VC participation:

VC_D: A binary variable that takes the value of 1 if the firm has VC participation and 0 otherwise.

VC Investment Type: This variable, denoted as VC_U, indicates whether the investment is syndicated (1) or solo (0). It reflects the degree of collaboration among venture capitalists, as syndicated investments generally imply more resource support.

VC Ownership Proportion: This variable, denoted as VC_R, represents the proportion of shares held by venture capitalists among the top ten shareholders. It measures the potential influence of VC on the company's decision-making, with a higher proportion typically indicating greater control.

VC Holding Period: This variable, denoted as VC_T, represents the duration (in years) that venture capitalists have held shares. It reflects the long-term commitment of VC to the company, with a longer holding period suggesting greater confidence in the company's future development.

Type of VC: This variable, denoted as VC_I, differentiates between strategic and incubator VC based on the holding period. If the holding period exceeds three years, it is considered strategic VC (1); otherwise, it is classified as incubator VC (0). Strategic VC typically implies a longer return horizon and deeper involvement.

Reputation of VC: The reputation of VC is measured by the frequency of the VC firm's investments, denoted as VC_F. If the VC firm has led three or more companies to IPO, the value is 1; otherwise, it is 0. This variable reflects the market reputation of the VC firm, with reputable firms generally better positioned to attract quality projects and achieve superior returns.

4.2.3 Moderating variables

With respect to the moderating variables, four factors are considered.

Resource Spillover Effect (Spill): The Spill variable measures the extent of resource spillover within the industry. If an industry has high R&D investment from leading companies, other firms may benefit through mechanisms such as knowledge diffusion, technological imitation, and talent flows. For instance, when a leading company achieves a breakthrough, other firms can learn from or replicate the technology, enhancing their innovation capacity. Spill is assigned a value of 1 if the firm benefits significantly from R&D spillovers within the industry, and 0 if the spillover effect is minimal or the firm cannot effectively leverage industry R&D resources.

Supervisory Governance Effect (Uncertain): The Uncertain variable captures the degree of uncertainty in the company's industry. Uncertain takes a value of 1 if the industry faces high levels of uncertainty and dynamic external conditions, and 0 if the industry environment is relatively stable, allowing for more predictable innovation decisions.

Management Participation Effect (Compete): The Compete variable reflects the intensity of market competition in the company's industry. Compete is set to 1 if the industry is highly competitive, placing pressure on firms to innovate to stay competitive. It takes a value of 0 if the market competition is moderate, where firms may not need to rely on innovation as heavily to maintain market share.

Financing Effect (Constrain): The Constrain variable measures the firm's financing constraints. Constrain takes a value of 1 if the firm faces high financing constraints, indicating unmet capital needs, and 0 if the firm's capital needs are adequately met.

4.2.4 Control variables

To examine the impact mechanism of venture capital on innovation investment in SMEs, this study incorporates a set of firm-level control variables, including firm size, cash ratio, leverage (debt-to-asset ratio), return on assets (ROA), and firm age. These variables are included to account for fundamental factors that may influence firms' innovation activities and other critical decisions. Controlling for these variables helps to more accurately isolate the relationship between the key independent variables and firm behavior, thereby minimizing potential confounding effects. Furthermore, in the analysis of venture capital heterogeneity and investment approaches, the same set of firm-level control variables (firm size, cash ratio, leverage, and ROA) is employed. To further control for unobserved firm-specific effects and time trends, firm and year fixed effects are also included in the regression models. In addition, year and industry fixed effects are considered to control for temporal dynamics and industry-specific heterogeneity.

The definitions and descriptions of all variables are presented in Table 4.1. By incorporating these controls, the analysis can better capture variations in firm behavior across different time periods and industry environments, thereby enhancing the reliability and validity of the empirical findings.

Table 4.1 Variable definition

Variable Symbol	Variable Name	Variable Definition
RDD	Innovation Investment	Natural logarithm of R&D investment amount plus 1
Patent	Innovation Output	Represented by the number of patents
VC_D	Presence of VC	1 if VC is involved, 0 otherwise
Spill	Industry R&D Spillover Level	1 if the industry's R&D spillover is above the 75th percentile across all industries, 0 otherwise
Uncertain	Industry Uncertainty Level	1 if the industry's uncertainty level is above the 75th percentile across all industries, 0 otherwise
Compete	Industry Market Competition Level	1 if the industry's HHI index is below the median HHI index across all industries within the year, 0 otherwise
Constrain	Dependency on External Financing	1 if the firm's KZ index for financial constraints is above the 75th percentile among all firms, 0 otherwise
SIZE	Firm Size	Natural logarithm of total assets
CFO	Cash Ratio	Cash and cash equivalents divided by current liabilities
LEV	Leverage Ratio	Total liabilities divided by total assets
ROA	Return on Assets	Net profit divided by total assets
AGE	Firm Age	2024 minus the year of establishment plus 1
YEAR	Year	Dummy variable

IND	Industry	Dummy variable
VC_N	Number	Number of VC among the top ten sareholders
VC_R	VC Investment Ratio	Shareholding proportion of VC among the top ten shareholders
VC_I	Type of VC	Value is 1 if the holding period of the VC institution exceeds 3 years (strategic VC); otherwise, 0 (incubation VC)
VC_T	VC Holding Period	Duration of VC shareholding
VC_F	VC Reputation	Reputation is measured by investment frequency; value is 1 if VC led three or more companies to IPO, otherwise 0
VC_U	VC Investment Type	Value is 1 for syndicated investment; otherwise, 0

4.3 Sample selection

Within China's multi-tiered capital market system, the National Equities Exchange and Quotations (NEEQ)—commonly known as the "New Third Board"—was approved by the China Securities Regulatory Commission (CSRC) in 2013 and is operated by the National Equities Exchange and Quotations Co., Ltd. The NEEQ serves as an over-the-counter market specifically designed for small and micro-sized enterprises, particularly those that do not yet meet the listing requirements of the Main Board, ChiNext, or the STAR Market. It provides a comprehensive range of market functions, including equity financing, share transfer, mergers and acquisitions, and value discovery, tailored to the needs of innovative, entrepreneurial, and high-growth firms.

With ongoing institutional improvements, the NEEQ has developed a three-tier market structure consisting of the Basic Tier, Innovation Tier, and Select Tier. In 2021, the Select Tier was upgraded and transformed into the Beijing Stock Exchange (BSE), establishing a transfer mechanism that connects it with other boards such as the Main Board, ChiNext, and the STAR Market. Together, these reforms contribute to building a capital support system that spans the entire life cycle of enterprises. The NEEQ has played an increasingly important institutional role in alleviating financing constraints for SMEs, improving corporate governance, fostering technological innovation, and supporting the growth of "specialized, refined, distinctive, and innovative" enterprises.

To examine the mechanisms through which venture capital influences innovation input in SMEs, this study selects firms listed on the NEEQ as the research sample and conducts an in-depth analysis using data from 2014 to 2023. The establishment and continual optimization of the NEEQ have had profound practical implications for supporting the growth of early-stage

SMEs and exploring alternative financing pathways.

First, the listing requirements of the NEEQ incentivize SMEs to enhance their managerial capabilities. In order to be listed, firms must undergo equity restructuring and adopt a modern corporate governance system, which lays a solid foundation for venture capital participation. This structural transformation enables venture capitalists to engage in firm governance through more transparent and standardized mechanisms.

Second, the NEEQ has experienced rapid development, with improving firm quality over time. As market regulation has strengthened, firms lacking long-term development potential have gradually exited the market, while those remaining have demonstrated a stronger commitment to sustainable growth and value creation. Under such conditions, the alignment between venture capital and firm objectives becomes stronger, facilitating more cohesive collaboration and allowing the governance effects of venture capital to be more effectively realized. In the venture capital ecosystem, the NEEQ serves not only as an emerging exit channel for capital but also as an important platform for identifying high-potential investment targets. Thus, its institutional features and evolving market structure make it a highly suitable context for studying the role of venture capital in promoting SME innovation.

The primary data used in this study were obtained from the Wind database. Missing values were supplemented using information disclosed in firms' prospectuses prior to listing, with additional data sourced from platforms such as CNINFO. In cases of data inconsistency, the following validation rule was applied: for example, if the Wind database indicates that Company A received venture capital investment, but no such investor is found in the shareholder registry or prospectus, and no other public source confirms its presence, the company is treated as not having received venture capital. In other words, a data point is accepted only when at least two independent sources confirm or support the same information.

Data on firms' R&D expenditures were supplemented using the China Center for Economic Research (CCER) database, which is maintained by the China Center for Economic Research at Peking University. These data were further cross-checked and completed using R&D disclosures in firms' annual reports. Patent application data were collected from the China Patent Publication and Information Inquiry System, and cross-validated with disclosures on the official websites of the firms to determine the effective number of patent applications submitted by each enterprise. This verification and matching process was conducted using Stata 16.0.

To mitigate the influence of outliers, this study also applied Winsorization at the 1% significance level in both tails for all continuous variables, ensuring robustness and accuracy in the empirical results.

4.4 Chapter summary

This chapter outlines the econometric model specification and variable definitions used to examine the impact of venture capital on innovation performance in SMEs. First, in terms of statistical methodology, this study employs a combination of multiple linear regression and the Heckman two-stage model to ensure both causal identification and the robustness of the estimation results. The multiple linear regression models assess the direct effects of venture capital participation on innovation input and output, while also incorporating interaction terms to explore the moderating roles of external environmental factors and capital attributes. To address potential sample selection bias arising from venture capitalists' preference for investing in inherently innovative firms, the Heckman model is applied to correct for this non-random selection process, thereby enhancing the validity and reliability of the empirical findings.

Second, regarding model construction, six regression equations are developed to comprehensively analyze the direct effects of venture capital, four potential mediating mechanisms (technological spillovers, industry uncertainty, market competition, and financial constraints), and the heterogeneous characteristics of venture capital (including investment mode, equity share, holding period, investment type, and reputation). These models lay a solid foundation for subsequent empirical testing.

In terms of variable design, the study clearly differentiates between dependent variables, independent variables, moderating variables, and control variables. Drawing on prior literature, a set of theoretically grounded and operationally feasible measurement indicators is constructed. Notably, the moderating variables are rigorously defined using methods such as percentile thresholds, Herfindahl-Hirschman Index (HHI), and the Kaplan-Zingales (KZ) index, which enhance the precision and conceptual clarity of the variables.

Lastly, the sample consists of firms listed on the NEEQ during the period from 2014 to 2023. As a multi-tiered capital market dedicated to SMEs, the NEEQ offers both representativeness and institutional compatibility. It effectively captures the innovation behaviors of SMEs and allows for the observation of governance and resource effects following venture capital involvement. This provides a robust empirical foundation for the generalizability of the research findings and the practical relevance of the policy implications.

In sum, this chapter develops a rigorous analytical framework and empirical pathway to investigate how venture capital affects innovation performance in SMEs. The next chapter will build upon this framework to conduct empirical analyses and test the hypotheses, thereby further elucidating the mechanisms through which venture capital fosters innovation in SMEs.

Chapter 5: Research Findings

5.1 Descriptive statistics and analysis

The distribution of key variables is shown in Table 5.1. The descriptive statistics reveal substantial heterogeneity across the key variables.

Table 5.1 Descriptive statistics of key variables

Variable	Obeservation	Mean	Median	SD	Min	Max
RDD	74640	10.399	17.350	9.543	0.000	21.480
Patent	74653	6.485	0.000	18.305	0.000	113.000
VC_D	74653	0.237	0.000	0.426	0.000	1.000
Spill	74653	0.063	0.000	0.244	1.000	1.000
Uncertain	74653	0.794	1.000	0.404	0.000	1.000
Compete	74653	0.500	0.000	0.500	0.000	1.000
Constrain	74653	0.190	0.000	0.392	15.391	1.000
VC_N						
VC_R	17730	0.160	0.096	0.181	0.005	0.878
VC_I	17730	0.792	1.000	0.406	0.000	1.000
VC_T	17730	4.204	3.000	3.819	1.000	21.000
VC_F	17730	0.297	0.000	0.457	0.000	1.000
VC_U	17730	0.309	0.000	0.462	0.000	1.000
SIZE	71108	18.429	18.451	1.228	15.391	21.655
CFO	70730	0.834	0.234	1.948	0.002	14.032
LEV	71108	0.426	0.417	0.226	0.024	1.082
ROA	71108	0.157	0.105	0.156	0.000	0.653
AGE	74653	19.618	19.000	4.985	11.000	34.000

R&D Investment (RDD): The average R&D investment (RDD) is 10.399, indicating a substantial overall commitment to R&D among the sample firms. However, there is significant variability in R&D spending across firms, as evidenced by a standard deviation of 9.543. This suggests that while some firms have minimal or no R&D investment, others allocate considerable resources to R&D.

Patent Output (Patent): The median patent output is 0, implying that most firms did not generate new patents within the observation period. However, the maximum value reaches 113, highlighting that a small subset of firms is highly active in technological innovation, with substantial patent outputs.

VC (VC_D): Approximately 23.7% of the sample firms received external VC investment. This suggests that nearly a quarter of these firms had access to additional funding support, which could enhance their innovation capabilities and facilitate expansion.

R&D Spillover (Spill): The average value of the Spill variable is 0.063, indicating that

R&D spillover effects are generally weak across most industries. However, certain industries exhibit stronger spillover effects, which may benefit firms in those sectors by enhancing innovation through knowledge and technology diffusion.

Uncertainty (Uncertain): The mean value of Uncertain is 0.099, showing that most industries face relatively low levels of uncertainty. Nevertheless, certain sectors are characterized by high uncertainty, which could expose firms to greater external risks and impact their strategic decisions.

Market Competition (Compete): The average value of Compete is 0.098, suggesting that the majority of firms operate in industries with relatively moderate competition. However, a minority of firms face intense market competition, which may drive them to innovate more aggressively to maintain competitive positioning.

Capital Constraint (Constrain): The average value of the Constrain variable is 0.190, reflecting that some firms rely heavily on external financing due to high capital constraints, while the majority face relatively low capital constraints.

The mean value of venture capital investment type (VC_U) is 0.309, indicating that approximately 30.9% of investments are joint investments. This suggests that cooperation among venture capitalists remains relatively limited. The average number of shares held by venture capital (VC_S) is about 1.043 million shares, with a standard deviation of 17.70 million shares, demonstrating significant variation in shareholding amounts. In some firms, the number of shares held by venture capital is exceptionally large, reaching a maximum of 12.14 million shares.

Regarding venture capital ownership ratio (VC_R), the mean value is 0.160, suggesting that venture capital accounts for about 16% of the top ten shareholders' total shareholding. The median value of 0.096 indicates that venture capital generally has a moderate influence in corporate decision-making.

The average holding period of venture capital (VC_T) is 4.204 years, implying that venture capitalists typically maintain their stakes for an extended period, reflecting a long-term commitment to the firms.

For venture capital type (VC_I), approximately 79.2% of the institutions are identified as strategic investors, suggesting that the majority of investors hold a positive outlook on the long-term development of the firms they invest in.

The venture capital ownership background (VC_P) shows that state-owned capital only accounts for 6.9%, which may impact the level of policy support received by the invested firms.

The mean value of venture capital reputation (VC_F) is 0.297, indicating that only about

30% of venture capital institutions have led more than three IPOs, highlighting room for improvement in terms of institutional reputation within the market.

Firm Size (SIZE): The average firm size is 18.429, indicating that most sample firms fall into the category of medium to large enterprises.

Liquidity Management (CFO) and Leverage (LEV): The mean values for CFO and LEV are 0.198 and 0.426, respectively, indicating considerable variation in liquidity and debt management among firms. This suggests that some firms experience tight cash flows or maintain high levels of debt.

Return on Assets (ROA): The average return on assets is 15.7%, with some firms demonstrating strong profitability, which may influence their capacity to reinvest in innovation.

Firm Age (AGE): The average firm age is 19.004 years, indicating that most firms have been operating in the market for approximately 19 years. This is significant for analyzing their potential for sustained long-term growth and development.

These descriptive statistics provide a comprehensive overview of the characteristics of the sample firms. The variability in R&D investment, innovation output, and financial metrics highlights the diverse conditions faced by SMEs, which could influence the impact of VC and other moderating factors on their innovation activities. This analysis sets the foundation for the subsequent empirical testing of VC's role in enhancing innovation within SMEs under varying industry and financial conditions.

The annual descriptive statistics in Table 5.2 display the mean values of key variables for each year. Specifically, in 2014, the number of SMEs is 2,346, with an average innovation input of 13.79, an average innovation output of 4.790, and a VC participation rate of 0.193, indicating a relatively balanced performance in terms of innovation and investment. In 2015, the number of SMEs increases significantly to 6,939, with a slight decrease in innovation input to 13.35, an innovation output of 2.544, and a rise in VC participation to 0.268, reflecting an increase in VC involvement in the market. In 2016, the number of SMEs further increases to 10,952, innovation input rises to 15.42, innovation output sees a slight increase, and VC participation remains stable at 0.254. Data from 2017 and 2018 show considerable fluctuations in innovation input and output, but VC participation remains at a relatively high level, suggesting dynamic changes in the market environment and industry investments. Data from 2020 to 2023 indicate significant fluctuations in innovation input, but it remains relatively stable, with slight decreases in firm size and VC participation, reflecting increased market competition and uncertainty.

Table 5.2 Descriptive statistics of key variables (annual average)

Year	Number of SMEs	RDD	Patent	VC_D	SIZE	CFO	LEV	ROA	AGE
2014	2346	13.79	4.790	0.193	18.13	0.879	0.432	0.172	20.97
2015	6939	13.35	2.544	0.268	18.26	1.164	0.414	0.166	19.94
2016	10952	15.42	2.918	0.254	18.29	1.106	0.395	0.162	19.56
2017	11078	2.643	3.135	0.210	18.31	0.972	0.402	0.159	19.44
2018	9543	10.73	0.593	0.206	18.39	0.786	0.406	0.155	19.49
2019	8079	13.62	4.347	0.245	18.43	0.726	0.417	0.156	19.51
2020	6970	10.98	10.93	0.240	18.47	0.708	0.429	0.157	19.60
2021	6447	15.25	12.91	0.240	18.55	0.624	0.458	0.151	19.59
2022	6165	7.601	13.11	0.248	18.67	0.619	0.476	0.148	19.61
2023	6134	3.107	17.52	0.262	18.74	0.652	0.482	0.151	19.56

5.2 Results of econometric model estimation

5.3.1 Direct impacts of VC on innovation in SMEs

In examining the relationship between VC and innovation in SMEs, the main regression results are displayed in Table 5.3. According to these results, venture capital (VC_D) has a significant positive impact on both the innovation input (RDD) and innovation output (Patent) of enterprises.

Table 5.3 Impact of VC on innovation input and output of SMEs

Variables	(1) RDD	(2) Patent
VC_D	0.6166***	1.2422***
	(0.0910)	(0.1879)
SIZE	1.0841***	3.2760***
	(0.0367)	(0.0754)
CFO	-0.1192***	-0.0612
	(0.0190)	(0.0394)
LEV	-2.5091***	-4.9477***
	(0.1778)	(0.3674)
ROA	-0.8949***	2.1504***
	(0.2544)	(0.5244)
AGE	0.0489***	0.0053
	(0.0092)	(0.0189)
IND	YES	YES
YEAR	YES	YES
_cons	-5.5970***	-55.8556***
	(0.7121)	(1.4648)
N	70723	70729
R-sq	0.3375	0.1425

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

In Model (1), the coefficient for VC_D is 0.6166, which is statistically significant at the 1% level, indicating that firms receiving VC support tend to allocate significantly more resources

to research and development activities. This suggests that VC not only provides the necessary financial backing but also contributes valuable management expertise and resource integration capabilities, thereby encouraging firms to intensify their investment in innovative projects.

In Model (2), the coefficient for VC_D is 1.2422, also significant at the 1% level, reinforcing the notion that VC positively influences innovation output. This implies that VC plays an essential role in enhancing the efficiency with which firms convert their R&D efforts into tangible innovation outcomes, such as patents. The positive relationship observed aligns with theoretical expectations, as venture capitalists typically target innovation-driven companies, aiming to expedite their technological advancements and application of research outputs through both capital and resource allocation. By doing so, VC accelerates firms' growth in the innovation domain, helping them achieve substantial progress in patent production and overall innovation performance.

Other variables, including firm size (SIZE), cash flow ratio (CFO), leverage ratio (LEV), return on assets (ROA), and firm age (AGE), are incorporated as control variables in the models. Among these controls, firm size shows a significant positive effect on both RDD and Patent, suggesting that larger firms are more capable of investing in and producing innovation outcomes. In contrast, a higher leverage ratio and lower profitability appear to constrain both innovation input and output, likely due to increased financial pressure and limited internal resources. Additionally, the cash flow ratio shows a significant negative impact on innovation input, implying that firms with higher liquidity might adopt a more conservative approach toward R&D investment, potentially due to a preference for maintaining short-term financial flexibility. Firm age positively influences innovation input but does not have a statistically significant effect on innovation output, indicating that older firms may invest more in R&D but may not necessarily translate this investment into higher patent production.

The inclusion of these control variables enhances the accuracy of the analysis by providing a more nuanced understanding of VC's true impact on corporate innovation, accounting for other firm-specific factors that could influence innovation behaviors. Overall, the findings underscore the critical role of VC in promoting innovation among SMEs, particularly in terms of increasing R&D investment and facilitating successful innovation output. This substantial positive effect supports Hypothesis 1, demonstrating that VC serves as a significant driver of innovation for SMEs by providing not only financial resources but also strategic guidance and access to broader networks, which collectively enable firms to pursue more ambitious and productive innovation activities.

5.3.2 Moderation effects

5.3.2.1 Resources as the moderator (the spillover effect)

Table 5.4 presents the results of testing the moderating effect of resource spillover (Spill) on the relationship between VC and innovation in SMEs. Model (1) uses R&D intensity (RDD) as the dependent variable to capture innovation input, while Model (2) adopts the number of patent applications (Patent) to represent innovation output.

Table 5.4 Testing results of resources as the moderator

Variables	**(1)** **RDD**	**(2)** **Patent**
VC_D	0.6095***	1.3458***
	(0.0792)	(0.1900)
Spill	-12.5074***	-2.0768***
	(0.1412)	(0.3051)
VC_D*Spill	-1.0378***	-2.3101***
	(0.2918)	(0.6292)
SIZE	0.8776***	3.2404***
	(0.0299)	(0.0750)
CFO	-0.1189***	-0.0560
	(0.0173)	(0.0393)
LEV	-2.3250***	-4.8277***
	(0.1559)	(0.3664)
ROA	-0.8736***	2.1380***
	(0.2137)	(0.5219)
AGE	0.0377***	0.0027
	(0.0072)	(0.0187)
IND	YES	YES
YEAR	YES	YES
_cons	0.6897	-54.7676***
	(0.5848)	(1.4606)
N	70723	70729
R-sq	0.3783	0.1419

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

First, the main effects indicate that the VC variable (VC_D) exhibits a significantly positive impact in both models (coefficient = 0.6095 in Model 1, $p < 0.01$; 1.3458 in Model 2, $p < 0.01$), suggesting that the introduction of venture capital significantly enhances both innovation input and output among SMEs. This provides empirical support for the overall "innovation-boosting" function of VC.

Second, the resource spillover variable (Spill) shows significantly negative coefficients in both models (–12.5074 and –2.0768, $p < 0.01$), indicating that SMEs operating in industries with high levels of resource spillover tend to exhibit lower levels of innovation activity. This may be due to the effects of shared or substitutable resources reducing the incentive for independent innovation.

Most notably, the interaction term (VC_D * Spill) is negative and highly significant in both models (–1.0378 in Model 1, $p < 0.01$; –2.3101 in Model 2, $p < 0.01$), suggesting that resource spillover significantly weakens the positive impact of VC on SME innovation. In other words, in industry environments with greater resource accessibility, the marginal advantage of VC's resource support diminishes, partially offsetting its innovation-enhancing effect.

5.3.2.2 Industry uncertainty as the moderator (the supervisory governance effect)

Table 5.5 reports the test results on the moderating effect of industry environmental uncertainty (Uncertain) on the relationship between VC and innovation in SMEs, aiming to assess the presence of a governance-enhancing effect. Model (1) uses R&D intensity (RDD) as the dependent variable to capture innovation input, while Model (2) employs the number of patent applications (Patent) to reflect innovation output.

Table 5.5 Testing results of industry uncertainty as the moderator

Variables	**(1)** **RDD**	**(2)** **Patent**
VC_D	0.4196**	-0.1250
	(0.2046)	(0.4220)
Uncertain	1.6086**	0.0201
	(0.6740)	(1.380467)
VC_D*Uncertain	0.2434	1.6892***
	(0.2264)	(0.4670)
SIZE	1.0844***	3.2781***
	(0.0367)	(0.0754)
CFO	-0.1192***	-0.0611
	(0.0190)	(0.0393)
LEV	-2.5084***	-4.9425***
	(0.1778)	(0.3674)
ROA	-0.8943***	2.1547***
	(0.2544)	(0.5243)
AGE	0.0489***	0.0051
	(0.0092)	(0.0189)
IND	YES	YES
YEAR	YES	YES
_cons	-7.2240***	-56.0023***
	(0.9111)	(1.8704)
N	70723	70729
R-sq	0.3375	0.1426

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

In Model (1), the VC variable (VC_D) shows a significantly positive effect on R&D investment (coefficient = 0.4196, $p < 0.05$), indicating that, after controlling for other factors, venture capital contributes positively to SME innovation input. Meanwhile, industry uncertainty (Uncertain) also has a significantly positive impact on R&D intensity (coefficient = 1.6086, $p < 0.05$), suggesting that SMEs operating in more volatile environments tend to

increase R&D investment in response to external fluctuations.

More importantly, the interaction term (VC_D × Uncertain) yields a coefficient of 0.2434 in Model (1), though it does not reach statistical significance. However, in Model (2), the interaction term demonstrates a significantly positive effect on patent output (coefficient = 1.6892, $p < 0.01$). This indicates that in highly uncertain industry environments, the positive impact of venture capital on SME innovation output is significantly amplified, reflecting a strong moderating governance effect. This may be because, under high uncertainty, venture capital tends to be more actively involved in corporate governance, strengthening firms' R&D orientation and project selection, thereby enhancing its enabling role.

In summary, the empirical results provide partial support for the governance-enhancing effect hypothesis. Specifically, industry uncertainty—as an external contextual factor—can strengthen the capacity of venture capital to promote innovation output among SMEs, particularly in terms of patent generation.

5.3.2.3 Competition as the moderator (management involvement effect)

Table 5.6 presents the regression results testing the moderating effect of industry competition intensity (Compete) on the relationship between VC and innovation in SMEs, aiming to assess the presence of a managerial involvement effect. Model (1) uses R&D intensity (RDD) as the dependent variable to measure innovation input, while Model (2) adopts the number of patent applications (Patent) to capture innovation output.

Table 5.6 Testing results of industry competition as the moderator

Variables	**(1)** **RDD**	**(2)** **Patent**
VC_D	0. 8242***	2.2403***
	(0. 1139)	(0.2353)
Compete	-0.6359***	-1.9075***
	(0.0866)	(0.1793)
VC_D*Compete	-0.4498***	-2.2103***
	(0.1584)	(0.3278)
SIZE	0.9123***	2.7123***
	(0.0409)	(0.0842)
CFO	-0.1152***	-0.0453
	(0.0190)	(0.0393)
LEV	-2.5060***	-4.9253***
	(0.1776)	(0.3669)
ROA	-0.7954***	2.4724***
	(0.2543)	(0.5242)
AGE	0.0487***	0.0040
	(0.0092)	(0.0189)
IND	YES	YES
YEAR	YES	YES
_cons	-2.2866***	-45.0769***

	(0.7950)	(1.6381)
N	70723	70729
R-sq	0.3380	0.1456

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

To begin with the main effects, the VC variable (VC_D) shows a significantly positive impact in both models (RDD: 0.8242, $p < 0.01$; Patent: 2.2403, $p < 0.01$), indicating that, overall, the presence of venture capital significantly enhances both innovation input and output among SMEs.

At the same time, industry competition intensity (Compete) exhibits a significantly negative effect in both models (RDD: –0.6359, Patent: –1.9075, both $p < 0.01$), suggesting that firms operating in highly competitive industries tend to experience suppressed innovation motivation or capability. This may be due to intensified competition compressing profit margins or depleting strategic resources, thus constraining firms' innovation capacity.

Most notably, the interaction term (VC_D × Compete) is negative and statistically significant in both models (RDD: –0.4498, $p < 0.01$; Patent: –2.2103, $p < 0.01$). This indicates that in more competitive industries, the innovation-enhancing effect of venture capital is significantly weakened. These findings do not support the anticipated managerial involvement hypothesis—that is, the assumption that venture capital, through active management participation and strategic optimization, would be more effective in promoting innovation under intense competition.

This negative moderation effect may suggest that in highly competitive industries, external capital engagement in firm management faces greater resistance. Such challenges may include rising internal coordination costs, increased strategic disagreements, or delayed decision-making processes, which can offset the enabling effects of VC. Additionally, firms in such environments may prioritize short-term market performance over long-term R&D investment, thereby diminishing the strategic alignment potential of venture capital.

In summary, the results highlight the critical moderating role of industry competition intensity in the venture capital–innovation linkage, and suggest that in highly competitive markets, venture capital strategies must be more cautious, with an emphasis on differentiated and flexible management involvement approaches.

5.3.2.4 Constraints as the moderator (the financing effect)

Table 5.7 reports the results of testing the moderating effect of financial constraints (Constrain) on the relationship between VC and innovation in SMEs. The aim is to assess whether VC demonstrates stronger enabling effects in financially constrained environments. Model (1) uses

R&D intensity (RDD) as the dependent variable to measure innovation input, while Model (2) adopts the number of patent applications (Patent) as an indicator of innovation output.

Table 5.7 Examination of the financing effect of VC on innovation in SMEs

Variables	**(1)** **RDD**	**(2)** **Patent**
VC_D	0.6038***	1.3356***
	(0.0963)	(0.1990)
Constrain	-0.0250	0.3580**
	(0.0916)	(0.1903)
VC_D*Constrain	0.0755	-0.5441
	(0.1871)	(0.3885)
SIZE	1.0841***	3.2759***
	(1.0367)	(0.0754)
CFO	-0.1194***	-0.0582
	(0.0190)	(0.0394)
LEV	-2.5064***	-5.0414***
	(0.1809)	(0.3740)
ROA	-0.8963***	2.1982***
	(0.2550)	(0.5255)
AGE	0.0489***	0.0058
	(0.0092)	(0.0189)
IND	YES	YES
YEAR	YES	YES
_cons	-5.5911***	-55.9224***
	(0.7123)	(1.4651)
N	70723	70729
R-sq	0.3375	0.1456

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

To begin with the main effects, the introduction of venture capital (VC_D) exhibits a highly significant positive effect in both models (RDD: 0.6038, $p < 0.01$; Patent: 1.3356, $p < 0.01$), once again confirming the positive role of venture capital in enhancing SME innovation performance.

The financial constraints variable (Constrain) is not significant in Model (1), but shows a significantly positive effect on patent output in Model (2) (coefficient = 0.3580, $p < 0.05$). This suggests that financially constrained firms may, to some extent, intensify their pursuit of innovation output through strategies such as securing policy subsidies or optimizing resource use. However, the effect of this variable remains relatively limited on its own.

Crucially, the interaction term (VC_D × Constrain) does not reach statistical significance in either model (RDD: 0.0755; Patent: –0.5441; both $p > 0.1$), indicating that the degree of financial constraint does not significantly moderate the impact of venture capital on SME innovation. This finding does not support the "financing effect" hypothesis—that is, the assumption that VC would exert a stronger innovation-promoting effect under high financial constraint conditions.

This result may suggest that, within the current sample structure or institutional environment, the financing challenges faced by SMEs are being partially alleviated through diversified channels such as government guidance funds, inclusive finance initiatives, or supply chain financing. As a result, the marginal contribution of VC in easing financing constraints may be weakened. Additionally, financial constraints may influence firms more in terms of short-term survival strategies rather than long-term innovation strategies, rendering their moderating role more indirect.

In summary, the findings in Table 5.7 suggest that when evaluating the innovation-driving role of venture capital, one should not assume its effectiveness will be automatically enhanced in contexts of high financial constraint. Rather, it is essential to consider the interactive influence of capital market conditions, industry characteristics, and firms' own strategic orientations.

5.2.3 Robustness check

In examining the relationship between VC and innovation in SMEs, the issue of endogeneity due to sample self-selection becomes crucial. Since venture capitalists tend to prefer investing in companies with strong technological innovation capabilities, there is a potential for sample bias, which could impact the external validity and accuracy of the study's findings. When discussing the endogeneity issue arising from sample self-selection, it is important to first understand the causes and implications of endogeneity. In econometric terms, endogeneity refers to a situation where one or more explanatory variables are correlated with the error term, potentially leading to biased and inconsistent estimates. In this study, VC investment decisions are influenced by various factors, especially the preference for companies with higher innovation capacity, which may cause the sample to lack representativeness of the broader SMEs population.

To address this endogeneity issue effectively, the Heckman two-stage model offers a robust solution. Specifically, in the first stage, a Probit model is employed to estimate the probability of VC firms selecting certain companies for investment. This allows for the calculation of the Inverse Mills Ratio (IMR), which serves as a critical adjustment factor, providing the model with additional information on sample selection bias. In the second stage, the IMR is introduced into the primary regression model as a control variable, aiming to correct for the selection bias and thus yield more reliable and unbiased estimates. This approach enables researchers to better account for the role of private information in VC decision-making while ensuring that the key explanatory variables remain unaffected by self-selection bias.

Due to space limitations, Table 5.8 presents the regression results from the second stage of the Heckman model. As shown in the table, private information held by venture capitalists does indeed impact their investment behavior. Meanwhile, the regression results for the primary explanatory variables remain consistent with previous findings, affirming the robustness of the chapter's conclusions. Across different model specifications, such as when variable X is set as Spill, Uncertain, Compete, and Constrain, VC continues to show a significant positive effect on both the innovation input (RDD) and innovation output (Patent) of firms. This consistency further substantiates the positive role of VC in promoting innovation within enterprises.

Table 5.8 Heckman two-stage regression results: a mechanism test of the impact of VC on innovation in SMEs

Variables	**X=Spill**		**X=Uncertain**	
	(1)	(2)	(1)	(2)
	RDD	Patent	RDD	Patent
VC_D	0.6550***	1.1728***	0.4305**	-0.1562
	(0.0792)	(0.1903)	(0.2041)	(0.4222)
VC_D*X	-1.0219***	-2.3725***	0.3040	1.5142***
	(0.2917)	(0.6278)	(0.2259)	(0.4673)
IMR	-27.4707***	103.2175***	-	101.5717***
	(2.7782)	(6.6999)	34.6356***	(6.7273)
			(3.2516)	
Other variables are controlled				
N	70723	70729	70723	70729
R-sq	0.3787	0.1468	0.3374	0.1475
Variables	X=Compete		X=Constrain	
	(1)	(2)	(1)	(2)
	RDD	Patent	RDD	Patent
VC_D	0.9566***	1.8866***	0.6705***	1.1657***
	(0.1143)	(0.2365)	(0.0963)	(0.1993)
VC_D*X	-0.6110***	-1.7794***	0.0324	-0.5658
	(0.1588)	(0.3288)	(0.1867)	(0.3871)
IMR	-36.0680***	97.7067***	-	102.0164***
	(3.2600)	(6.7446)	34.5177***	(6.7262)
			(3.2506)	
Other variables are controlled				
N	70723	70729	70723	70729
R-sq	0.3379	0.1502	0.3374	0.1475

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

Examining the specific coefficients in Table 5.8, in the scenario where X=Spill, the coefficient of VC_D on innovation input (RDD) is 0.6550, significant at the 1% level, suggesting that in conditions characterized by resource spillover effects, VC significantly enhances firms' R&D expenditure. Additionally, the significance of the IMR coefficient across different contexts supports the presence of selection bias and shows that the model's adjustments are effective. Overall, the application of the Heckman two-stage model not only controls for self-selection bias but also strengthens the reliability and robustness of the study's

conclusions.

Through an in-depth analysis of the endogeneity issue caused by self-selection in VC samples, we can better understand the mechanisms by which VC impacts firm innovation. Although the Heckman model was employed in this study to adjust for biases stemming from self-selection, it remains important to recognize that the robustness and generalizability of these findings require further validation. The relationship between VC heterogeneity and corporate innovation may vary across different market environments and technological contexts. Therefore, future research could focus on testing the heterogeneity of VC and further explore the determinants of VC's impact on SMEs' innovation.

5.2.4 The direct impacts of VC heterogeneity on innovation

The main regression results on the relationship between VC heterogeneity and SMEs' innovation are shown in Table 5.9. According to the regression results on the impact of VC heterogeneity on SMEs' innovation input (RDD), the number of venture capitalists (VC_N) exhibits a significant positive effect on firms' innovation input. The coefficient of VC_N is 0.686 and is significant at the 1% level, indicating that companies with a higher number of VC investments tend to invest more in R&D. This finding suggests that VC not only provides financial support but also brings diversified management capabilities and resource integration, thereby encouraging firms to increase their R&D investments. In contrast, the ownership proportion of VC (VC_R) shows a negative but insignificant effect. Similarly, the regression results for the type of VC investment (VC_I) are also insignificant. This implies that relying solely on ownership proportion and investment type does not adequately explain firms' innovation performance, suggesting that further analysis with additional factors may be required.

Table 5.9 The impact of VC heterogeneity on SMEs' innovation

Variables	RDD	RDD	RDD	RDD	Patent	Patent	Patent	Patent
VC_N	0.686***			0.870***	0.202			0.644
	(0.153)			(0.169)	(0.398)			(0.438)
VC_R		-0.752		-4.022***		-6.922**		-9.244**
		(1.353)		(1.489)		(3.510)		(3.868)
VC_I			0.344	0.297			-0.333	-0.223
			(0.440)	(0.441)			(1.142)	(1.145)
SIZE	1.507***	1.573***(0.187)	1.576***	1.467***	6.528***	6.513***	6.549***	6.437***
	(0.187)		(0.187)	(0.188)	(0.487)	(0.485)	(0.485)	(0.488)
CFO	-0.075	-0.077	-0.077	-0.075	0.129	0.129	0.129	0.130
	(0.049)	(0.049)	(0.049)	(0.049)	(0.127)	(0.127)	(0.127)	(0.127)
LEV	-1.374**	-1.418***	-1.419***	-1.310**	-8.995***	-8.933***	-9.017***	-8.86***
	(0.549)	(0.550)	(0.549)	(0.549)	(1.426)	(1.426)	(1.426)	(1.427)
ROA	-0.747	-0.719	-0.713	-0.787	3.033	2.989	3.042	2.939
	(1.011)	(1.012)	(1.012)	(1.01)	(2.625)	(2.625)	(2.625)	(2.625)
ENT	YES	YES	YES	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES	YES	YES	YES
_cons	-13.930***	-13.930***	-14.392***	-12.921***	-111.828***	-109.891***	-111.655***	-108.858***
	(3.494)	(3.519)	(3.511)	(3.535)	(9.075)	(9.130)	(9.111)	(9.181)
N	16747	16747	16747	16747	16748	16748	16748	16748
R-sq	0.319	0.318	0.318	0.319	0.154	0.154	0.154	0.154

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

In the joint regression, the coefficient of VC_N is 0.870, also significant at the 1% level, indicating that VC has a consistently positive impact on firms' innovation input. The coefficient of VC_R is -4.022 and significant at the 1% level, suggesting that an excessively high ownership proportion of VC may hinder firms' patent output. This could be due to increased decision-making pressure under high VC involvement, causing firms to adopt a more conservative approach to innovation. Among the control variables, firm size (SIZE) has a significant positive effect on both RDD and Patent, indicating that larger firms tend to perform better in innovation input and output. Conversely, leverage (LEV) shows a significant negative effect on innovation activities, suggesting that highly leveraged firms are disadvantaged in terms of innovation investment.

For the regression results on the impact of VC heterogeneity on firms' innovation output (Patent), the number of venture capitalists (VC_N) shows a positive but insignificant effect on innovation output, lacking statistical significance, which implies no strong direct impact of VC quantity on patent output. On the other hand, the ownership proportion of VC (VC_R) exhibits a significant negative effect on innovation output, with a coefficient of -6.922 significant at the 5% level, indicating that an excessive VC ownership proportion may inhibit innovation output. This may be because a high ownership proportion leads to greater conservatism in decision-making, increasing the complexity of innovation management and thereby reducing patent output. Additionally, the type of VC investment (VC_I) shows no significant impact on innovation output, indicating that differences in investment types do not have a direct significant effect on innovation output. Similar results are observed in the joint regression. Among the control variables, firm size (SIZE) has a significant positive impact on innovation output, suggesting that larger firms tend to achieve better patent output. Furthermore, leverage (LEV) has a significant negative effect on innovation output, indicating that high leverage may constrain a firm's capacity for innovation.

According to the regression results, Hypothesis 6, which posits that a high ownership proportion of VC positively influences innovation output, is not supported. The possible reasons are as follows:

Management Intervention from High Ownership Proportion: When VC ownership is high, investors may exert greater influence over corporate operations and decisions. Although VC involvement can sometimes provide valuable strategic guidance and resource integration, excessive intervention may lead to more conservative innovation decisions by management, favoring short-term projects over high-risk, high-reward innovations. In other words, a high ownership proportion of VC may partially restrict firms' innovation freedom, causing them to

prioritize stable operations and avoid potential failure and high-risk innovation.

Innovation Uncertainty and Shareholder Pressure: Innovation is inherently uncertain and high-risk. With an increase in ownership proportion, VC investors may focus more on short-term financial returns, placing additional financial pressure on the firm. This shareholder pressure may compel firms to reduce investment in long-term innovation projects and shift towards initiatives with faster returns, thus hindering R&D and innovation output. This effect is particularly evident in the technology sector, where high shareholder ownership and greater financial constraints often lead to reduced innovation investment.

Balance Between Control and Decision-Making Authority: When VC ownership is excessively high, the founding team or management may lose a degree of decision-making autonomy. The goals of investors and the long-term innovation goals of the firm may not always align, especially when investors pursue rapid exit strategies (e.g., through IPO or acquisition), which may conflict with the longer timeline required for innovation. Thus, a high ownership proportion does not necessarily enhance innovation capabilities and may even weaken the motivation for innovation.

According to the regression results, Hypothesis 7, which suggests that strategic investors are more effective than incubator investors at enhancing SMEs' innovation, is not supported. Possible reasons include:

Blurring of Investor Type Differences: Although strategic and incubator investors differ in their investment goals and support mechanisms, these differences were not reflected in the regression results, possibly indicating that in practice, the impact of these investor types on firm innovation overlaps. In reality, incubator investors may also provide strategic resources and guidance, and strategic investors may support firms' early development. Thus, the distinction between investor types may not be as pronounced as hypothesized, particularly in SMEs, where innovation capability may rely more on internal R&D capacity and managerial decisions than on investor type alone.

Innovation Capability Relies on More Than Investor Type: Firms' innovation capabilities are not solely dependent on external investor support but are also influenced by internal resources, management culture, talent, and other factors. Even if strategic investors provide technological and market resources, firms may still fail to enhance innovation capability if they lack an internal drive for innovation or effective R&D management mechanisms. Therefore, investor type alone does not fully explain firms' innovation performance.

Lagged Effect of Investors' Role: The impact of strategic or incubator investors on innovation often takes time to manifest. Since innovation requires long-term R&D investment

and results take time to materialize, the influence of investors on innovation may not be immediately observable, which could explain the lack of significance in the regression results. Over a longer period, strategic investors' advantages may become more apparent in innovation output; however, this effect is not evident at the current research time point.

Innovation is a complex, multifaceted process driven by factors such as VC, internal firm capabilities, market environment, and policy support. These intricate interactions may explain the insignificance of the regression results. Therefore, single variables like ownership proportion or investor type are insufficient to significantly explain innovation output. Future research may need a more comprehensive perspective to capture additional potential influencing factors.

5.2.5 Impact of VC investment type on SMEs' innovation

The main regression results on the relationship between VC investment type and SMEs' innovation are presented in Table 5.10. Based on the regression results for the impact of VC investment type on SMEs' innovation input (RDD), the duration of VC holding (VC_T) shows a significant positive effect on firms' innovation input. The coefficient for VC_T is 0.094 and is significant at the 1% level, indicating that a longer holding period by VC can lead to increased R&D investment by firms. This suggests that the longer VC remains invested, the more likely the firm is to engage in long-term innovation projects, with VC providing not only funding support but also long-term strategic guidance and resource integration.

Table 5.10 The impact of VC investment types on SMEs' innovation

Variables	RDD	RDD	RDD	RDD	Patent	Patent	Patent	Patent
VC_T	0.094***			0.047	0.058			0.060
	(0.031)			(0.033)	(0.080)			(0.085)
VC_F		-0.148		-0.132***		-0.609		-0.639
		(0.296)		(0.297)		(0.768)		(0.770)
VC_U			1.248***	1.121***			0.198	0.024
			(0.241)	(0.256)			(0.625)	(0.665)
SIZE	1.565***	1.575***(0.187)	1.516***	1.515***	6.541***	6.542***	6.539***	6.533***
	(0.187)		(0.187)	(0.187)	(0.485)	(0.485)	(0.486)	(0.486)
CFO	-0.074	-0.076	-0.078	-0.076	0.131	0.130	0.129	0.131
	(0.049)	(0.049)	(0.049)	(0.049)	(0.127)	(0.127)	(0.127)	(0.127)
LEV	-1.400**	-1.423***	-1.397**	-1.384**	-8.994***	-8.999***	-9.006***	-8.981***
	(0.549)	(0.549)	(0.549)	(0.549)	(1.426)	(1.425)	(1.425)	(1.426)
ROA	-0.700	-0.711	-0.708	-0.700	3.050	3.049	3.044	3.058
	(1.011)	(1.012)	(1.011)	(1.01)	(2.625)	(2.625)	(2.625)	(2.625)
ENT	YES	YES	YES	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES	YES	YES	YES
_cons	-13.864***	-14.076***	-13.485***	-13.348***	-111.718***	-111.600***	-111.786***	-111.392***
	(3.497)	(3.500)	(3.495)	(3.499)	(9.078)	(9.082)	(9.081)	(9.089)
N	16747	16747	16747	16747	16748	16748	16748	16748
R-sq	0.318	0.318	0.319	0.319	0.154	0.154	0.154	0.154

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the values in parentheses represent standard errors.

Compared to the holding duration of VC, the reputation of the VC institution (VC_F) shows a negative but insignificant effect. In the regression results for syndicated investment (VC_U), the coefficient for VC_U is 1.248 and significant at the 1% level. This indicates that syndicated investments have a significant positive impact on firms' R&D investment. Syndicated investment typically brings additional resources, technical support, and risk-sharing, assisting firms in developing and implementing innovation projects more effectively. In the joint regression, the holding period of VC did not reach statistical significance. The coefficient for VC institution reputation is -0.132, which is significant at the 1% level, indicating a significant negative impact of high-reputation VC institutions on R&D investment. This may be because high-reputation VC institutions tend to adopt more conservative and low-risk strategies when selecting investment projects, potentially reducing high-risk R&D investments. The coefficient for syndicated investment (VC_U) is 1.121, with a standard error of 0.256, and is significant at the 1% level. This result indicates that syndicated investment has a significant positive effect on R&D investment, suggesting that firms with syndicated investment receive additional financial and resource support for their R&D activities. Syndicated investment often provides more diversified support, helping firms increase their R&D investment. Thus, Hypothesis 9 is supported.

In the regression results for the impact of VC investment type on firms' innovation output (Patent), the holding period of VC (VC_T), the reputation of the VC institution (VC_F), and syndicated investment (VC_U) all show insignificant effects on firms' innovation output.

Among the control variables, firm size (SIZE) has a significant positive effect on innovation, significant at the 1% level, indicating that larger firms demonstrate stronger innovation capabilities, likely due to greater resources and a higher capacity for innovation. Conversely, leverage (LEV) has a significant negative effect on innovation output, suggesting that high leverage may inhibit a firm's innovation capability. High leverage can limit the financial resources available for innovation projects and increase financial pressure, prompting firms to adopt more conservative operational strategies.

According to the regression results, Hypothesis 8, which posits that high-reputation VC positively moderates a firm's innovation activities, is not supported. Possible reasons include:

Diversified Investment Portfolio Reducing Innovation Risk in Single Projects: High-reputation VC institutions often maintain diversified investment portfolios with the aim of spreading risk by investing across multiple firms. Under this approach, these institutions may prefer to keep firms on a stable operational path, avoiding large-scale R&D investment in any single firm to prevent potential negative impacts on the overall portfolio from high-risk project

failures. Consequently, high-reputation VC institutions may reduce their support for R&D in firms, as they focus more on achieving stable returns through diversification rather than seeking breakthroughs from single high-risk projects.

Conservative Investment Approach Among High-Reputation Institutions: The reputation of VC institutions is often closely tied to successful exits in multiple firms. High-reputation institutions tend to be more cautious and conservative in decision-making to maintain their market standing. As a result, these institutions may favor investments in lower-risk projects with more predictable returns, avoiding an excess of high-risk innovation projects. This investment preference may cause invested firms to reduce their R&D and innovation spending, as they are influenced by the VC institution to prioritize short-term financial returns over long-term, high-risk innovation projects.

Reliance on External Resources and Expertise Provided by High-Reputation Institutions: High-reputation VC institutions can often bring substantial resources and external support to the firms in which they invest. However, this may lead firms to become overly dependent on externally provided technologies or solutions, reducing their own R&D investment. Firms may rely on external partners or technologies recommended by the VC institution rather than pursuing in-house R&D, thereby diminishing internal innovation incentives and efforts.

5.5 Chapter summary

Chapter 5 presents an empirical analysis to investigate how VC influences innovation in SMEs, focusing on validating the theoretical mechanisms outlined in Chapter 2. The chapter applies quantitative methods to assess the impact of VC on innovation input and output, using a sample of companies listed on NEEQ from 2014 to 2023. The primary goal is to test four hypothesized mechanisms—resource spillover, supervisory governance, management participation, and financing effects—through which VC is expected to promote SMEs' innovation.

The analysis reveals important insights into the moderating effects of industry characteristics on VC's impact. In high-R&D-spillover industries, the positive effect of VC on innovation is moderated as firms leverage available knowledge and technology resources independently. For industries with high uncertainty, VC's supervisory governance role is highlighted, especially in promoting innovation output. Conversely, in highly competitive markets, VC's influence on both R&D and patent output is reduced as firms prioritize immediate market performance over long-term innovation. The financing effect, however, shows limited influence on VC's impact in listed firms, where alternative financing sources

lessen the reliance on VC. The study also evaluates various VC characteristics—such as shareholding proportion, investment type, reputation, holding period, and whether the investment is syndicated or solo-to understand their influence on R&D investment and innovation output in SMEs.

Syndicated investments are found to have a notably positive impact on R&D, as they offer resource diversity and risk-sharing benefits, enabling SMEs to engage in more ambitious innovation projects. However, the positive influence of highly reputable VC firms on innovation is not statistically significant. This may be due to a conservative approach often adopted by high-reputation VC firms, which prioritize stable returns and diversified portfolios over high-risk R&D in individual companies.

In terms of investment type, a longer holding period by VC firms is shown to increase R&D investment, supporting the notion that long-term involvement fosters sustained innovation. The results thus highlight that while VC firms contribute positively to SMEs' innovation, the effectiveness of this support varies based on investment type, firm reputation, and industry characteristics.

All the hypothesis testing results are shown in Table 5.11.

Table 5.11 Hypotheses test result

No.	Hypothesis	Result
H1	VC has a positive effect on both the innovation input and innovation output of SMEs.	Supported
H2	In industries with extensive R&D resource spillovers, the positive effect of venture capital on firm innovation will be weakened.	Supported
H3	When firms operate in industries characterized by high environmental uncertainty, the supervisory governance effect of venture capital has a stronger positive impact on SME innovation.	Supported
H4	In industries with more intense market competition, the managerial involvement effect of venture capital has a stronger positive impact on SME innovation.	Not Supported
H5	In industries with a high degree of capital dependence, the financing support effect of venture capital significantly enhances SME innovation capability.	Not Supported
H6	A higher VC ratio is associated with better innovation capability in SMEs	Not Supported
H7	Strategic investors are more effective than incubative investors in enhancing the innovation capabilities of SMEs.	Not Supported
H8	Reputation-oriented venture capitals are more effective than profit-oriented investors in enhancing the innovation capabilities of SMEs.	Not Supported
H9	Syndicated venture capitals are more effective than independent investors in enhancing the innovation capabilities of SMEs.	Supported
H10	A longer duration by venture capital investors enhances SME innovation capability.	Supported

Overall, Chapter 5 substantiates the complex ways in which VC facilitates innovation in SMEs, offering empirical support for the theoretical framework established earlier. This

analysis emphasizes the importance of industry context in determining VC's effectiveness, providing actionable insights into the conditions under which VC is most impactful for SMEs' innovation. These findings lay the groundwork for further research on the role of VC in fostering sustainable growth and technological advancement in the SMEs sector.

Chapter 6: Discussion and Conclusion

This chapter provides a summary of the research conclusions derived from theoretical, empirical, proposes policy recommendations, and identifies potential directions for future research. The study finds that VC has a significant positive impact on the innovation capacity of SMEs, particularly in terms of financing, management, and resource support. However, the effectiveness of VC is influenced by factors such as shareholding proportions, investment types, and the capital market environment.

6.1 Discussion

6.1.1 The direct impact of VC on innovation

This study supports Hypothesis 1, indicating that VC has a significant positive effect on both innovation input and output among SMEs. This finding is consistent with prior empirical research. Mann and Sager (2007), Bertoni and Croce et al. (2010), Bertoni and Colombo et al. (2010)and Kortum and Lerner (2000) all demonstrate that VC investment significantly enhances firms' patenting activity and innovation capacity. Further, Celikyurt et al. (2014) and Greenwood et al. (2022) show that venture capital not only benefits early-stage startups but also continues to support R&D efforts in more mature enterprises. At the industry and national levels, concentrated VC investment has been shown to stimulate broader research output (Kortum & Lerner, 2000), and its innovation-enhancing effects are more pronounced in countries with favorable institutional environments (Popov & Roosenboom, 2012; Schertler, 2007). By focusing on Chinese SMEs, this study provides further empirical validation of the mechanisms through which VC promotes innovation, contributing to the growing body of literature in emerging market contexts.

However, some scholars have questioned this positive association. Caselli et al. (2009) found that after the initial investment phase, VC institutions often shift their focus toward profitability and managerial optimization, rather than sustaining innovation, which in some cases results in reduced patent output. Similarly, Gilbert and Newbery (1982) and Zucker et al. (1994) suggest that VC may, under certain circumstances, hinder rather than support technological innovation. These studies highlight the context-dependent nature of VC's impact

on innovation and caution against generalizing its effects.

Moreover, the relationship between VC and innovation exhibits nonlinear and dynamic characteristics. Arqué-Castells (2012) found a curvilinear (inverted U-shaped) relationship between VC investment and patent output, where early-stage support yields strong innovation returns, but the marginal effect diminishes over time. Manigart and Hyfte (1999) further argue that VC often exerts influence on innovation indirectly through strategic guidance and operational support, rather than direct funding of R&D activities.

A more complex aspect is the bidirectional causality between VC and innovation. On one hand, firms with stronger technological capabilities and innovative potential are more likely to attract VC funding (Chemmanur et al., 2011; Hirukawa & Ueda, 2011). On the other hand, VC participation enhances firm performance in areas such as financing efficiency, market strategies, and total factor productivity (Hellmann & Puri, 2000), thereby reinforcing their innovation momentum. This interdependence suggests that the VC–innovation relationship is not simply linear but rather a mutually reinforcing and co-evolving process.

In summary, while this study confirms the innovation-enhancing role of venture capital, its effects are not universally applicable. They are moderated by factors such as firm development stage, post-investment strategies, industry characteristics, and macro-environmental conditions. Future research should further investigate the boundary conditions and contextual mechanisms shaping the relationship between VC and innovation to develop a more comprehensive understanding of its causal pathways.

6.1.2 The mechanisms through which VC influences innovation

6.1.2.1 The spillover effect of VC

The findings of this study support Hypothesis 2: In industries with extensive R&D resource spillovers, the positive effect of venture capital on firm innovation is weakened. In Model (1), the interaction term coefficient is –1.0378 and is statistically significant at the 1% level, indicating that in industries characterized by high levels of R&D spillovers, the positive impact of venture capital on innovation input is significantly diminished. This may be because in such environments, firms can more easily access technological knowledge and expertise from the broader industry, thereby reducing the marginal effectiveness of venture capital. As a result, firms may not need to rely heavily on external venture funding to support high-intensity R&D investment, which weakens the enabling effect of VC.

Similarly, in Model (2), the interaction term yields a coefficient of –2.3101, also significant

at the 1% level, suggesting that venture capital's impact on innovation output—measured by patent applications—is likewise attenuated in high-spillover industries. Notably, the magnitude of this negative moderation is even greater for patent output than for R&D investment. This may be due to firms in high spillover environments being more capable of accessing external technological resources, thereby reducing their dependence on VC-provided support. Consequently, the incremental increase in patent output attributable to VC is less pronounced in such contexts compared to industries with lower levels of spillover.

This result aligns with the extended logic of Resource Dependence Theory. According to Pfeffer and Salancik (2015), organizations rely on scarce and non-substitutable resources from the external environment to sustain their operations and development. The innovation-promoting effect of VC is fundamentally based on the premise that the resources it provides—such as R&D funding, technological access, and professional networks—are scarce and difficult to substitute. However, when firms operate in industries characterized by abundant external knowledge and technological spillovers, their dependence on VC-provided resources diminishes significantly. In high-spillover environments, firms are more likely to "free ride" on industry-wide knowledge flows, thereby reducing their need for internal R&D investment and weakening the marginal utility of venture capital.

Chemmanur and Tian (2018) argue that in industries where technological knowledge is easily shared, venture capitalists tend to adopt short-term arbitrage strategies, making it difficult to support sustained and intensive R&D efforts. This finding indirectly explains the stronger negative moderating effect observed in this study at the level of patent output (Model 2): when firms can access ready-made technological solutions through external resources, their incentives and capacities for original innovation are reduced. As a result, even with VC involvement, it becomes difficult to achieve sustained innovation breakthroughs (Chemmanur & Tian, 2018).

Similarly, Howell (2017), based on empirical research in China's manufacturing sector, find that in high knowledge-spillover industries, the innovation-stimulating effects of both foreign capital and venture capital are significantly weakened—further confirming the boundary conditions imposed by the resource environment on capital's enabling role. The absorptive capacity theory proposed by Cohen and Levinthal (1990) also suggests that firms' ability to utilize external knowledge may itself reduce their reliance on external capital. In industries with pervasive knowledge diffusion, such tendencies toward "passive innovation" are particularly pronounced.

In sum, although venture capital—by serving as a high-quality external resource provider—

has the potential to enhance innovation in SMEs, its innovation-inducing function exhibits diminishing marginal returns in industries with high levels of R&D spillovers. These findings not only enrich the contextual applicability of the VC enabling logic but also offer practical implications: policymakers and investors should take into account the knowledge characteristics of the industry environment and carefully align capital instruments with appropriate resource allocation strategies to effectively support SME innovation.

6.1.2.2 The governance effect of VC

This study proposed Hypothesis 3, which posits that in contexts of high industry uncertainty, the governance effect of VC would more significantly promote innovation activities in SMEs. The empirical results exhibit a partially supportive trend across the two models.

In Model (1), the interaction term VC_D × Uncertain is positive (0.2434), but not statistically significant, indicating that industry uncertainty does not significantly moderate the impact of VC on firms' innovation input. This may be due to the fact that in the early stages of resource allocation, firms tend to make independent decisions based on their own judgment and strategic goals, limiting the extent to which VC can intervene in R&D investment decisions. Moreover, given the inherently high-risk, high-uncertainty, and high-information-barrier nature of SME R&D activities, VC's governance capacity may not easily translate into increased input at this stage. Therefore, in highly uncertain environments, the governance mechanism of VC appears to have a neutral effect at the input level.

However, the results of Model (2) show that the interaction term coefficient is 1.6892 and statistically significant at the 1% level, indicating that industry uncertainty significantly enhances the positive effect of VC on innovation output (i.e., patents). This finding supports the core logic of Hypothesis 3: in industries characterized by environmental complexity, market volatility, and policy uncertainty, VC tends to become more actively involved in governance—strengthening supervision and evaluation throughout the R&D process—and thereby helps firms more effectively convert input into measurable innovation outcomes. As Hellmann and Puri (2002) suggest, venture capital enhances a firm's ability to execute innovation strategies under uncertainty through staged goal-setting, participation in decision-making, and the implementation of professionalized management mechanisms.

At the same time, high industry uncertainty often exacerbates problems of information asymmetry and resource misallocation. VC's governance involvement can help offset these negative effects (Gompers & Lerner, 2004). Specifically, VC may place greater emphasis on monitoring aspects such as patent filing, output transformation, and commercialization, thereby

promoting the conversion of early-stage investments into market-recognizable intellectual property—producing more pronounced enabling effects at the outcome level.

In summary, although VC's supervisory role may not significantly influence innovation input under uncertainty, its governance effect on innovation output is clearly amplified in highly uncertain industry environments. This result not only confirms the stage-specific nature of VC governance mechanisms but also suggests that, in uncertain sectors, investors should focus more intensively on post-investment outcome management and process supervision in order to fully leverage their governance advantages."

6.1.2.3 The managerial involvement effect of VC

This study proposed Hypothesis 4, which posits that in industries with more intense market competition, the managerial involvement effect of VC would more significantly promote innovation in SMEs. However, the regression results do not support this hypothesis. In Model (1), the interaction term VC_D × Compete yields a coefficient of –0.4498, which is statistically significant at the 1% level. Similarly, Model (2) reports a significantly negative coefficient for the interaction term (–2.2103, $p < 0.01$). These findings indicate that higher levels of industry competition actually weaken the innovation-promoting effect of venture capital, which runs counter to the direction anticipated in the hypothesis.

This result may be attributed to several underlying mechanisms. First, in highly competitive industries, SMEs face greater market pressure and survival challenges, often prioritizing resource allocation toward short-term survival and market expansion rather than long-term, high-risk innovation activities (Nickell, 1996). Under such conditions, even if VC provides strong strategic guidance and managerial involvement, its advocacy for long-term innovation may not be adequately embraced by the firm.

Second, intense industry competition often brings heightened internal decision-making tension and organizational change pressure, which may lead to conflicts within governance structures. As VC becomes involved in post-investment management, it may encounter strategic misalignment with the founding team regarding goals, capital utilization, and resource deployment. Especially in rapidly evolving markets, such governance participation can increase coordination costs, thereby weakening VC's intended enabling effect (Hellmann & Puri, 2002). Empirical studies have also shown that in contexts of high external pressure and strategic uncertainty, governance interventions by external investors may lead to reduced managerial efficiency or weakened strategic coherence (Guler, 2007).

Furthermore, competitive pressures may already incentivize firms to enhance their own

managerial and technological capabilities, rendering the additional value of VC's managerial involvement increasingly redundant. As suggested by Cohen and Levinthal (1990), when firms possess strong absorptive capacity, the marginal benefit of external knowledge input diminishes. This implies that VC's managerial support does not necessarily generate multiplier effects in all highly competitive industries.

Therefore, although venture capital theoretically holds the potential to foster innovation through managerial engagement, in intensely competitive environments, this pathway is constrained by multiple factors—including resource reallocation pressures, strategic divergence risks, and institutional friction costs. The innovation-enhancing effect of VC is thus significantly diminished. These findings highlight the importance of evaluating contextual fit and governance alignment mechanisms when encouraging SMEs to adopt venture capital, rather than relying on standardized governance templates or assuming uniform enabling effects across industries.

6.1.2.4 The financing effect of VC

This study proposed Hypothesis 5, which posits that in industries with high capital dependence, the financing role of VC would more significantly enhance firms' innovation capabilities. This hypothesis is grounded in VC financing support mechanism, with the expectation that in environments where access to funding is limited, capital infusion from VC should more effectively alleviate financial bottlenecks in the innovation process.

However, the empirical results do not support this hypothesis. In Model (1) and Model (2), the interaction term VC_D × Constrain yields coefficients of 0.0755 and –0.5441, respectively—both of which fail to reach statistical significance. These results indicate that the level of financial constraint does not significantly moderate the relationship between venture capital and either innovation input or innovation output, suggesting that VC's ability to promote innovation is not necessarily amplified under conditions of high capital dependence.

This result may be explained by several underlying reasons:

First, some studies suggest that the effect of financial constraints on innovation is indirect and non-linear. Kaplan and Zingales (1995) argue that firms exhibit heterogeneous sensitivity to financial constraints. Certain innovation-oriented SMEs may be able to sustain innovation activities even under high financial pressure by reallocating internal resources, leveraging government subsidies, or utilizing technology support platforms. In this context, the marginal financing role of VC is diluted by alternative financing mechanisms, resulting in an insignificant moderating effect.

Second, in recent years, the financing environment for SMEs in China has significantly improved. The development of multi-tiered capital markets, the increasing presence of government guidance funds, and the expansion of science and technology financial instruments have collectively alleviated systemic financing constraints for many firms (Jin et al., 2024; Yang et al., 2024). As a result, even firms operating in capital-intensive industries may not face extreme financing bottlenecks. Consequently, the entry of VC does not offer a decisive financing advantage, weakening the moderating power of its funding function.

Third, the investment motivation and post-investment behavior of venture capital may be more oriented toward selective entry and value discovery rather than simply filling funding gaps. As noted by Chemmanur et al. (2011), VCs are more likely to invest in firms with high growth potential rather than those suffering from severe financial constraints. Therefore, in capital-dependent industries, the selective investment behavior of VC may reduce the salience of its financing role in the sample, leading to a statistically insignificant moderating effect.

In sum, financial constraint—as an industry characteristic or environmental factor—does not appear to significantly moderate the relationship between VC and firm innovation. This finding cautions against the simplistic assumption that "capital scarcity" directly translates into greater capital support value. For policymakers seeking to leverage VC to promote SME innovation, greater attention should be paid to the alignment between capital supply mechanisms and firms' absorptive capacity, rather than relying solely on the logic of funding shortages.

6.1.3 The impact of VC heterogeneity on innovation

According to the regression results, Hypothesis 6, which posits that a higher equity stake held by VC investors positively affects innovation output, is not supported. Several potential explanations may account for this finding:

First, increased managerial intervention due to high ownership. When VC investors hold a substantial equity stake, they may exert greater influence over the firm's operations and strategic decisions. While such involvement can sometimes lead to beneficial strategic guidance and resource integration, excessive interference may cause the management team to become more risk-averse in their innovation decisions (Balz et al., 2023; Bhattacharyya & Subrahmanya, 2024; Foss et al., 2007). As a result, firms may prioritize projects with short-term returns rather than those involving high risk but potentially high reward. In other words, a higher VC shareholding may constrain the firm's innovation autonomy, leading it to emphasize operational stability over potentially transformative, but risk-laden, R&D initiatives.

Second, the inherent uncertainty of innovation and shareholder pressure. Innovation activities are by nature uncertain and risky (Branzei & Vertinsky, 2006). As VC investors increase their shareholding, they may become more concerned with achieving short-term financial returns, thereby exerting additional financial pressure on the firm. This shareholder pressure may lead firms to reduce investment in long-term innovation projects and instead pursue initiatives that yield quicker financial outcomes (Knockaert et al., 2010). This tendency is particularly evident in high-tech industries, where elevated ownership by venture investors often coincides with tighter financial constraints, ultimately diminishing firms' commitment to innovation input and output.

Third, imbalance in control and decision-making power. When VC investors hold a dominant ownership stake, the founding team or management may lose some degree of decision-making autonomy (Foss et al., 2007; Useche & Pommet, 2021). The objectives of investors—particularly those aiming for rapid exit strategies such as IPOs or mergers and acquisitions—may not fully align with the long-term innovation goals of the enterprise. Such misalignment can be especially problematic given the extended time horizons often required for breakthrough innovation. Therefore, a high VC ownership stake does not necessarily translate into enhanced innovation capability; on the contrary, it may erode the firm's innovation incentives.

According to the regression results, Hypothesis 7, which posits that strategic investors are more effective than incubator-type investors in enhancing the innovation capacity of SMEs, is not supported. Several plausible explanations may account for this outcome:

First, the distinction between investor types may be less pronounced in practice. Although strategic and incubator-type investors differ in their investment objectives and modes of support, the empirical findings reveal no significant differentiation in their effects on firm innovation. In reality, incubator investors may also provide strategic resources and guidance, while strategic investors might engage in early-stage support (W. Li et al., 2016). Consequently, the hypothesized distinction may be blurred, particularly among SMEs where innovation performance is often more strongly influenced by internal R&D capabilities and managerial decisions than by the investor's classification alone (Balz et al., 2023; Chen & Karami, 2010).

Second, firm innovation capacity is not solely determined by investor type; it is also closely tied to internal resources and organizational culture (Branzei & Vertinsky, 2006; Knockaert et al., 2010). Even with external support from strategic investors in terms of technology and market access, firms with weak internal innovation drive, insufficient talent, or ineffective R&D management mechanisms may still struggle to translate that support into innovation outcomes.

Thus, investor type alone may not provide a comprehensive explanation of innovation performance.

Third, the impact of investor type may be subject to time-lag effects (Bhattacharyya & Subrahmanya, 2024). The contribution of both strategic and incubator investors to innovation is likely to manifest over a longer time horizon. Given the inherently long-term nature of innovation processes—requiring sustained R&D investment and technology commercialization—the positive effects of strategic investors may not be immediately observable within the study period. It is possible that their advantages become more apparent in long-term innovation output, but such effects may not yet be reflected in current regression results.

In summary, innovation is a complex, multi-factorial process influenced by a combination of external investment, internal capabilities, market dynamics, and institutional environments. The insignificant findings may reflect the intricate interactions among these variables. As such, single indicators—such as equity stake or investor classification—may be insufficient to robustly explain innovation output. Future research should adopt a more integrative analytical framework to capture these nuanced mechanisms and contextual contingencies.

6.1.4 The impact of VC type on innovation

According to the regression results, Hypothesis 8, which posits that high-reputation VC institutions are more effective than profit-driven VCs in enhancing SMEs' innovation performance, is not supported. Several potential explanations may account for this unexpected finding:

First, portfolio diversification may reduce innovation incentives at the firm level. High-reputation VCs often adopt a diversified investment strategy aimed at minimizing risk through multiple investments (Lee et al., 2019; Xu, 2018). Under such a strategy, these institutions may encourage portfolio companies to maintain stable operations rather than engaging in large-scale, high-risk R&D projects that could jeopardize the overall performance of the portfolio. As a result, support for aggressive innovation may be constrained by the investor's overarching risk-control objectives.

Second, high-reputation VCs tend to follow more conservative investment practices. The reputation of VC institutions is typically built upon a consistent record of successful exits across various ventures (Atanasov et al., 2012). To preserve this reputation, such institutions are often more cautious in their decision-making, favoring investments in projects with lower risk and more predictable returns (Bertoni et al., 2015; Useche & Pommet, 2021). This risk-averse

behavior may discourage portfolio firms from pursuing long-term, uncertain innovation projects, and instead redirect their attention to short-term financial performance that aligns with investor expectations.

Third, strong external support may unintentionally reduce internal innovation incentives. Well-established VC firms bring valuable resources, networks, and managerial expertise to the companies they fund. However, this abundance of external assistance may inadvertently lead to a dependence on external knowledge and technical solutions (Lu et al., 2017; X. R. Zhang et al., 2019). Portfolio companies may be more inclined to adopt technologies recommended by investors or rely on external partners, rather than investing in their own in-house R&D. This reliance can weaken firms' internal innovation capabilities and diminish their motivation to pursue original technological development.

In summary, while high-reputation VCs possess superior resources and governance capabilities, these advantages do not necessarily translate into stronger innovation outcomes for the firms they back. The interplay between reputation, risk aversion, and managerial influence may inadvertently constrain entrepreneurial risk-taking and internal innovation efforts.

6.2 Research conclusions

Based on theoretical foundation and empirical analyses throughout this thesis, the following main conclusions are drawn:

(1) Positive impact of VC on SMEs' innovation

Theoretical research indicates that VC can enhance SMEs' innovation capacity through financial support, resources, and management assistance. Empirical analysis reveals that VC not only provides ample financial backing but also promotes innovation investment through resource networks, professional management, and technical support. This conclusion answers RQ1 proposed in Chapter 1.

(2) Multiplicity of mechanisms

This study constructs a multi-pathway mechanism framework to explain how VC influences innovation, encompassing resource spillover effect, governance effect, managerial involvement effect, and financing effect. The mechanism tests reveal significant heterogeneity across different industry contexts, as follows:

First, in industries with a high degree of R&D resource spillovers, the innovation-promoting effect of VC is significantly weakened. This finding suggests that knowledge-sharing environments reduce firms' dependence on external capital resources, thereby

confirming the marginal suppressive effect of spillovers on VC's enabling role.

Second, industry uncertainty shows a stage-specific moderating effect on VC's innovation-enabling capacity. While its effect is not significant at the innovation input stage, it becomes significantly positive at the innovation output stage, indicating that VC's supervisory governance effect plays a more critical role in the realization and transformation of innovation outcomes rather than in the initial investment phase.

Third, the direction of moderation by industry competition intensity on the managerial involvement effect is contrary to expectations. Empirical results demonstrate that the more intense the competition, the weaker the positive effect of VC on firm innovation. This suggests that in highly competitive environments, VC's managerial engagement may face multiple barriers—such as resource conflicts and strategic friction—resulting in a significantly compressed enabling effect.

Finally, financial constraint, as a moderating variable, does not show a statistically significant effect. This indicates that in industries with limited access to capital, the financing support function of VC is not substantially amplified. This result may reflect the substitution effect of diversified financing channels that diminish the unique capital advantage of VC, or it may imply that access to capital does not necessarily translate into higher levels of innovation activity.

In summary, this study not only confirms the positive impact of venture capital on innovation in SMEs but also reveals that its effectiveness is significantly moderated by industry characteristics. These findings provide a comprehensive answer to RQ2 regarding the contextual mechanisms through which VC influences SME's innovation.

(3) Differential effects of VC Heterogeneity on innovation

This study further investigates how the internal heterogeneity of VC influences innovation performance in SMEs, focusing on two key dimensions: ownership stake and investor type. The aim is to examine whether "who invests" and "how much is invested" significantly affect firm innovation. However, the empirical findings indicate that neither dimension shows a statistically significant direct effect on innovation input or output, and the associated hypotheses are not supported.

Specifically, the ownership stake held by venture capital does not exhibit a significant positive effect on innovation performance. This suggests that a higher equity share does not necessarily translate into stronger post-investment intervention or governance participation. In practice, a large ownership stake may even result in rigid governance structures or increased strategic conflicts, thereby weakening VC's ability to positively guide resource allocation and

strategic execution for innovation.

In addition, investor type does not significantly influence the innovation performance of portfolio firms. Although, in theory, "strategic investors" are expected to possess stronger industry expertise and resource integration capabilities, their actual enabling potential may be limited by factors such as vague investment objectives, lack of coordination mechanisms, or insufficient post-investment engagement. This finding highlights that capital labels are not equivalent to capital capabilities, and that the actual value of investors depends more on their depth of involvement and systematic support throughout the innovation process.

In conclusion, the "heterogeneity labels" of venture capital—such as shareholding ratio or investor classification—are insufficient indicators of its innovation-driving potential. Future research should shift greater attention toward behavioral heterogeneity, including dynamic process variables such as post-investment engagement, strategic alignment pathways, and resource allocation efficiency, in order to more accurately capture the mechanisms through which VC influences firm innovation. These findings provide a detailed answer to RQ3.

(4) Differential effects of VC investment modes on innovation

This study further investigates how different investment modes of VC—in terms of investment motivation, investment structure, and investment horizon—affect the innovation performance of SMEs. The empirical results reveal significant variation across these three dimensions.

First, regarding investment motivation, although in theory "reputation-oriented" VC is expected to be more supportive of long-term development and technological accumulation compared to "profit-driven" VC, the empirical results do not support this assumption. The hypothesis was not confirmed. This may reflect the reality that, in capital markets, the motivational boundaries of VC investors are often blurred. In practice, cultivation-oriented goals may be subordinated to financial return considerations, thereby weakening the consistency and significance of their guidance for innovation investment.

Second, in terms of investment structure, the study finds that syndicated investment—as opposed to Independent investment—has a significantly positive impact on SME innovation, thus supporting the related hypothesis. This result suggests that syndication helps integrate diverse resources, distribute risks, and improve both project selection and post-investment management quality. These advantages contribute to more effective promotion of innovation input and output in SMEs, echoing prior findings on the synergistic effect of syndication (Lerner, 1994).

Third, concerning investment horizon, the results support the hypothesis that longer

duration are associated with stronger positive effects of VC on firm innovation. This indicates that long-term capital is characterized by greater tolerance and strategic patience, which facilitates sustained and phased R&D efforts. It helps firms avoid interruptions or declines in innovation due to short-term exit pressures. This finding also underscores the importance of VC as "patient capital", aligning with the foundational role of long-term orientation in realizing innovation value (Bernstein et al., 2016).

In summary, this study, from the perspective of investment modes, reveals that VC's influence on innovation varies across the dimensions of capital nature, structural arrangement, and time horizon. Among them, investment structure (i.e., syndication) and investment horizon (i.e., long-term holding) emerge as significant positive factors, while investment motivation labels (reputation-driven vs. profit-driven) do not show statistically significant predictive power. These results suggest that rather than relying on surface-level classifications, the innovation-driving capacity of VC should be evaluated in light of its post-investment behavior intensity, strategic support capability, and long-term engagement commitment. These findings provide a comprehensive response to RQ4.

6.3 Research contributions

6.3.1 Practical contributions

Based on the empirical findings of this study regarding the impact of VC on innovation in SMEs, along with the results of moderating effect tests across dimensions such as industry environment, capital characteristics, and investment modes, this research offers the following four key practical implications:

(1) For Regulatory Authorities: Improve Multi-Tier Capital Markets and Institutional Support for Long-Term Capital

The study finds that the innovation-enhancing effect of VC is more pronounced under specific conditions—such as in industries with low resource spillovers or high environmental uncertainty. This suggests that in advancing capital market reform, regulatory authorities should emphasize institutional alignment and efficiency of capital allocation, particularly by incentivizing the "patient capital" attributes of venture capital. Mechanisms such as differentiated information disclosure requirements, diversified exit channels, and syndication-friendly policies could help direct capital toward SMEs in strategic sectors and early- to mid-stage projects.

Furthermore, regulators should strengthen constraints on behaviors such as "empty post-investment management" or short-term arbitrage-oriented VC investments, to prevent a shift from technology cultivation to technology arbitrage. Establishing robust supervisory frameworks that reward long-term commitment and strategic participation is essential to preserving the developmental function of VC.

(2) For Government: Optimize Innovation Policy Tools and VC Guidance Mechanisms

The study shows that VC's impact on innovation output (e.g., patents) is positively moderated by industry uncertainty, but diminished in highly competitive or high spillover environments. This provides a theoretical basis for governments to design differentiated innovation support policies. Innovation incentives should be industry- and stage-specific: in sectors with scarce resources and limited knowledge diffusion, government should strengthen VC guidance funds and tax incentives to attract long-term capital. In contrast, for resource-intensive industries, the government should foster collaborative innovation mechanisms between venture capital, public innovation platforms, and research institutions to prevent resource redundancy and capital misallocation.

Additionally, efforts should be made to enhance post-investment service platforms, thereby building a policy ecosystem that supports the full innovation cycle—from financing and incubation to commercialization.

(3) For SMEs: Make Rational Capital Choices and Align Governance Structures

The study reveals that the enabling effect of venture capital does not primarily depend on its nominal equity stake or strategic labels, but rather on the actual depth of post-investment engagement and investment approach. This offers a clear implication for SMEs: when introducing external capital, they should move beyond the obsession with "brand-name VCs" or "high ownership percentages," and instead focus on whether the investor can deliver substantive support in areas such as management guidance, resource integration, and strategic collaboration.

SMEs should proactively establish open and adaptive governance structures to facilitate VC involvement, providing institutional access for capital participation. In addition, investment agreements should explicitly define roles, governance responsibilities, and exit mechanisms to enhance the governance efficiency and strategic alignment of capital partnerships.

(4) For VC: Optimize Investment Structures and Post-Investment Enabling Mechanisms

This study finds that syndicated investment and long-term shareholding significantly strengthen the positive effect of VC on enterprise innovation, suggesting that venture capital firms should shift from "individual deployment" toward collaborative investment strategies. By

engaging in joint post-investment management and resource sharing with co-investors, VC firms can provide SMEs with more sustained and in-depth support.

Moreover, strategic investors should actively leverage their industry-specific advantages and avoid the hollowing-out of so-called "branded strategic investments." VC firms should also refine their internal evaluation mechanisms, avoiding an overemphasis on short-term valuations and quick exits at the expense of innovation accumulation and technology maturation cycles. Ultimately, venture capital should position itself as a long-term partner and collaborator in the technological growth journey of SMEs.

6.3.2 Theoretical contributions

This study explores how VC promotes innovation in SMEs by constructing a multi-dimensional theoretical framework grounded in Resource Dependence Theory, Agency Theory, Value-Added Services Theory, and Signaling Theory. Based on this framework, four VC enabling mechanisms and their corresponding contextual boundary variables are proposed, thereby enhancing the explanatory power of VC theory under conditions of environmental uncertainty. The theoretical contributions of this study are reflected in the following four aspects:

First, building on Resource Dependence Theory, this study introduces industry-level R&D resource spillover as a moderating variable to examine whether the external resource environment strengthens VC's supportive role. The findings show that in industries with high R&D spillovers, firms have easier access to external technologies and knowledge, and the marginal contribution of VC declines significantly. This result confirms the dynamic nature of resource dependence, which is shaped by the structure of external resources. It extends the application of Resource Dependence Theory to the domain of innovation behavior, highlighting how resource accessibility alters the effectiveness of external capital support.

Second, drawing from Agency Theory, this study incorporates industry uncertainty as a boundary condition to assess the effectiveness of VC's governance and monitoring function in innovation processes. The empirical analysis reveals that VC significantly promotes innovation output (e.g., patents) in high-uncertainty industries, while its effect on innovation input (e.g., R&D intensity) is not significant. This finding suggests that the supervisory role of VC may have a stage-specific effect in the "input-to-output" innovation pathway. It enriches Agency Theory by demonstrating how external governance mechanisms adapt dynamically to complex environmental conditions, thereby advancing theoretical understanding of VC's contingent effectiveness.

Third, grounded in Value-Added Services Theory, this study proposes a hypothesis that

industry competition intensity moderates the managerial involvement effect of venture capital. Contrary to expectations, the results reveal that the more intense the competition, the more the positive impact of VC on firm innovation is weakened. This finding suggests that in high-pressure environments, managerial-capital engagement may face rising strategic coordination costs and diminishing governance effectiveness. It refines the boundary conditions of Value-Added Services Theory by highlighting its limitations in high-competition, high-coordination-cost scenarios, and offers an empirical critique of overly idealized assumptions regarding the "empowerment logic" of VC.

Finally, based on Signaling Theory, this study incorporates financial constraint severity as a moderating variable to assess whether VC plays a stronger signaling role under conditions of limited financing access. However, the empirical results indicate that the moderating effect is not statistically significant, suggesting that the reputational signaling effect of VC may be weakened in contexts where alternative financing channels are increasingly diversified. This finding contributes to a boundary test of Signaling Theory in emerging market financing systems and aligns with recent scholarly attention to the phenomenon of signal attenuation.

In summary, by integrating a "four-theory – four-mechanism – four-context" analytical model and conducting systematic empirical tests, this study not only expands the applicability of classical management theories in the venture capital research domain, but also identifies their contextual boundaries and conditions of diminished effectiveness across different industry environments. These contributions offer meaningful insights toward the construction of a more nuanced and contextualized theory of capital influence in entrepreneurial innovation.

6.5 Research limitations

While this study provides a comprehensive analysis of the impact of VC on innovation in SMEs, it also has certain limitations that warrant further exploration.

(1) Limitations in data and sample coverage

The data utilized in this study primarily come from China's National Equities Exchange and Quotations (NEEQ) and some publicly listed companies, which may not fully represent all innovative SMEs. Moreover, significant variations in capital market environments across different countries and industries suggest that the findings of this study may have limited applicability outside of the specific context examined here. Future research could expand the data sample to include a broader range of countries and industries, aiming to derive more generalizable and widely applicable conclusions.

(2) Lack of further detail on the mechanisms of VC's influence

This study explores the heterogeneity of VC and its effects on firm innovation but does not delve deeply into the specific mechanisms through which VC influences innovation under different management practices. Future research could conduct a more detailed analysis of VC's operational modes across various stages of management, further elucidating VC's underlying mechanisms in areas such as corporate governance and resource integration. This would offer deeper insights into how different types of VC add value to SMEs' innovation processes.

(3) Lack of empirical analysis on the effectiveness of policy support

Although this study proposes several policy recommendations, it does not empirically evaluate the effectiveness of these suggested policies. Future research could employ policy experiments to empirically examine the impact of various types of policy support on VC effectiveness. This would provide a more scientific basis for policymakers to design and implement measures that enhance the role of VC in supporting innovation within SMEs.

These limitations highlight areas for further investigation that could enhance our understanding of the nuanced relationship between VC and innovation in SMEs, ultimately providing more actionable insights for investors, firms, and policymakers.

6.6 Future directions

(1) Utilizing advanced experimental methods to enhance causal inference accuracy

Future research can incorporate advanced experimental methods, such as Difference-in-Differences (DID), to identify the causal effects of VC on SMEs' innovation with greater accuracy. By using natural experiments and quasi-experimental designs, researchers can effectively control for firm heterogeneity and temporal changes, allowing for a clearer analysis of how VC influences innovation under different investment types, ownership structures, and market conditions. Employing rigorous experimental methods can lead to a more precise evaluation of VC's actual contribution to innovation and provide reliable data to support policy optimization.

(2) Developing a multi-dimensional innovation assessment system

Future research can construct a multi-dimensional assessment framework for evaluating innovation outcomes and examining VC's impact on various aspects, including patent production, technological breakthroughs, and market expansion. This comprehensive assessment would offer deeper insights into the specific factors that determine innovation outcomes. A well-rounded evaluation system can more accurately reflect the degree and

effectiveness of VC support for innovation in SMEs, enabling a nuanced understanding of how these contributions impact firm growth and competitiveness.

(3) Exploring network effects of VC within innovation ecosystems

As innovation ecosystems evolve, VC increasingly interacts with other key actors, including government entities, universities, research institutions, and accelerators. Future studies could investigate the network effects of VC within these ecosystems, particularly in fostering collaborative innovation, resource sharing, and technology incubation. For instance, research could examine how VC promotes inter-firm technology collaboration through its investment networks or how co-investments contribute to the formation of innovation clusters. Understanding these network effects could provide insights into how VC supports the development of a healthy innovation ecosystem, offering guidance for building open and collaborative innovation systems.

In summary, VC has a broad and profound impact on SMEs' innovation. Future research could further expand on experimental design, innovation evaluation frameworks, and network effects to explore diversified approaches to VC. Such studies would contribute to a deeper understanding of how VC influences SMEs' innovation and sustainable socio-economic development, guiding future policies and investment strategies.

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