

# ***The Impact of Private Equity Investment on Technological Innovation in Enterprises: A Case Study of Bloomage Biotechnology***

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**Abstract:** Technological innovation serves as a crucial driving force for the development of enterprises, and the construction of a modern economic system relies heavily on continuous innovation. Private equity investment, with its unique characteristics, provides comprehensive support for enterprise innovation. Private equity firms not only contribute financial investment but also meet the deeper needs of enterprises through profound business cooperation and empowerment. Using Bloomage Biotechnology as a case study, this paper analyzes the impact of private equity investment on technological innovation in enterprises. The study delves into the analysis from the perspectives of research and development investment and innovation output, reaching the conclusion that private equity investment can provide stable capital support and abundant resource integration for enterprises. This effectively promotes the enterprises' investment in research and development and innovation output, thereby enhancing their technological innovation capabilities.

**Keywords:** Private Equity Investment, Enterprise Technological Innovation, Case Study, Bloomage Biotechnology

## **1. Introduction**

The competitive position and profitability of enterprises are primarily influenced by technological innovation in the market. Technological innovation not only introduces new products, services, processes, and market expansion but also aids in attracting more customers, creating additional value, enhancing efficiency and productivity, reducing costs, and establishing sustainable competitive advantages. Especially in high-tech fields, technological innovation becomes a key factor for the success of enterprises as it can bring about disruptive changes, reshaping business models.

Private equity investment plays a crucial role in driving innovation within enterprises. This form of long-term value-creating investment is often associated with entrepreneurial and high-growth potential enterprises. By infusing capital into enterprises, private equity investment contributes to scaling up, driving market promotion, accelerating research and development, and fostering innovation activities, thereby promoting enterprise growth. Additionally, private equity investment typically provides strategic and managerial support, assisting enterprises in optimizing organizational structures, expanding market channels, and establishing partnerships, further facilitating enterprise growth and development.

This study aims to comprehensively analyze the impact of private equity investment on technological innovation within enterprises, with Bloomage Biotechnology as a case study. We chose Bloomage Biotechnology because the company has demonstrated outstanding performance in the field of biotechnology and possesses significant technological innovation capabilities. As a renowned biotechnology company, Bloomage Biotechnology has achieved remarkable success in the fields of biomedicine and bioengineering. Moreover, the company has undergone private equity financing, collaborating with several well-known private equity investment institutions, enabling us to delve into the impact of private equity investment on the technological innovation of Bloomage Biotechnology.

Through a case analysis of private equity investment and its impact on technological innovation at Bloomage Biotechnology, we aim to gain a better understanding of the role and mechanisms of private equity investment in driving enterprise technological innovation. The research findings are expected to provide valuable insights for other enterprises and investors in similar fields, promoting the development of technological innovation, and driving economic growth and social progress.

## **2. Literature Review**

### **2.1. Overview of Private Equity Investment**

Private equity investment is a form of investment that provides equity financing to non-listed companies through private placement. It plays a facilitating role in the development and innovation processes of enterprises by offering multifaceted support, including capital support, strategic guidance, and resource integration. According to Chris Armstrong, private equity investment involves funds flowing from private clients with high net worth to non-listed companies considered undervalued, following the selection of investment institutions, thus acquiring value-added capital [1]. The emergence and development of the private equity investment market inject new vitality into enterprises, becoming a key force driving economic growth and technological advancement.

### **2.2. Impact of Private Equity Investment on Technological Innovation in Enterprises**

Private equity investment plays a crucial role in the technological innovation of enterprises, profoundly influencing their technological innovation capabilities and output. Cruz-Cázares indicates that, to measure enterprise outcomes, the efficiency of technological innovation development is more important than a mere analysis of input and output [2]. Research by Manigart et al. suggests that private equity investment can provide funds and knowledge resources, promoting innovative activities in technological research and development, technology introduction, and technology transfer [3]. Samila & Sorenson argue that, compared to traditional financing methods, private equity investment offers a longer-term investment perspective and higher investment intensity, allowing enterprises more resources and time for innovation, accelerating the process of technological innovation [4].

Studies by Hellmann & Puri and Bottazzi & Da Rin find that private equity investment not only provides financial support but also, through its investor networks and experience, brings more opportunities for technological collaboration and exchange to enterprises [5], [6]. Bartelsman et al. argue that private equity investors typically possess rich industry experience and technological expertise, providing technical consultation, market intelligence, and commercialization support, thus assisting enterprises in overcoming technological barriers and driving technological innovation [7]. Additionally, private equity investment contributes to the construction of an innovation ecosystem for enterprises, connecting innovative enterprises with other innovation resources, further promoting interdisciplinary collaboration and knowledge sharing in technological innovation.

However, private equity investment poses several challenges and limitations for enterprise technological innovation. Specifically, Bertoni's research indicates that private equity investment tends to favor mature enterprises over startups, potentially constraining support for technological innovation in startups [8]. Moreover, private equity investment in technological innovation may prioritize short-term economic returns while overlooking the potential and risks inherent in long-term technological innovation. Therefore, a careful balance between short-term economic interests and the pursuit of long-term technological innovation is needed between enterprises and investors seeking private equity investment to achieve sustainable and continuous development in technological innovation.

### 2.3. Measurement Standards for Corporate Technological Innovation

In the assessment of corporate technological innovation, the focus is typically on innovation output, i.e., the ability of enterprises to generate inventive outcomes through various resources in research and development projects. However, as of now, there is no precise theoretical framework clearly defining specific metrics for measuring the level of technological innovation. Through a comprehensive review of existing research findings, it is evident that in the early stages of assessing technological innovation in companies, indicators such as technological output are commonly employed. Yet, with the continuous maturation of the private equity investment market, related research has become more diverse, with some scholars proposing that various indicators from research and development (R&D) input to revenue generation play a crucial role in innovation activities. Therefore, the evaluation indicators for corporate technological innovation have gradually evolved from singular to more comprehensive methods. Currently, we can examine a company's performance from three dimensions of technological innovation:

#### (1) Input

Evaluation from the perspective of technological innovation input. This includes financial, human, and material inputs. Studies have indicated that, generally, the greater the intensity of a company's investment in R&D, the corresponding increase in innovation output. Thus, indicators related to innovation input reflect the importance a company places on technological innovation and represent the developmental trend of its R&D capabilities [9]. In the literature, most scholars choose R&D capital investment and personnel input as indicators to measure a company's innovative activities. Some scholars also argue that, in addition to R&D expenses, the proportion of R&D expenditure to operating income should also be included as an input indicator. If a company invests significantly in research and development, it will have a promoting effect on the enhancement of its technological innovation capabilities.

#### (2) Output

From the perspective of innovation output, Griliches suggests that it is reasonable to evaluate technological innovation using the number of patents [10]. Additionally, some researchers believe that financial performance indicators can also reflect a company's level of technological innovation, as the market value realization of technological innovation can be represented through quantifiable financial indicators [11]. For example, sales revenue from new products can reflect the market conversion efficiency of innovative outcomes, although some scholars express concerns about the acquisition and completeness of data on sales revenue from new products [12].

#### (3) Technological Innovation Efficiency

The relationship between technological innovation input and output can be reflected through technological innovation efficiency, which is closer to the essence of innovation for a company. Catozzella suggests that innovation efficiency needs to calculate the efficiency value of "multiple inputs to multiple outputs" [13].

In summary, this study adopts two perspectives, R&D input and innovation output, selecting R&D capital investment, R&D personnel input, and the number of patents as standards for assessing corporate technological innovation.

### **3. Case Study**

#### **3.1. Introduction to Bloomage Biotechnology Co., Ltd.**

Founded in 2000, Bloomage Biotechnology Co., Ltd. is a globally renowned biotechnology and biomaterials company. With microbial fermentation technology at its core, the company holds a leading position worldwide in the production of hyaluronic acid, boasting a vast scale. Leveraging microbial fermentation and cross-linking technologies, the company is dedicated to researching and developing bioactive materials that contribute to maintaining human health. It has established a complete industry chain business system, covering raw materials to medical end products, functional skincare products, and functional foods, providing services to global pharmaceutical, cosmetics, and food manufacturing enterprises, medical institutions, and end-users. The company firmly believes that technological innovation is the driving force behind its development, adhering to the belief that talent is the cornerstone of growth. It uses science and technology as a foundation, manufacturing and industrial transformation as support, and market transformation as its goal. While achieving its own development, Bloomage Biotechnology also supports the robust development of the “trillion-level” life health industry. Bloomage Biotechnology is not only the world’s largest developer, producer, and seller of hyaluronic acid but also a leader in the globalization of this field. The company has consistently adhered to the “three-chain isomorphism” strategy, aiming to become a setter and leader of industry standards on the industrial chain, a crucial link in the supply chain by controlling intermediate links, and the center for core resource optimization on the value chain. Looking ahead, Bloomage Biotechnology will adhere to the development philosophy of “long-termism,” relying on technological strength to continuously enhance product capabilities, build brand image, gain competitiveness, and establish a genuine competitive advantage for the enterprise.

#### **3.2. Development and Financing History of Bloomage Biotechnology**

The predecessor of Bloomage Biotechnology was Shandong Freda Company, founded in 2000 by Biochemical Company, CP Freda, Zhengda Tech, and Freda USA. On October 3, 2008, Bloomage Biotechnology was listed on the main board of the Hong Kong Stock Exchange with the stock code “Bloomage Biotechnology,” issuing 78 million shares at a price of HKD 0.92 per share, raising a total of HKD 71.7241 million. However, due to the impact of the financial crisis, these limited funds were entirely used for the research and development of Freda Biochemical and team building.

In 2010, Freda Biochemical underwent a substantial change and was officially renamed “Shandong Freda Biopharmaceutical Co., Ltd.” Based on the research, production, and sales of the hyaluronic acid product series, the company continuously expanded downstream in the industrial chain, developing and promoting related products. Faced with the highly competitive end-market, Freda Biochemical launched the hyaluronic acid gel brand “BIOHYALUX” in 2012, successfully replacing some foreign brands. To swiftly enter the international market, the company established a subsidiary in New Jersey, USA, which passed FDA approval.

On June 13, 2012, to further optimize the equity structure, Shandong Freda Biopharmaceutical Co., Ltd. changed its name to “Bloomage Freda Biopharmaceutical Co., Ltd.” By December 2017, Freda transferred its stake in Bloomage Freda to Hong Kong Qinxin (a subsidiary of Bloomage Group), only 5.63% equity, turning this joint venture into a wholly-owned subsidiary of Bloomage Group.

Due to the persistently low stock price during the Hong Kong listing, Bloomage Freda’s stock was privatized in 2017. The management, including Zhao Yan, no longer satisfied with the current state,

decided to turn its attention to the A-share market. This led to the comprehensive separation of Bloomage Biotechnology and Freda in 2019. Prior to the company’s listing, Bloomage Freda underwent another substantial change, becoming a limited liability company and changing its name from “ Bloomage Freda Biopharmaceutical Co., Ltd.” to “Bloomage Biotechnology Co., Ltd.” On October 15, 2019, the company released its IPO prospectus on the A-share Sci-Tech Innovation Board. With Bloomage Biotechnology’s listing on the A-share market, it marked the splendid transformation from Freda Biochemical to Bloomage Biotechnology over nearly 20 years.

In 2019, with a substantial influx of funds and multiple rounds of equity integration, numerous investors entered the scene. According to the 2019 prospectus, the company had 31 shareholders, with many institutional investors actively participating. Many institutional investors chose to increase their investment in the second round of financing, indicating confidence in Bloomage Biotechnology. Considering the impact of private equity investment on companies and the substantial capital inflow in 2019 and 2020, this paper, through the R&D investment data of Bloomage Biotechnology from 2018 to 2022, discusses the impact of private equity on the company’s technological innovation.

### 3.3. Impact of Private Equity Investment on Technological Innovation at Bloomage Biotechnology

#### 3.3.1. Impact of Private Equity Investment on R&D Investment

Table 1: Bloomage Biotechnology’s R&D Investment 2018-2022

	2018	2019	2020	2021	2022
Amount of R&D investment (million)	5286.59	9,388.62	14,115.78	28,433.80	38,818.80
R&D investment as a percentage of revenue	3.52	4.98	5.36	5.75	6.10

During the period from 2018 to 2022, Bloomage Biotechnology has consistently witnessed a growth trend in research and development (R&D) funding, with this proportion steadily rising in comparison to the company’s total operating income. Regarding the percentage of R&D expenses, since 2018, the proportion of annual R&D expenses to the current year’s operating income has continued to increase. Particularly noteworthy is the significant enhancement in R&D efforts from 2019 onwards, indicating that the introduction of private equity investment has made the company more daring and proactive in the field of research and development. From both the perspectives of capital investment and proportion, the influx of private equity investment has evidently propelled the company’s R&D investment.

#### 3.3.2. Impact of Private Equity Investment on R&D Personnel

To ensure its leading position in the industry, Bloomage Biotechnology places high importance on talent acquisition and consistently increases its investment in research and development. The company has established a technology management system that adapts to corporate development, complete with departmental regulations and employee work standards, effectively guiding the efficient work of the R&D team. The company particularly emphasizes building a strong team of talents, with outstanding technical talents at its core. It has recruited thousands of talents with master’s degrees or higher, establishing a leading industry R&D team. Furthermore, to enhance its core competitiveness, the company not only increases investment in talent acquisition but also prioritizes the ongoing development of its personnel. Bloomage Biotechnology aims for international advanced technology, providing technical personnel with opportunities for domestic and international technical

exchanges. The company stays abreast of industry advancements, constantly enhancing the overall capabilities of its staff, and fostering comprehensive independent research and development innovation.

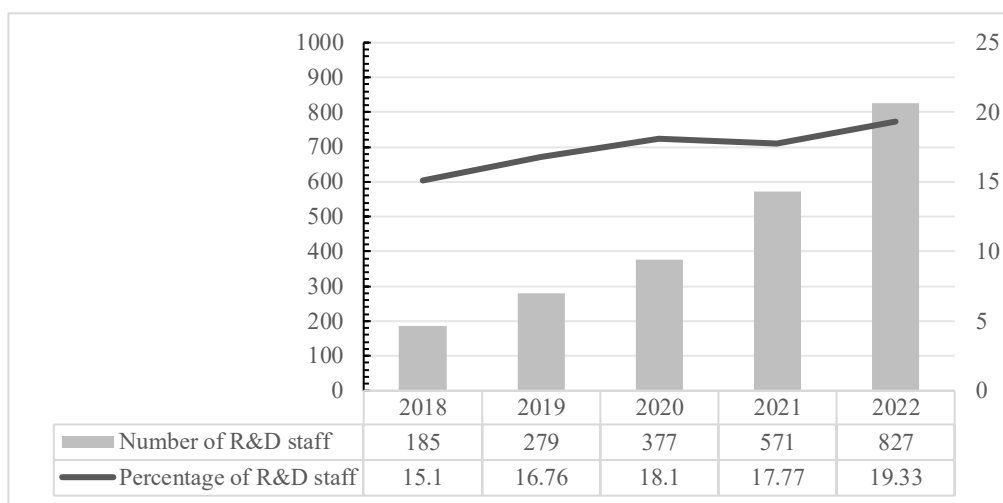


Figure 1: Bloomage Biotechnology's R&D Staff 2018-2022

Table 2: Bloomage Biotechnology's R&D Compensation 2019-2022

	2019	2020	2021	2022
Wages per capita (million)	19.35	19.51	26.29	22.94
Total remuneration (million)	5,397.73	7,354.81	15,013.99	18,971.52

As shown in Figure 1, from 2018 to 2022, the size of Bloomage Biotechnology's R&D team has expanded nearly eightfold. The company's annual reports indicate that during the period from 2016 to 2018, the number of R&D personnel was 126, 149, and 185, showing a relatively slow growth. However, starting in 2019, the number of R&D personnel was almost double that of the previous year, indicating a substantial increase in the recruitment of R&D talent in 2019.

With the increase in the number of R&D personnel, the average salary per person has also increased annually, maintaining above 200,000 RMB, despite a slight decrease in 2022. It is evident that after the entry of private equity investment into Bloomage Biotechnology, the company has intensified the recruitment of R&D talent, strengthened the R&D team, and significantly increased investment in R&D personnel. The overall size and strength of the R&D team have continuously improved, establishing a robust research force that injects new vitality and momentum into the company's innovation activities, enhancing its competitive advantage within the industry.

### 3.3.3. Impact of Private Equity Investment on the Output of Patent Quantity

As of the end of 2022, the company and its subsidiaries collectively possess a total of 4,181 domestic and international patents. Bloomage Biotechnology's proprietary patented technology serves as the primary technical support for the company's production and operations, successfully establishing a core competitive advantage.

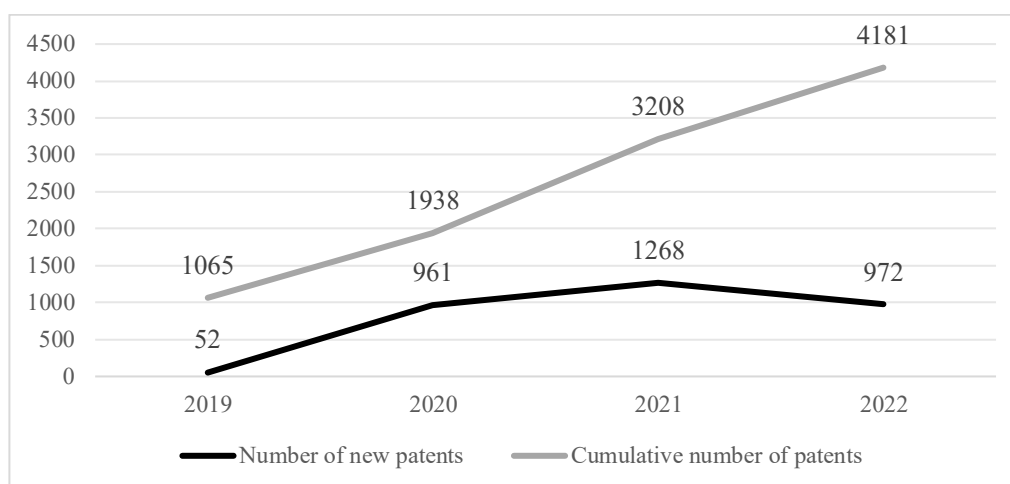


Figure 2: Number of Patent Applications for Bloomage Biotechnology, 2019-2022

As depicted in Figure 2, since 2019, the number of patent applications for Bloomage Biotechnology has shown continuous growth, particularly during the period from 2019 to 2020, where there was a rapid surge. The number of patent applications in 2020 was nearly 20 times that of the previous year, indicating significant vibrancy in research and development innovation and patent layout activities. The quantity of patents reflects the company’s innovation output, demonstrating that private equity investment plays a positively driving role in the innovation output of the enterprise. The support from private equity has instilled greater confidence in Bloomage Biotechnology regarding technological innovation, enabling the company to possess core competitiveness. This, in turn, allows the company to seize market opportunities promptly, stand out in intense competition, and emerge as a leading enterprise in the industry.

### 3.4. Discussion

(1) Capital Support and Resource Integration: Private equity investment has endowed Bloomage Biotechnology with robust financial support, meeting the funding requirements for research and innovation, including basic research, product development, technological improvements, and market promotion. Beyond funds, private equity investment has brought rich resources such as industry experience, networks, and market channels, accelerating the innovation process at Bloomage Biotechnology. Over the past five years, Bloomage Biotechnology has experienced rapid growth since its IPO, with its revenue increasing fivefold from CNY 424 million in 2018 to CNY 970 million in 2022. Although the revenue growth rate slightly slowed in 2022 compared to 2018-2021, the net profit growth rate significantly increased. Moreover, the company’s gross profit margin has remained stable at around 78% since 2018, demonstrating good profitability. The injection of these funds has significantly increased Bloomage Biotechnology’s research and development investment, enabling it to possess core technology and patents, reducing dependence on external technology, and building a more complete upstream and downstream industry chain. This has effectively utilized the role of funds, improved innovative technological capabilities, and achieved sustained growth in competitive advantages.

(2) Management Experience and Strategic Guidance: Private equity investors typically possess rich industry experience and management knowledge, providing guidance and support in strategic decision-making and operational management. They collaborate with Bloomage Biotechnology’s management team to formulate strategic plans, market positioning, and product development strategies, better guiding innovation directions and implementation. The success of excellent products

not only relies on exquisite market promotion but also requires robust technological capabilities. In this regard, Bloomage Biotechnology has consistently been at the forefront. The company adheres to the development logic of “Science→Technology→Product→Brand,” continuously expanding production capacity through innovative research and technological process improvements. It has established internationally advanced research institutions in Jinan, Shanghai, Beijing, France, and the United States, consolidating the company’s competitive barriers. The company has a strong ability for independent innovation in research and development, providing a solid foundation for downstream consumer applications. The hyaluronic acid industry scale also ranks at the forefront internationally, with increasing production capacity. Leveraging abundant research and industrialization talents, the company rapidly realized the technological transformation and industrialization of laboratory results. The fermentation yield of hyaluronic acid reached 12-14g/L, and the production capacity increased year by year. With the construction of the hyaluronic acid sodium production line in Tianjin, the company achieved the large-scale production of hyaluronic acid oligomers. The production of hyaluronic acid increased from 0.8 tons in 2000 to 770 tons in 2022, firmly maintaining its leading position in the industry.

(3) Market Opportunities and Partnership: Private equity investors typically possess extensive market experience and business contacts, helping Bloomage Biotechnology discover market opportunities, expand partnerships, and provide marketing support. This industry insight and market connectivity contribute to accelerating technology transfer and product promotion, facilitating the commercialization of innovative outcomes. In recent years, Bloomage Biotechnology’s major highlight has been its functional skincare business. This business generated revenue of CNY 2.90 billion in 2018, accounting for 23.04% of the total revenue, close to the share of the company’s medical terminal products. From 2019 to 2022, the operating income of the functional skincare business was CNY 6.34 billion, CNY 13.46 billion, CNY 33.19 billion, and CNY 46.07 billion, becoming the company’s largest source of revenue. The proportion of skincare business to total revenue increased from 33.6%, 51.15%, and 67.10% in 2019, 2020, and 2021, respectively, further rising to 72.45% in 2022.

In summary, private equity investment has had a positive impact on the innovative development of Bloomage Biotechnology. Capital support and resource integration provide a solid foundation for innovation, management experience promotes the stable development of innovative projects, and market opportunities and partnerships offer a broader platform for the commercialization of innovative outcomes. Through private equity investment, Bloomage Biotechnology can enhance its innovation capabilities, drive industry progress, and achieve sustainable development.

#### 4. Conclusion

Through the analysis of Bloomage Biotechnology as a case study of private equity investment, the following conclusions have been drawn: Private equity investment has significantly positive effects on the technological innovation of enterprises. Following private equity investment, Bloomage Biotechnology has demonstrated outstanding performance in research and development investment, the number of research and development personnel, and the number of patents. This indicates that private equity investment provides Bloomage Biotechnology with stable financial support and rich resource integration, promoting the enhancement of its technological innovation capabilities.

Firstly, private equity investment provides ample financial support for enterprises, enabling them to increase research and development investment and undertake more risky and innovative projects. This financial support establishes a solid foundation for the technological innovation of enterprises, assisting the company in making significant progress in technical research and development and product improvement.



Secondly, private equity investment brings a more extensive talent and resource network to enterprises. Private equity investors usually have rich industry experience and management knowledge, providing guidance and support in strategic decision-making and operational management. At the same time, private equity investors can bring enormous benefits to enterprises in terms of market channels, market opportunities, and partner networks. The integration of these resources provides a broader platform and more opportunities for the technological innovation of enterprises.

To promote the better development of private equity investment in technological innovation for enterprises, this paper proposes the following policy suggestions:

(1) Policy Suggestions for Private Equity Investment Institutions:

**Strengthen Regulation and Standardization:** The government should strengthen the regulation of private equity investment institutions, ensuring compliance with laws and regulations, providing accurate information disclosure, and safeguarding the interests of investors.

**Provide Incentive Policies:** The government can encourage private equity investment institutions to participate in investments in the field of technological innovation through tax incentives, financial subsidies, etc., attracting more funds into innovative enterprises.

**Provide Professional Support:** Establish a rating system for institutions, rate private equity investment institutions, promote competition among institutions, and provide references for enterprises and investors.

(2) Policy Suggestions for Enterprises:

**Provide Innovation Support Policies:** The government can formulate policies that encourage enterprises to increase research and development investment and strengthen technological innovation, such as giving deductions for research and development expenses before tax and providing financial support for technological innovation, reducing the cost and risk of enterprise technological innovation.

**Strengthen Talent Cultivation and Attraction:** The government can strengthen talent cultivation and attractiveness through measures such as establishing research positions, providing research funding, encouraging collaboration between universities and enterprises, and providing talent support for technological innovation in enterprises.

**Reduce Innovation Barriers:** The government can simplify the approval process for innovation projects, reduce administrative approval and regulatory costs in innovation activities, create a favorable innovation environment, and encourage enterprises to be more proactive in technological innovation.

(3) Policy Suggestions for Relevant Government Departments:

**Optimize the Policy Environment:** Government departments can strengthen policy coordination, optimize the policy system for innovative investment, avoid conflicts and duplications between policies, and create a policy environment conducive to technological innovation.

**Strengthen Data Sharing and Cooperation:** Government departments can establish an information-sharing platform, strengthen data sharing and cooperation between enterprises and private equity investment institutions, and provide more comprehensive and accurate data support for policy formulation.

**Strengthen Monitoring and Evaluation:** Government departments should establish a monitoring and evaluation mechanism, regularly assess the impact of private equity investment on technological innovation, adjust policy measures in a timely manner, and ensure the effectiveness and pertinence of policies.

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