

# The Impact of Technology Innovation Input on Firm Value of Technology Innovation SMEs in China

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## Abstract

As a result of the continuous changes in the global economic market, technology innovation small and medium-sized enterprises (SMEs) face complex uncertainties. In addition, the rapidly changing economic environment in which enterprises operate makes the development of technology innovation SMEs unpredictable, and the return on their investment in technological innovation is also subject to great uncertainty. This research the impact of technological innovation input on the firm value of technology innovation SMEs and considering the impact of different property rights (ownership and control of an asset or resource). this research the unique nature of Chinese enterprises which are categorized into state-owned enterprises (SOEs), where the nature of property rights implies that the state owns the asset and has control over it, and non-state-owned enterprises (NSOEs), where the property rights are owned by private, collective or foreign entities. This study is based on the data from 2019 to 2022 of the listed enterprises in China's Science and Technology Innovation Board (STAR MARKET), and regression analyses are conducted on R&D intensity and Proportion of R&D respectively. It was found the intensity of R&D inputs has a positive effect on firm value, while the percentage of R&D cost inputs has a negative effect on firm value. This effect has the same impact in non-state-owned enterprises, while none of the variables, are statistically significant for firm value in state-owned enterprises.

**Keywords:** Technology Innovation Input, Technology Innovation SMEs, Firm Heterogeneity.

## Introduction

In recent years, technological innovation has become an increasingly important factor for enterprises in gaining a competitive advantage and improving their performance. With the rise of technology innovation SMEs, technology innovation small and medium-sized

enterprises (SMEs) have played a crucial role in driving technological innovation and contributing to economic growth. China is in dire need of technological innovation to propel high-quality economic growth in an increasingly competitive marketplace (Wang, 2022). As China's economy transitions from rapid growth to high-quality development, industry competition is intensifying and the demand for innovative products and technologies is exploding. As a result, technological innovation has evolved into a potent tool for many businesses seeking to expand and become more competitive. Technological innovation is the embodiment of an enterprise's fundamental strength, which can generate exorbitant profits and play a vital role in the development of the enterprise (Liu et al., 2019). By increasing R&D investment, accelerating technological innovation, and boosting product-added value, businesses can provide the market with products that have shorter production cycles, greater production capacity, greater profitability, and better satisfy the specific needs of consumers (Wen, 2020).

The impact of technological innovation on the firm value of technology innovation SMEs is multifaceted. Technological innovation can assist technology innovation SMEs in developing new products or enhancing existing ones, thereby increasing their competitiveness in the market (Zhang et al., 2021). This aids in attracting more customers and business opportunities, ultimately elevating the technology innovation SMEs' market position.

Furthermore, new technologies and innovative processes typically enhance production efficiency, leading to reduced production costs (Liu et al., 2021). This contributes to improved gross profit margins, resulting in increased profitability (Vătămănescu et al., 2021). Technology innovation SMEs can also enter new markets or expand their share in existing ones, facilitating growth and boosting their market value (Civelek, M. et al., 2023). It's worth noting that technology innovation SMEs showcasing the potential for technological innovations often find it easier to capture the attention of investors and financing institutions (Modi et al., 2021). This in turn helps enhance the technology innovation SMEs' valuation and access to funding. In general, technological innovation has a positive impact on the firm value of technology innovation SMEs (Hamburg, I., 2020). It bolsters competitiveness, expands market share, reduces costs, attracts investment, and enhances the value of intellectual property rights. However, effective management and resource allocation are essential to ensure successful innovation and the subsequent growth of firm's value.

## Problem Statement

Table – 1

### *The development of technological innovation in China (RMB)*

Year Category	2017	2018	2019	2020	2021
Number of R&D staff (thousands/RMB)	46.2	46.4	48.5	51.9	52.9
R&D expenditure (billion/RMB)	2435.	2691.	3080.	3408.	3717.
Government R&D funding expenditure (billion/RMB)	7	7	8	8	9
Enterprise R&D capital expenditure (billion/RMB)	2025.	2285	2582.	2847.	3007.
Number of patent applications (pieces)	9	4	4	1	
Enterprise R&D capital expenditure (billion/RMB)	91.9	102.6	118.7	135.1	203.9
Number of patent applications (pieces)	5626	5722	5469	5706	5619

Source: National Bureau of Statistics (2022)

China is gaining prominence as a global innovation pioneer. Enterprises are increasing their investment in R&D to increase their competitiveness. The National Bureau of Statistics ([www.stats.gov.cn/sj/ndsj](http://www.stats.gov.cn/sj/ndsj)) reports that from 2017 to 2021, China's R&D expenditures will increase annually. Specifically, government expenditure on research and development rose from RMB 202.59 billion in 2017 to RMB 300.71 billion in 2021. In 2021, enterprises will have spent RMB20.39 billion on R&D, up from RMB9.19 billion in 2017(Huang, 2023). R&D investment has increased the competitiveness of Chinese technology innovation SMEs. For Chinese technology innovation SMEs to maintain their firm value, it is crucial that they priorities the development of their own innovation capabilities.

China cannot achieve a new development pattern without technological innovation (Cheng, 2022). As a consequence of businesses investing substantial resources in innovation initiatives to maintain their position in a more competitive environment, R&D expenditures have increased dramatically (Huang, 2023). However, there is a paucity of research on enterprise innovation activities in developing Asian markets, and businesses in transition economies often find it challenging to undertake significant innovations due to the high capital, talent, and risk requirements for such endeavors (Na & Kang, 2019).

Due to the high upfront costs of technological innovation, the difficulty of realizing significant returns in the short term, and the likelihood that competitors will replicate some innovations, domestic firms lack the motivation to invest in technological innovation (Qi & Wang, 2022). In China, which continues to remain behind economically developed nations in a number of respects, the intrinsic mechanisms of science and technology innovation SMEs are not properly understood or valued (Sheng, 2018). Due to the probability of business R&D failure, managers may act egotistically and shortsightedly, avoiding technological innovation initiatives in their organizations (Wang, 2022).

To address these issues, this study investigates how technological innovation input affects the firm value of technology innovation SMEs. Through the combination of theoretical and regression analysis. Regression analysis is carried out on the two variables of technological innovation input and technological innovation output respectively. In order to make the research results more comprehensive, this study also considers the different impacts of technological innovation input on state-owned and non-state-owned enterprises.

## **Literature Review**

### *Signaling Theory*

The signaling theory relies on effective enterprise information disclosure, which refers to the actions of market participants who disclose their operational and financial information in conformance with the law. Not only does information disclosure reflect the public's right to know, but it also reflects the market regulatory information published annually by publicly traded enterprises. According to this theory, managers are able to understand the future development of the product market based on market information, and by obtaining future profits from market information, investors are also able to obtain more accurate and truthful information in order to select projects that are more in line with investment expectations and have a more reasonable profit-to-risk ratio. When managers reveal more favorable information, they are able to attract additional external capital. This theory is utilized

primarily in markets with asymmetric signals, in which information is transmitted from the signal sender to the signal receiver.

As an essential factor in an enterprise's growth, R&D expenditures have a significant impact on the investment decisions of external investors. If an enterprise does not disclose sufficient information to the outside world, investors will lose confidence in the enterprise's development if they do not comprehend the enterprise's future direction. When enterprises disclose their R&D activities to market investors in a timely manner, the negative impact of information asymmetry can be eliminated, allowing investors to obtain accurate information about the enterprise, learn about its future plans and R&D direction, and increase their confidence. Intellectual property and technology patents are essential to the development of technology innovation SMEs in particular. Even though the research process is time-consuming and uncertain, and there is always the risk of R&D failure, the majority of investors concur that R&D represents the importance that technology innovation SMEs place on their innovation capabilities and long-term development plans. In addition, enterprise managers can conceal the fact that the R&D activities of an enterprise are advantageous to its development by actively communicating information about the R&D process, the amount of R&D investment, and the effectiveness of R&D investment to the outside world when disclosing information. In short, R&D investment can improve the enterprise's innovation capability and core competitiveness, which can communicate to external investors that the enterprise has a high growth potential, attracting external investors and boosting investor confidence, which can then increase the firm value. Technological innovation is the foundation of technology innovation SMEs, and the development of fundamental technologies necessitates extensive R&D efforts.

#### *Firm Heterogeneity Theory*

Firm heterogeneity refers to differences in firm value in terms of enterprise size, year of establishment, capital intensity, ownership, human capital, organizational practices, and technology selection. Through product innovation, enterprises can implement product differentiation strategies, reduce manufacturing costs, and abbreviate production cycles (Xu et al., 2019). In China, technology innovation SMEs constitutes the preponderance of businesses. The fierce competition necessitates that technology innovation SMEs be more innovative in order to obtain a competitive edge over their domestic and international rivals. As a new type of enterprise in modern society, the primary professional work focus of technology innovation SMEs is the development and sale of technology innovation products and this type of enterprise has a brief operating history but an astounding growth rate (Li, 2021). They have contributed significantly to the advancement of the national economy (Li et al., 2021).

Due to China's unique circumstances, enterprises are divided into state-owned and non-state-owned enterprises. The enterprise is a state-owned enterprise when the proportion of state-owned capital contribution exceeds fifty percent. When the proportion of non-state-owned capital contribution exceeds fifty percent, the enterprise is considered private. National policy has the greatest impact on the business strategy of a state-owned enterprise, and the enterprise's business strategy and orientation should align with the country's overall direction and demonstrate greater social responsibility. Private enterprises, on the other hand, are profit-driven and determine their business direction based on market fluctuations.

## Empirical Review

### *Technology Innovation Input and Firm Value*

The technological innovation input includes investment intensity of R&D and proportion of R&D. The investment intensity of R&D expenditure is the ratio of R&D expenditure to total sales revenue. The proportion of R&D is the ratio of research and development expenses to total assets.

In a study by Wen (2020), 786 technology innovation SMEs that disclosed R&D investment from 2010 to 2019 were selected as the sample data for empirical analysis. The empirical investigation determined that R&D expenditure and R&D intensity were positively associated with firm value. Nie (2016) collected research data from these 95 enterprises in 2014 and 59 of them in 2007 and 2014, and established an index system of technological innovation energy of listed enterprises in the pharmaceutical manufacturing industry based on the theoretical foundation of R&D intensity of technological innovation and intrinsic value of firms. The results of the empirical study showed that the R&D intensity of the pharmaceutical manufacturing industry for science and technology innovation has been increasing over time, and the overall science and technology innovation energy of listed companies in the pharmaceutical manufacturing industry has a significant positive relationship with firm value. Chatterjee and Bhattacharjee (2020) examined the effect of ownership and R&D intensity on the market performance of 264 Indian technology innovation SMEs. The interaction between promoter ownership concentration and R&D intensity had a positive effect on the performance of Indian technology innovation SMEs, according to the study. According to Zhu and Huang (2012), technological innovation is central to a enterprise's business strategy to compete in a competitive market, and enterprises that adopt an intensive investment strategy in terms of R&D intensity will have a significantly higher financial performance in the second year. According to Bennett et al. (2021), the intensity of enterprise innovation investment as a driver of economic sustainability is the subject of study. Enterprise governance and financial performance influence the intensity of enterprise innovation investment in the context of economic sustainability, as indicated by empirical calculations based on empirical evidence. Empirical studies show that technology innovation SMEs with higher investment intensity in R&D tend to have higher levels of innovation and superior firm performance. This is because R&D activities create new products, processes and services that improve an enterprise's competitiveness and profitability.

Li and He (2021) reported that a multiple linear regression model was developed to analyze the factors influencing the investment value of Anhui KDDI Co. using relevant data from 2008 to 2018. The results showed that there was a positive relationship between the share of R&D investment and the investment value of technology innovation SMEs. Bouwman et al. (2019) conducted an empirical study of 321 European technology innovation SMEs using social media, big data and information technology for business model innovation. The study showed that more resources allocated to business model experimentation and greater involvement in strategy implementation practices had a positive impact on the share of R&D in the technology innovation SMEs. This study by Lin et al. (2013) obtained a total of 208 valid questionnaires from four of the most prominent foreign motorbike manufacturers in Vietnam. The empirical findings indicate a positive relationship between the share of R&D investment and firm value. Based on Wang et al. (2022), this paper develops a mediating effects model using data from Chinese manufacturing enterprises between 2007 and 2017.

The study finds that the share of R&D investment has a large impact on the innovation performance of technology innovation SMEs. Alam et al. (2019) empirically investigate how R&D investment affects the carbon intensity of enterprises' environmental performance as measured by energy and energy sources, using firm-level data from 2006 to 2016 for G-2004 countries. The study concludes that the share of R&D investment enhances the value of firm. Empirical theory on the share of investment in R&D suggests that the higher the proportion of investment in R&D activities relative to total revenue, the greater the value of the firm. This is because R&D activities can lead to the development of new products and services, improved production processes and greater efficiency, which in turn lead to higher revenues and profits.

#### *Technology Innovation and Firm Value of Enterprises of Different Natures*

The enterprises in this study can be classified into state-owned enterprises and non-state-owned enterprises according to the nature of the enterprises. State-owned enterprises are enterprises with most of the controlling shares held by the state or the government. Out of state-owned enterprises, all other industries are classified as non-state-owned enterprises.

Qiand Wang (2022) examines the relationship between changes in executive shareholding, technological innovation, and firm value using a sample of A-share listed enterprises from 2012 to 2019. Both technological innovation inputs and outputs have a positive impact on firm value, and for enterprises with different property rights, the impact of technological innovation activities on firm value and the moderating effect of changes in executive shareholding are significantly smaller for state-owned enterprises than for non-state-owned enterprises. Kim et al. (2018) conducted a regression analysis using OLS and GMM on a sample of 563 technology innovation enterprises between 2005 and 2013. The study found that as R&D expenditure increased, the firm value rose to a certain threshold and then declined. In addition, NSOEs exhibited a stronger inverted U-shaped relationship than SOEs. Xu et al. (2023) found, using data from A-share resource-based listed enterprises, that digital transformation significantly improves enterprise environmental performance by stimulating green technological innovation, accelerating human capital accumulation, increasing environmental information disclosure, and strengthening environmental governance. Digital transformation has a greater impact on the environmental performance of large, technology innovation, resource-based state-owned enterprises. In eastern regions and regions with stricter environmental protection regulations, the impact of digital transformation on the environmental performance of resource-based enterprises was greater.

Liu et al. (2019) Empirical evidence derived from a dataset of the Chinese electronics manufacturing industry confirms that subsidies can promote enterprises' technological innovation, but excessive subsidies inhibit innovation. Subsidies have a greater impact on non-state enterprises than on state-owned enterprises. This study by Sun et al. (2021) investigated the R&D manipulation behavior of technology innovation SMEs under a portfolio-based tax incentive policy. The empirical findings suggest that tax incentives are effective in reducing the effective tax burden of non-state-owned enterprises. Xie et al. (2022) conducted a regression analysis using panel data on the technology innovation manufacturing and automobile manufacturing industries listed on China's A-shares from 2011 to 2015. The results show that government subsidies increase firm value; however, there are significant differences in the incentive effects of government subsidies on the innovation performance

of state-owned and non-state-owned enterprises. Zhang and Aumeboonsuke (2022) conducted a study using a sample of 1,166 listed enterprises in China between 2012 and 2020. The study shows that technological innovation has a negative impact on enterprise performance. Based on a test of ownership heterogeneity, the negative impact of technological innovation on the performance of non-state-owned enterprises is much greater than that of state-owned enterprises.

Empirical research has found that state-owned enterprises (SOEs) have a mixed impact on technological innovation and firm value. On the one hand, SOEs typically have greater access to resources, such as financing and government support, which can facilitate R&D investment and technology adoption. On the other hand, SOEs may face bureaucratic inefficiencies and political pressures that hinder their ability to innovate and compete in the marketplace. Compared to state-owned enterprises, non-state-owned enterprises are characterized by greater flexibility and autonomy, and are usually subject to less government intervention. As a result, non-state-owned enterprises are expected to have a greater ability to react quickly to changes in the market and to adopt new technologies more effectively. This may lead to higher levels of technological innovation and ultimately to greater firm value.

### **Hypotheses Development**

#### *Technology Innovation Input and Firm Value*

Sun et al. (2021) notes that the hazards inherent in technological innovation can reduce the R&D investment intensity of enterprises due to the existence of R&D failures and extended technological innovation activity cycles. Initially, the marginal productivity of R&D investment is low, making it challenging for enterprises to generate significant input returns. It requires a considerable amount of time to convert innovation investment into commercialized innovation outcomes. When enterprises are unable to generate sufficient profits from their innovation activities, it is difficult for them to counterbalance the associated high up-front costs, which can have a negative effect on firm value. Innovation in technology is a technology innovation SMEs, and product research and development will have both positive and negative effects on enterprises (Lin et al., 2021).

According to previous studies, technological innovation may be one of the variables that have an impact on the firm value. Enterprises can ensure and improve the economic sustainability of the country as a whole by effectively managing financial resources and pursuing high-value-added innovations (Benetyt et al., 2010). Technological resources are enterprise assets that can be used to develop new products or enhance production processes, and they have attracted the interest of numerous researchers as proportion of R&D (Liu et al., 2019). Despite the fact that technological innovation in enterprises is characterized by high frequency, uncertainty and high risk. According to the signaling theory, when enterprises are willing to spend a certain amount of money on technological innovation, they are also communicating to the outside world that their managers are optimistic about the enterprise's future. The enterprise continues to invest in R&D to increase its value. As an enterprise's technology evolves, R&D becomes crucial to its survival, success, and expansion. The conclusion therefore is that technological innovation may have a catalytic effect on the firm's value. Thus, technological innovation will increase the firm value. Consequently, the following hypothesis 1 is formulated:

*H1: Technological innovation initiatives contribute positively to firm value.*

*H1 (a) : Investment intensity of R&D expenses contribution positively to the firm value.*

*H11 (b) : Investment in R&D as a percentage contribution positively to the firm value.*

#### *Technology Innovation and Enterprises of a Different Nature*

Technological innovation can reconfigure an enterprise's production factors and is crucial for enterprises to meet market demand, enhance competitiveness, and develop a sustainable competitive advantage (Zhang & Aumeboonsuke, 2022). Moreover, from a dynamic standpoint, the innovation activities and levels of various enterprises vary to a degree due to differences in enterprise ownership structure, scale, and capabilities. Consequently, the firm heterogeneity hypothesis is the foundation for the study of enterprise behavior, and a study of technological innovation SMEs behavior that disregards distinctions in the nature of enterprise ownership lacks validity and relevance. On the basis of China's unique national context, the relationship between enterprise ownership on technological innovation and firm value is introduced, and the sample is divided into state-owned and non-state-owned enterprises to further investigate the heterogeneous impact of technological innovation on enterprise performance and to determine whether there are significant differences between groups. This is conducive to assessing the actual impact of enterprise ownership on innovation activities, thereby enriching and making the study more pertinent.

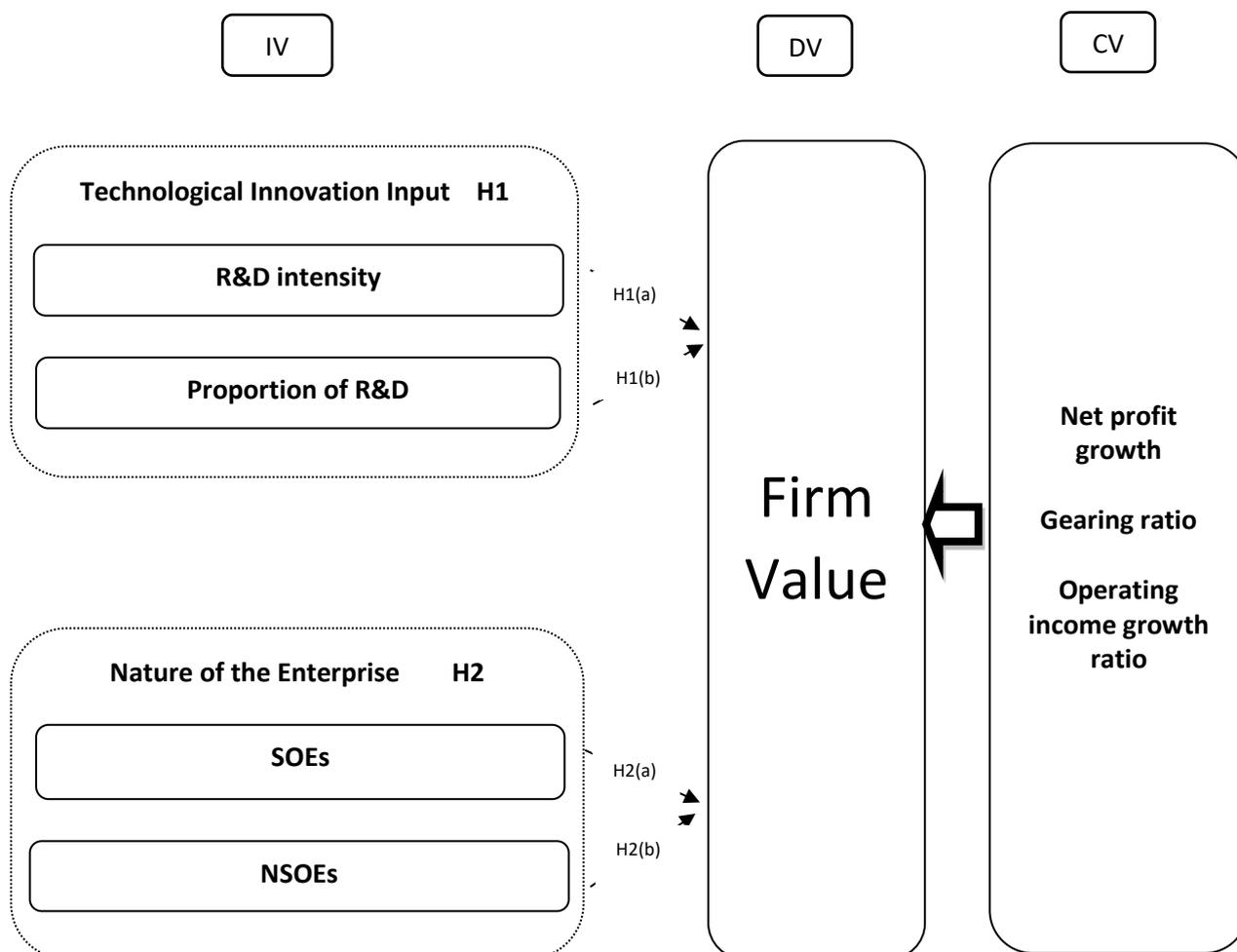
Relevant government departments and market participants must comprehend the impact of technological innovation SMEs on enterprise performance and its mechanisms in order to regulate and strengthen enterprise R&D management, reduce the market and technological risks associated with technological innovation SMEs, and enhance the modern enterprise system. It facilitates the formulation of a paradigm of sustainable development for the technological innovation cycle of enterprises. The ownership structure is another internal governance mechanism that may impact the firm value. State-owned enterprises in China typically possess a vast number of resources and are not required to consider enterprise profitability. Aziz and Abbas (2021) suggest that enterprises with a greater focus on research and development and innovation obtain a competitive advantage and increase their future value. Consequently, hypothesis 2 is formed:

*H2: Technological innovation activities are more effective at increasing the value of non-state-owned enterprises than state-owned enterprises.*

*H2 (a) : Technological innovation activities are more effective in increasing the value of state-owned enterprises.*

*H2 (b) : Technological innovation activities are more effective in increasing the value of non-state-owned enterprises.*

## Research Framework



## Methodology

As most of the indicators required for this study come from the financial statements of enterprises, a secondary database has been chosen for this research. This study collects relevant financial indicators and technological innovation indicators of technology innovation SMEs through the Wind database. The processing of data pertaining to The Science and Technology Innovation Board (STAR MARKET) listed enterprises for 2019-2022 is as follows. (1) According to the China Securities Regulatory Commission (CSRC) 2021 Industry Classification, financial enterprises providing capital market services, monetary and financial services, or insurance, as well as enterprises in other financial sectors, are excluded. (2) Exclude ST enterprises, \*ST enterprises, and other enterprises with abnormal financial conditions. (3) Enterprises lacking information were excluded.

When selecting an appropriate model, the Fixed Effects Model (FEM) is often considered an effective approach. The equation is as follows:

$$Q_{it} = a_0 + a_3C_{it} + a_4B_{it} + x_5M_{it} + x_6A_{it} + x_7G_{it} + x_8D_{it} + x_9E_{it} + x_{10}O_{it} + d \quad (1)$$

## Where

In the formula,  $Q_{it}$  is the dependent variable and represents the TobinQ value. Technological innovation is the independent variable in this study, where  $a_0$  is the constant term.  $C_{it}$

represents the intensity of R&D expenditure investment.  $B_{it}$  represents the percentage of R&D expenditure investment. The control variables in this study are  $M_{it}$ ,  $G_{it}$ , and  $D_{it}$ . They represent the market capitalization of the enterprise, net profit growth rate and gearing ratio respectively.

### Measurement of Variables

(1) Dependent variable:

**TobinQ:** Can be used to measure whether the market value of an asset is overvalued or undervalued. One of the measures of firm value. Denoted by the letter 'Q'.

(2) Independent variables:

**The intensity of R&D expenditure investment:** R&D cost refers to the capital invested by enterprises in the R&D process, specifically including the sum of all costs incurred in the research and development of products, technologies, materials, processes and standards (Wen, 2020). R&D expenses / operating income. Denoted by the letter 'C'.

**The percentage of R&D expenditure investment:** R&D expenditure refers to all R&D funds invested by the enterprise. R&D expenses / total assets. Denoted by the letter 'B'.

**Nature of the enterprise:** Whether the company is a state-owned enterprise, if it is a state-owned enterprise, the value is 1, otherwise it is 0. The letter 'N' is used to indicate this.

(3) Control variables:

**Net profit growth rate:** represents the rate of growth of net profit, which also affects the firm value, usually the faster the growth of net profit, the greater the firm value. (Current net profit - Previous net profit)/Previous net profit\*100%. The letter 'G' is used to indicate this.

**Gearing ratio:** Represents the solvency of the enterprise. The stronger the solvency, the greater the firm value. Total liabilities at the end of the period / total assets at the end of the period. Denoted by the letter 'D'.

**The market capitalization of the enterprise:** The total market value of the enterprise at the end of a period, denoted by the letter 'M'.

Table – 2

### Description of Variables

Type	Name	Symbol	Description	Reference
DV	Tobin Q	Q	Market capitalization/net asset	
IV	The intensity of R&D expenditure investment	C	R&D expenses/operating income	(Wen, 2020)
	The percentage of R&D expenditure investment	B	R&D expenses/total assets	Li and He (2021)
CV	Net profit growth rate	G	(Current net profit - Previous net profit)/Previous net profit*100%	
	Gearing ratio	D	Total liabilities at the end of the period / Total assets at the end of the period	
	The market capitalization of the enterprise	M	The total market value of the enterprise at the end of a period	

Source: National Bureau of Statistics (2022)

## Results and Discussion

### *Descriptive Statistics*

Table 3 shows the descriptive statistical results. For the dependent variable TobinQ, the mean value is 5.617, the standard deviation is 4.461, the minimum value is 1.191, and the maximum value is 25.907. This shows that there are significant differences in market valuation and asset quality among sample enterprises. . This may be due to the market's different expectations for the enterprise's future profitability and growth potential.

Among the independent variables, the average value of R&D expenditure intensity is 18.525, the standard deviation is 34.854, the minimum value is 1.738, and the maximum value is 297.048. This may be due to the different strategic orientations of enterprises in maintaining competitive advantages and technological leadership. The average value of R&D investment proportion is 4.678, the standard deviation is 3.647, the minimum value is 0.858, and the maximum value is 21.497, indicating that there are large differences in the investment in technological innovation of different enterprises.

Among the control variables, the mean value of return on equity is -2.614, the standard deviation is 141.595, the minimum value is -686.306, and the maximum value is 563.904, showing the differences between enterprises in terms of asset operation efficiency and return on investment. The average value of the Gearing ratio is 25.776, the standard deviation is 17.109, the minimum value is 3.233, and the maximum value is 71.7. This may be due to the different preferences and market reactions of enterprises in capital structure and risk management strategies. The average value of the enterprise's market capitalization is 22.746, the standard deviation is 0.966, the minimum value is 21.076, and the maximum value is 25.525, showing the enterprise's extensive changes in market evaluation and shareholder value management, which may be due to the market's influence on the enterprise's future development potential and market competition, different expectations and assessments of status.

Table – 3

### *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
Q	1706	5.617	4.461	1.191	25.907
C	1706	18.525	34.854	1.738	297.048
B	1706	4.678	3.647	.858	21.497
G	1706	-2.614	141.595	-686.306	563.904
D	1706	25.776	17.109	3.233	71.7
M	1622	22.746	0.966	21.076	25.525

### *Pairwise Correlation*

Table 4 shows the results of correlation analysis. By calculating the correlation coefficients between various variables, it is found that all correlation coefficients are less than 0.7. This indicates that there is no serious multicollinearity problem among the selected variables in this study. A correlation coefficient lower than 0.7 reflects that the variables used are relatively independent in quantitative analysis, which helps ensure the reliability and interpretability of the analysis results. Multicollinearity usually refers to a high degree of correlation between variables, which may cause the coefficients of explanatory variables in regression analysis to be unstable or difficult to interpret.

Table – 4

*Pairwise Correlation*

	Q	C	B	G	D	O
Q	1					
C	0.098***	1				
B	0.156***	0.729***	1			
G	0.221***	-0.229***	-0.101***	1		
D	-0.048**	-0.301***	-0.044*	-0.0160	1	
M	0.270***	0.0330	0.070**	0.367***	0.118***	1

*Regression Analysis*

Table 5 shows the regression analysis of technological innovation input on firm value.

In contrast, R&D investment intensity has a positive and significant impact on the firm value of technology innovation SMEs. For every 1 unit increase in R&D investment intensity, the firm value increases by 0.021 units. This may be because high R&D investment intensity indicates a enterprise's continued investment in technological innovation and product development, which helps enhance its technological leadership and market competitiveness, thereby enhancing the firm's overall value.

However, the impact of the proportion of R&D expenditure on firm value is negative. For every increase in the proportion of R&D expenditure by one unit, the firm value decreases by 0.529 units. This may be because a high proportion of R&D investment may reflect the enterprise's challenges in cost management and resource allocation, especially the failure to meet market expectations in terms of capital efficiency and return on investment, thus affecting the enterprise's market positioning and investors' confidence.

In terms of control variables, the impact of corporate market value on firm value is positive and significant. For every increase in corporate market value by one unit, firm value increases by 5.800 units. This may be because a high market value not only reflects an enterprise's recognition in the market and investor confidence, but may also reflect market expectations of its future profitability and growth potential, thus having a significant positive impact on the firm's overall value.

Table – 5  
*The Impact of Technology Innovation Input on Firm Value*

VARIABLES	(1) Q
C	-0.529*** (-7.17)
B	0.021*** (3.23)
G	0.002*** (2.66)
D	-0.063*** (-4.90)
M	5.800*** (21.08)
Constant	-122.617*** (-19.36)
Observations	1,706
Number of Id	561
R-squared	0.378

Note: t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### Robustness Test

#### *Add Control Variable (Operating income growth ratio)*

In order to ensure the reliability of the research results, this study conducted a stability test by introducing the control variable operating income growth ratio.

In addition, for every increase in the proportion of R&D investment by one unit, the firm value decreases by 0.529 units. This may be because the high proportion of R&D investment fails to bring expected returns in terms of capital efficiency and market competitiveness, affecting the enterprise's market positioning and investors' confidence.

However, R&D investment intensity still shows a positive and significant impact on firm value. For every additional unit of R&D investment intensity, firm value will increase by 0.021 units, which shows that enterprises continue to invest in technological innovation and long-term competitiveness maintenance importance. These results are consistent with the main results of the regression analysis, further strengthening the reliability and explanatory power of this study on the impact of technological innovation input on firm value.

Table – 6

*The Impact of Technology Innovation input on Firm Value (Operating income growth ratio)*

VARIABLES	(1) Q
C	-0.529*** (-7.16)
B	0.021*** (3.23)
G	0.002** (2.39)
D	-0.063*** (-4.87)
M	5.804*** (20.01)
O	-0.000 (-0.04)
Constant	-122.701*** (-18.39)
Observations	1,706
Number of Id	561
R-squared	0.378

Note: t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

*Change the Sample (Exclude 2020)*

This study also conducted a stability test again by reducing the sample size and eliminating data from 2020.

Specifically, every increase in R&D investment intensity by one unit, the firm value decreased by 0.150 units. This shows that despite excluding data from specific years, the pattern of the impact of these factors on firm value remains stable.

At the same time, R&D investment intensity still has a positive and significant impact on firm value. For every additional unit of R&D investment intensity, firm value will increase by 0.019 units. This shows that, whether in the overall sample or in the sample excluding specific years, enterprises can still effectively improve their market competitiveness and long-term value with high R&D investment.

Table – 7

*The Impact of Technology Innovation on Firm Value (Exclude 2020)*

VARIABLES	(1) Q
C	-0.150** (-2.06)
B	0.019*** (3.25)
G	0.001 (1.48)
D	0.044*** (3.15)
M	5.274*** (18.76)
Constant	-110.055*** (-17.24)
Observations	1,706
Number of Id	561
R-squared	0.480

Note: t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

*Heterogeneity Test*

In order to analyze more deeply the impact of technological innovation on the value of technology innovation SMEs, this study divided the sample into two groups: state-owned enterprises and non-state-owned enterprises according to the nature of the enterprise. As can be seen from Table 8, there are significant differences in the impact of technological innovation on the firm value of these two types of enterprises.

Among non-state-owned enterprises, the proportion of R&D investment all has a negative and significant impact on firm value. For every additional unit of intangible assets, the firm value decreases by 0.588 units. This may be because non-state-owned enterprises are more sensitive to asset allocation and market recognition in market competition. Despite the increase in intangible assets, technological capital or market competition Lack of strength.

However, the impact of R&D investment intensity on the firm value of non-state-owned enterprises is positive and significant. For every increase in R&D investment intensity by one unit, the firm value increases by 0.022 units. This shows that when non-state-owned enterprises invest heavily in research and development, they can effectively improve their technological innovation capabilities and market competitive advantages, thereby enhancing the firm overall value.

In contrast, in state-owned enterprises, the impact of R&D expenditure proportion has no statistically significant impact on the firm value of state-owned enterprises.

Table – 8  
*The Impact of Technology Innovation input on Firm Value (Different Natures)*

VARIABLES	(0)	(1)
	y	y
C	-0.189 (-1.01)	-0.588*** (-7.28)
B	-0.054 (-1.02)	0.022*** (3.47)
G	0.001 (0.60)	0.002** (2.45)
D	-0.080* (-1.91)	-0.062*** (-4.53)
M	5.068*** (6.28)	5.869*** (19.98)
Constant	-108.328*** (-5.65)	-123.406*** (-18.34)
Observations	272	1,434
Number of Id	96	465
R-squared	0.268	0.399

Note: t-statistics in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Conclusion

### *Summary of Main Finding*

In terms of technological innovation investment, R&D investment intensity and R&D expenditure proportion have slightly different impacts on firm value. Specifically, R&D investment intensity has a positive impact on firm value, which means that increased R&D investment may bring more technological innovation and market competitive advantages. However, the impact of the proportion of R&D investment on firm value is negative, which may reflect the failure of a high proportion of R&D investment to effectively translate into market value or investor trust.

Among non-state-owned enterprises, the proportion of R&D expenditures has a significant negative impact on firm value, while the intensity of R&D investment has a positive impact on firm value. This shows that non-state-owned enterprises may be more sensitive to technological innovation strategies and resource allocation in management and operations, and high R&D investment intensity can effectively enhance their market competitiveness and long-term value.

Among state-owned enterprises, the impact of proportion of R&D investment on firm value fails to reach statistical significance. This may reflect the particularity of state-owned enterprises in terms of resource allocation and market competition. These factors may not necessarily reflect their true market value simply through quantitative indicators.

## Practical Implication

### *For Enterprises*

Although both technological innovation output and input have a negative impact on firm value, this may be due to the low quality of technological innovation of small and medium-

sized enterprises and the difficulty in monetizing their products. Therefore, the following suggestions are made for technology innovation SMEs:

Firstly, enterprises should focus on improving the core competitiveness of technological innovation and transform R&D results into products and services with actual market value through effective market research and product development. Establish a sound technology transfer and commercialization mechanism to ensure that R&D outputs can be quickly put on the market and achieve economic benefits.

Secondly, during the product development process, enterprises should focus on innovation and differentiation, develop unique, high value-added products, and avoid homogeneous competition. Improve the competitive advantage of products through technological innovation, enable them to occupy a favorable position in the market, and enhance the overall competitiveness of the enterprise.

In addition, enterprises should focus on R&D quality rather than quantity, optimize the allocation of R&D resources, and improve the management and execution of R&D projects. By introducing advanced R&D management tools and methods, study improve R&D efficiency and result quality, ensuring that every R&D investment can bring substantial market returns and value enhancements.

#### *For Investors*

For investors, first of all, investors should be cautious when investing in technology innovation SMEs. These enterprises usually have longer R&D cycles, make it more difficult to monetize their products, and may take longer to reap returns. Investors need to be patient and prepared for possible short-term earnings shortfalls.

Firstly, investors should have a detailed understanding of the market demand for the products developed by the target enterprise to ensure that these products have actual sales potential in the market. Evaluate whether products can meet consumer needs and preferences through market research and analysis. And evaluate the competitiveness of the product in the market to understand whether similar products exist and how these products perform in the market. Investors should pay attention to whether the target enterprise's products have unique advantages or innovative features and can stand out in the fierce market competition.

Secondly, examine the enterprise's technical research and development capabilities and team strength to understand its professionalism and experience in technological innovation. Enterprises with strong technological capabilities are more likely to develop products that are competitive in the market. At the same time, pay attention to the enterprise's investment in research and development, including capital, talent and resource allocation. High-quality R&D investment can often improve the success rate of R&D projects and the market acceptance of products.

In addition, understand the enterprise's technology transfer and commercialization mechanism to ensure that R&D results can be smoothly transformed into market products. Investors should examine the enterprise's capabilities and experience in technology transfer, manufacturing and marketing. Examine the enterprise's sales channels and market coverage

capabilities to ensure that products can quickly enter the market and achieve sales. Strong sales channels and market networks are important guarantees for successful product monetization.

Understand the financial status of the enterprise in detail. Financially healthy companies are more capable of supporting long-term R&D investment and market expansion. At the same time, evaluate the enterprise's financing capabilities and funding sources to ensure that it has sufficient funds to support R&D and operational activities. Stable financing channels and a good credit record are important guarantees for the long-term development of an enterprise. In short, investors should remain cautious when considering investing in technology innovation small and medium-sized enterprises, and ensure that the invested enterprises have market demand, technical strength and commercialization capabilities through comprehensive inspection and analysis.

#### *For Policymakers*

For policymakers, more support and assistance need to be provided to promote the development of technology innovation SMEs.

Firstly, the government can organize and fund technical training and consulting services to help technology innovation small and medium-sized enterprises improve their technical capabilities and innovation levels. By holding regular technical exchange meetings, seminars and training courses, policymakers can provide SMEs with the latest technical knowledge and industry trends to help them cope with technological challenges and market changes.

At the same time, a cooperation platform between the government, scientific research institutions and enterprises can be established to promote cooperation between technology innovation small and medium-sized enterprises and universities, research institutes and large enterprises. By sharing R&D resources and technological achievements, policymakers can help SMEs accelerate technological innovation and achievement transformation, and improve market competitiveness.

Formulate and implement preferential tax policies for technology innovation SMEs, such as corporate income tax reduction and exemption, super deduction of R&D expenses, and recognition of high-tech enterprises. By reducing tax burdens, policymakers can provide more financial support to SMEs and encourage them to increase investment in R&D and technological innovation.

Secondly, the government can set up special funds to provide financial subsidies and funding for research and development projects, technological transformation and market promotion of SMEs. By providing various forms of financial support such as free grants, low-interest loans and venture capital, policymakers can help SMEs reduce R&D costs and market risks and promote their rapid growth.

For technology innovation SMEs, the administrative approval process should be simplified, unnecessary approval links and procedures should be reduced, and administrative efficiency should be improved. By establishing a one-stop service platform, policymakers can provide convenient government services to SMEs and reduce their operating costs and time costs. It also strengthens intellectual property protection and establishes a complete intellectual

property protection mechanism to provide legal protection for the innovative achievements of technology innovation SMEs. Policymakers can help SMEs safeguard their legitimate rights and interests and stimulate their enthusiasm for innovation by increasing law enforcement, improving laws and regulations, and raising social awareness. Formulate and implement government procurement policies to encourage governments at all levels and state-owned enterprises to give priority to purchasing products and services from technology innovation SMEs. By expanding market demand, policymakers can provide SMEs with stable sales channels and sources of income and promote their sustainable development.

### **Limitations and Suggestions for Research**

#### *Limitations*

Since the STAR MARKET has only been established in 2019, the available data is shorter, which may result in the sample size being insufficient to fully represent the characteristics and trends of the overall technology innovation SMEs group. Secondly, the sample and analysis of this study are limited to the Chinese market, so the generalizability of the research results may be limited by geography and market environment, making it difficult to generalize to technology innovation SMEs in other countries or regions.

Although the study controlled some key variables such as enterprise market value and asset-liability ratio, it failed to consider all potential factors that may affect the relationship between technological innovation and firm value, such as industry characteristics or changes in the macroeconomic environment.

The data span of this study is from 2019 to 2022 and cannot capture the long-term impact of long-term trends or structural changes on technological innovation and firm value, so the conclusions may be limited by the time span.

Although the differences between state-owned enterprises and non-state-owned enterprises are considered, other possible enterprise types, such as foreign-owned enterprises or multinational corporations, are not covered, which may limit a comprehensive understanding of the effects of technological innovation among different enterprise types.

These limiting factors need to be considered when interpreting the research results and generalizing the research conclusions. They also provide directions for further exploration and improvement in future related research.

#### **Suggestions for Future Research**

Future research can consider crossing national boundaries and comparing the differences in the impact of technological innovation on firm value among technology innovation SMEs in different countries or regions. In addition, the industry scope of the research objects can be expanded, especially those technology-intensive and innovation-driven industries, to gain a more comprehensive understanding of the impact of technological innovation on enterprises. Considering the limitation of the time span of this study, future research can use longer-term data to capture long-term trends and structural changes in the relationship between technological innovation and firm value. This can better understand how technological innovation affects the long-term development and competitive advantage of enterprises under different economic cycles and market environments.

In addition to state-owned enterprises and non-state-owned enterprises, future research can further explore the differences in the impact of technological innovation on firm value among other types of enterprises (such as foreign-invested enterprises and joint ventures), which will help to establish a more comprehensive theoretical framework and policy recommendations. .

In addition, a further in-depth understanding of the specific impact of the internal mechanism of technological innovation on firm value, including the type, degree and correlation of technological innovation with market competition and strategic goals, will help enterprises formulate innovation strategies and resource allocation more effectively.

Through these suggestions, future research can more comprehensively explore the role of technological innovation in technology innovation SMEs and its specific impact on firm value, thereby providing more precise guidance and suggestions for actual management and policy formulation.

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