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The Impact of Technology Innovation Output on Firm Value of Technology Innovation SMEs in China

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Abstract

With the advent of the big data era, technological innovation has become the driving force behind the expansion of technology innovation SMEs. Where feasible, enterprises must rely on the development of technology innovation SMEs as soon as possible to strengthen their national power and achieve sustainable development. Understanding the relationship between technological innovation output and firm value is crucial for developing R&D budgets and guiding some strategic decisions of top managers in firms. This article research the impact of technological innovation output on the firm value of technology innovation SMEs, this study is based on the data from 2019 to 2023 of the listed enterprises in China's Science and Technology Innovation Board (STAR MARKET), and regression analyses are technological innovation outputs (Intangible assets and Patent) and firm value. It was found that technological innovation output has a negative effect on firm value. This effect is equally applicable to companies of different age of establishment, especially for companies with a shorter period of establishment; the negative effect is more prominent.

Keywords: technology innovation output, technology innovation SMEs, firm value

1. Introduction

In addition to being crucial to the development of human society, technological innovation has a substantial impact on economic expansion. China has selected a strategy based on innovation to increase the level of innovation among domestic enterprises (Wang et al., 2022). However, the high risk associated with enterprises' innovation activities and the positive characteristics of innovation outcomes have resulted in a lack of innovation among enterprises (Aziz, S.et al., 2021). China's present innovation capacity is not yet suited for high-quality development (Wang et al, 2022).There are a vast number of high-quality resources at the disposal of technology innovation small and medium-sized enterprises (SMEs) that can contribute significantly to technological innovation operations. The R&D capabilities of technology innovation SMEs have become a critical factor in determining the country's strategic transformation, as well as the improvement of the enterprises' innovation, competition, development, and value creation capacities (Wen, 2020).

Small and medium-sized enterprises (SMEs) have always played a vital role in China's economy. They provide employment for a large labor force and are one of the main drivers of China's economic growth (Bouwman, H.et al., 2019). At the same time, technology innovation enterprises are emerging, especially in the fields of information technology, biotechnology, new energy, and artificial intelligence (Huang, 2023). Government policy support and investment have fueled the development of technology innovation enterprises, making them a key sector in China's economic upgrading (Cao, S.et al., 2021). Technology innovation SMEs not only actively participate in technological innovation, but also seek opportunities in market competition (Hanadi, A.L.et al., 2013). They usually possess high growth potential, can expand rapidly in a short period of time, and provide a driving force for the upgrading of the Chinese economy. However, they also face a series of challenges, such as technological risks and financing problems (Wang et al., 2022). Therefore, this study aims to delve into the impact of technology innovation output on the firm value of technology innovation SMEs in China in order to better understand the role of technology innovation SMEs in the Chinese economy. By analyzing their innovation activities, market position and financial performance, we can reveal the impact of technology innovation output on these enterprises and provide valuable references for the Chinese government, investors and enterprises (Hervas-Oliver, J.L.et al., 2021). This will help promote the sustainable development of technology innovation SMEs and provide more opportunities for the future of China's economy (Jiang, Y.et al., 2022).

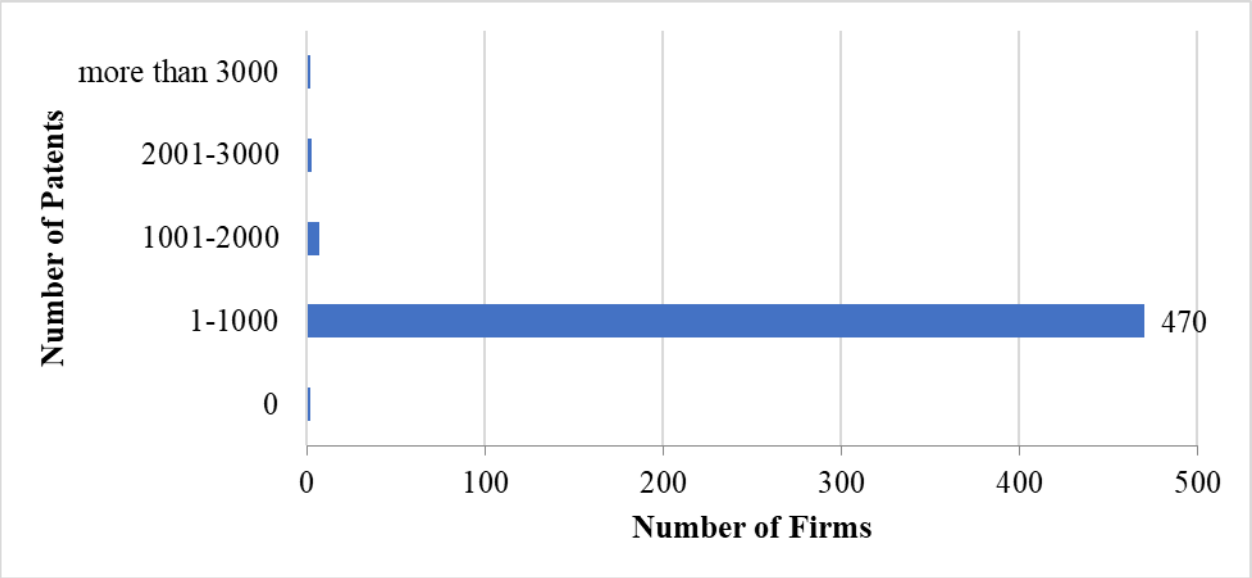


Figure 1. Number of Patents for Technology Innovation SMEs

Source: Wind Database (2023)

Technological innovation is very important to technology innovation SMEs (Li Xuelian, 2021). Figure 1.1 shows the number of patents of technological innovation SMEs listed on the Science and Technology Innovation Board (STAR MARKET).As can be seen from the figure, the majority of enterprises have a number of patents in the range of 1-1000, with a total of 470 enterprises. The lowest number of patents is 0, with a total of two enterprises. There are two enterprises with a total of 3,000 or more patents. This shows that the majority of listed enterprises in China do not have a large number of patents. The number of patents is an important indicator to assess the technological innovation capability of technology innovation SMEs and the same can be tested to technology innovation SMEs for the process of technological innovation, which has a long way to go.

The main contribution of this study is: (1) Regarding the selection of technological innovation indicators for SMEs, most domestic and international research scholars use R&D investment intensity instead of overall technological innovation capabilities for evaluation. To supplement the innovation research literature, this study selected technological innovation output, namely intangible asset and patent, as evaluation indicators of technological innovation. (2) in many studies, the dependent variable is used as an indicator of firm performance rather than an indicator representing the firm's intrinsic value, which prevents market investors from obtaining an effective assessment of the value of firm investment. To supplement the innovation research literature, this study selected Tobin Q as an evaluation indicator of company value. (3) The research is highly time-sensitive, which significantly affects its practical significance and urgency in the current economic and technological background.

This study recognizes the significance of technological innovation and conducts an in-depth analysis of its role in economic development. It examines the relationship between technological innovation capability and firm value, providing a decision-making basis for policymakers to promote technological innovation and facilitate the sustainable development of technology innovation SMEs. Additionally, this study fills the gap in systematic research on China's technology innovation SMEs, offering theoretical support for the high-quality transformation of the Chinese economy.

2. Literature Review

2.1 Technical Innovation Theory

In the technical innovation theory, economist Joseph Schumpeter first devised the theory of technological innovation. In his Theory of Economic Development, Schumpeter explains the relationship between innovation and invention, contending that invention is a precondition for innovation and that innovation is the combination of never-before-existing elements to form a new system that increases productivity. Innovation is not only a technological but also an economic breakthrough, and innovation is the source of economic development. Creating a new product that has never existed before, introducing a completely new method of generation, discovering a new market that has never been explored before, utilizing a new combination of resource allocation, and employing a new model of enterprise governance are the five primary components of innovation (Liang, T.et al., 2022). As can be seen, innovation includes conventional product and process innovation, as well as institutional innovation, market expansion, and governance concept innovation, among other aspects, whereas the R&D investment discussed in this study is limited to product, equipment, process, and other technological innovation (Kim, W.S.et al., 2018).

Transformation of R&D resources into considerable outputs and the creation of firm value through patented products is the most important aspect of technological innovation (Lo, K. L.et al., 2022). However, costly R&D expenditures are not correlated with the efficacy of innovation outputs, and enterprises with outstanding innovation capabilities and various intangible assets (such as patents and trademark rights) do not necessarily maximize the economic benefits of these assets (Lin et al., 2017).

2.2. Empirical Review

Technological innovation output includes the proportion of intangible assets and the number of patent applications. The percentage of intangible assets can be used to assess the effectiveness of an enterprise's innovation strategy (Sun JG et al., 2022). A higher percentage of intangible assets may indicate greater innovation capability and a more effective innovation strategy, which can increase the overall value and competitiveness of an enterprise. The number of patent applications is a common indicator of an enterprise's technological innovation, and research generally suggests that enterprises with more patent applications are likely to have a higher firm value. Empirical evidence suggests that this relationship between

patent filings and firm value is particularly true for technology innovation SMEs in China (Hamburg, I, 2020).

According to a study by Wu et al. (2022) Ping, which collected data from 2010 to 2019 for enterprises listed on green bonds, the level of intangible assets increased after bond issuance, leading to a significant increase in firm value. Liu et al. (2019) conducted a hierarchical multiple regression analysis on 274 Chinese technology innovation SMEs. Three intangible resources, measured by top management team diversity, R&D intensity, and government subsidies, positively influence the innovation performance of Chinese technology innovation SMEs, according to the findings. Findings show that although R&D intensity is negatively related to cash dividend payments, the relationship between R&D intensity and dividend payments becomes positive as investor protection and other country-level mechanisms interact. Qing-wei (2006) created a multiplier model to comprehensively analyze the contribution of technological innovation to a firm's value creation system, in which intangible assets play an important role in the creation of firm value (Ocak&Fndk, 2019).Observations of 2013 in Turkey over a period of nine years, from 1353 to 2005. The estimation results of the OLS and Heckman two-stage procedures indicate that the cumulative value of intangible assets has a positive effect on the enterprise's sustainable growth rate and growth rate. According to Xiong (2017), technology innovation SMEs in Shenzhen SME and GEM from 2007-2015 were selected to study the influence mechanism of technological innovation capability on the value of technology innovation SMEs, and the study found that the technological innovation capability of technology innovation SMEs was positively related to enterprise intangible assets. Most of the evidence shows that the proportion of intangible assets has a positive impact on the price of the enterprise.

Wang (2022) study utilized a sample of 3,416 A-share listed enterprises from 2012 to 2020. Technological innovation output, measured by the number of patent applications, is significantly and positively associated with firm value. Scholars have also made comparable discoveries. According to Park et al. (2018), financial data were extracted via Fngudieand made available via WINTELIPS (www.wintelips.com). The study's findings indicate that patenting activities have a positive effect on the firm's value as a technological innovation. Secondly, the greater the quantity of patent information held, the greater the firm's value. Using unbalanced panel data from 2008-2017 for severely polluting listed enterprises in China, Xie et al. (2022) investigated the effect of green innovation on firm value. It was discovered that increasing the proportion of green patent applications resulted in a decline in firm value, but this decline was only temporary. Overall, the evidence suggests that the number of patent applications is an important determinant of a firm's value, particularly for technology innovation SMEs in China. Enterprises that invest in innovation and protect their IP through patents are more likely to achieve higher firm value and long-term success. Hasan et al. (2024), Policymakers should also take note of the increasing importance of Fintech stock markets and consider fostering an enabling regulatory environment to support their growth and resilience.

2.3 Hypotheses Development

In the rapidly changing world of technology, enterprises need to meet the expectations of their customers if they wish to remain competitive in the marketplace. Technological innovation is an intrinsic engine for enterprise development. The positive impact of intangible assets and patent on the firm value has been confirmed by many studies. It helps enterprises to gain benefits in terms of market space and profit from new products developed as a result of innovative activities (Zhang, D.et al, 2018)). Enterprises with more intangible assets and patents help them to improve their process technology, which helps to improve product quality and reduce production costs. Kayani, U. N. et al. (2024) Understanding the impact of various regulatory measures on investor confidence, market integrity, and technological advancement will be critical for future research. The R&D experience of talented people is enriched by trial and error. Learning by doing increases the efficiency of innovation (Zhu, Z.et al., 2012). An enterprise with more intangible assets and patents not only increases the production of new products, but also improves product quality. The scale and cumulative effects of enterprises with more intangible assets and patents increase the innovation output of enterprises.

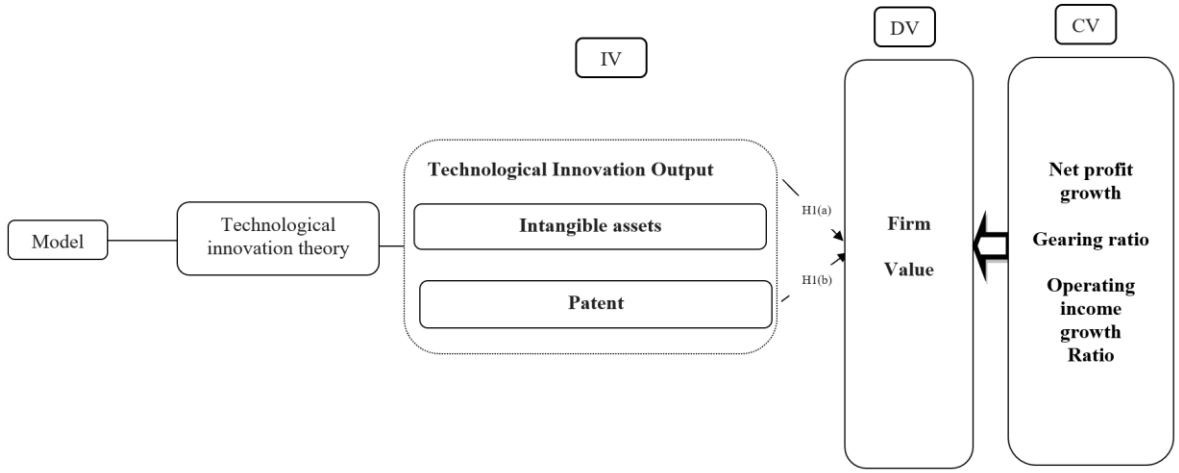
Increased innovation efficiency increases the innovation output of limited R&D resources, excluding unnecessary development activities. Liu et al. (2022) state that innovation capability has a significant positive impact on the core competitiveness of enterprises. Enterprises expand their market space through a variety of new products. Production costs are also reduced due to optimized manufacturing processes. The improved quality of products provides a better consumer experience for which consumers are willing to pay a higher price (Xue, 2020). Enterprises that innovate more efficiently have higher expected returns and are more likely to have access to cheaper external financing. Therefore, hypothesis 1 is formulated:

H1: The outputs of technological innovation can effectively increase the value of a firm.

H1 (a): Intangible assets as a percentage can effectively increase the value of technology innovation SMEs.

H1 (b): Number of patent applications can effectively increase the value of technology innovation SMEs.

2.4 Research Framework



3. Methodology

3.1 Model Setting

The Fixed Effects Model is typically more flexible, better suited to handling spatial and temporal variations, nonlinear relationships, and data heterogeneity. It can capture the complexity within the data and enhance predictive accuracy.

This study selects panel data from enterprises listed on The Science and Technology Innovation Board (STAR MARKET), develops a reasonable technology innovation capability index system to evaluate the technology innovation output of enterprises, and investigates the relationship between technology innovation output and firm value. The equation is as follows:

$$Q_{it} = a_0 + a_1 I_{it} + a_2 P_{it} + a_3 C_{it} + a_4 B_{it} + x_5 M_{it} + x_6 A_{it} + x_7 E_{it} + x_8 O_{it} + d \quad (1)$$

Where

In the formula, Q_{it} is the dependent variable and represents the TobinQ. Technological innovation is the independent variable in this study, where a_0 is the constant term. I_{it} represents the proportion of intangible assets. P_{it} represents the number of patent applications. The control variables in this study are M_{it}, A_{it}, G_{it}, D_{it}, E_{it} and O_{it}. They represent the market capitalization of the enterprise, enterprise assets, net profit growth rate, gearing ratio, age and operating income growth ratio respectively.

3.2 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 proportion of intangible assets: For technology innovation SMEs, intangible assets occupy an important share and are a more objective representation of the firm's value in terms of future growth and profitability. Incremental intangible assets/total assets at the beginning of the period. Denoted by the letter 'I'.

The number of patent applications: As the technological innovation achievements of enterprises are mostly in the form of patents (Xiong, 2017). Therefore, this study considers the number of patent applications filed by an enterprise as an assessment indicator (Ln (total number of patent applications + 1)). The patent data was based on the name of the technology innovation SMEs according to Juchao Information Website and as such by searching the patent database of the China Patent Information Centre (http://www.cnpat.com.cn/) and then counting the patents accepted and obtained by each listed enterprises. The letter 'P' 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.

Age: indicates the number of years the enterprise has been in existence. Ln (target year - year of inception). Denoted by the letter 'E'.

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'.

Operating income growth ratio: represents the growth rate of the enterprise's operating income, usually positively correlated with firm value.(Current period operating income - Previous period operating income) / Previous period operating income*100%. This is represented by the letter ‘O’.

Table 1. Description of Variables

Type	Name	Symbol	Description	Reference
DV	Tobin Q	Q	Market capitalization/net asset	
IV	The proportion of intangible assets	I	Intangible assets	Wu et. (2022)
	The number of patent applications	P	Ln (Total number of patent applications+1)	(Xiong, 2017)
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	
	Operating income growth ratio	O	(Current period operating income - Previous period operating income) / Previous period operating income*100%	

Source: Wind Database (2023)

3.3 Data Selection

The processing of data pertaining to The Science and Technology Innovation Board (STAR MARKET) listed enterprises for 2019-2023 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.

4. Results and Discussion

4.1 Descriptive Statistics

Table 2 shows the descriptive statistical results. For the dependent variable Tobin Q, the mean value is 5.617, the standard deviation is 4.459, 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 intangible assets is 2.696, the standard deviation is 2.514, the minimum value is 0.009, and the maximum value is 14.444, indicating that there are large differences between the intangible assets of different enterprises. This may be because enterprises compete in technology and market. Investment in strengths and development strategies vary. The average number of patents is 185.091, the standard deviation is 247.032, the minimum value is 4, and the maximum value is 1496, showing that enterprises also have large differences in technological innovation and intellectual property protection. This may be due to enterprises' investment in innovation and market competition. Differences in strategy.

Among the control variables, the mean value of return on equity is -2.616, the standard deviation is 141.513, 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 25.759, the standard deviation is 17.106, 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 operating income growth ratio is 3.121, the standard deviation is 0.966, the minimum value is -2.718, and the maximum value is 5.892, 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 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Q	1708	5.617	4.459	1.191	25.907
I	1708	2.696	2.514	0.009	14.444
P	1620	185.091	247.032	4	1496
G	1708	-2.616	141.513	-686.306	563.904
D	1708	25.759	17.106	3.233	71.7
O	1252	3.121	1.129	-2.718	5.892

4.2 Pairwise Correlation

Table 3 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.

Table 3. Pairwise Correlation

	Q	I	P	G	D	O
Q	1					
I	-0.0330	1				
P	0.00500	-0.0310	1			
G	0.221***	-0.053**	0.095***	1		
D	-0.048**	0.052**	0.395***	-0.0160	1	
O	0.270***	-0.0260	0.152***	0.367***	0.118***	1

4.3 Regression Analysis

Table 4 shows the regression analysis of technological innovation output on firm value. The study

found that intangible assets have a significant negative impact on the firm value of technology innovation SMEs. For every additional unit of intangible assets, the firm value decreases by 0.223 units. This may be because technology innovation SMEs has relatively low technological competition or market recognition in the market, which affects their overall firm value.

On the other hand, the impact of the number of patents on firm value also shows a negative and significant trend. For every increase in the number of patents by one unit, the firm value decreases by 3.911 units. This may be because, although the number of patents reflects a enterprise's investment and results in technological innovation, too many patents may also imply that technology is fragmented or cannot be effectively transformed into market competitive advantages, thus affecting the enterprise's market pricing and performance. Investor assessments had a negative impact.

In terms of control variables, the impact of Net profit growth rate on firm value is positive and significant. For every increase in corporate market value by one unit, firm value increases by 0.003 units. The Operating income growth ratio also has a positive impact on the enterprise value. Every increase of one unit in the Operating income growth ratio, the enterprise value increases by 0.651 units. This may be because a high Net profit growth rate and Operating income growth ratio 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 4. The Impact of Technology Innovation output on Firm Value

	(1)
VARIABLES	Q
I	-0.223**
	(-2.31)
P	-3.911***
	(-3.80)
G	0.003***
	(2.59)
D	0.005
	(0.21)
O	0.651***
	(4.61)
Constant	122.856***
	(9.60)
Observations	1,193
Number of id	476
R-squared	0.222

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

4.4 Robustness Test

4.4.1 Add Control Variable (Market Value)

In order to ensure the reliability of the research results, this study conducted a stability test by introducing the control variable market value. The research results show that intangible assets and the number of patents all have a positive and significant impact on firm value. Specifically, for every additional unit of intangible assets, the firm value decreases by 0.187 units, which shows that although intangible assets may reflect the enterprise's investment in market knowledge and technological capital, its increase may also mean the decline of market competition.

On the other hand, for every unit increase in the number of patents, the firm value decreases by 4.343 units, which may reflect that excessive patent numbers may not be effectively transformed into market competitive advantages, thus affecting the enterprise's overall market positioning and investor evaluation. 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 on firm value.

Table 5. The Impact of Technology Innovation output on Firm Value (add market value)

	(1)
VARIABLES	Q
I	-0.187**
	(-2.39)
P	-4.343***
	(-5.19)
G	0.001
	(1.02)
D	0.078***
	(4.06)
O	-0.005
	(-0.04)
M	6.641***
	(19.20)
Constant	9.822
	(0.82)
Observations	1,193
Number of id	476
R-squared	0.488

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

4.4.2 Change the Sample (Exclude 2020)

This study also conducted a stability test again by reducing the sample size and eliminating data from 2020. In Table 6, the impact of intangible assets and number of patents on firm value is still significant and shows a negative trend. This further verifies that even within different sample periods, the negative impact of these factors on firm value still exists.

Specifically, after excluding the 2020 data, for every increase in intangible assets of one unit, the firm value decreases by 0.284 units, for every increase in the number of patents by one unit, the firm value decreases by 3.127 units. This shows that despite excluding data from specific years, the pattern of the impact of these factors on firm value remains stable.

Table 6. The Impact of Technology Innovation output on Firm Value (Exclude 2020)

	(1)
VARIABLES	Q
I	-0.284**
	(-2.58)
P	-3.127***
	(-2.75)
G	0.003**
	(2.02)
D	0.014
	(0.56)
O	0.721***
	(4.74)
Constant	131.600***
	(9.15)
Observations	1,036
Number of id	475
R-squared	0.240

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

4.5 Heterogeneity Test

In order to analyze more deeply the impact of technological innovation output on the value of different age technology innovation SMEs, this study divided the sample into three groups: less than ten years, ten to twenty years and more than twenty years. As can be seen from Table 7, there are significant negative in the impact of technological innovation output on the firm value of these three types of enterprises.

Among less than ten years enterprises, intangible assets and the number of patents all have a negative and significant impact on firm value. For every additional unit of intangible assets, the firm value decreases by 3.400 units. This may be because less than ten years enterprises

are lower to asset allocation and market recognition in market competition. Despite the increase in intangible assets, technological capital or market competition Lack of strength. At the same time, for every increase in the number of patents by one unit, the firm value decreases by 15.893 units, which may reflect that too many patents may lead to the decentralization of technological innovation or the failure to effectively transform it into market competitive advantage.

In addition, the technological innovation output has a significant negative impact on the enterprises established 10 to 20 years and more than 20 years, but the negative impact is smaller than that of the enterprises established less than 10 years. For every unit increase in intangible assets, the enterprise value of enterprises with 10 to 20 years decreases by 0.223 units, and that of enterprises with more than 20 years decreases by 0.414 units. For every unit increase in the number of patents, the enterprise value of enterprises with 10 to 20 years of age decreases by 3.911 units, and that of enterprises with more than 20 years of age decreases by 4.348 units. This may be less effective than the ability of younger firms to commercialize their intangible assets and patents.

Table 7. The Impact of Technology Innovation on Firm Value (Different age)

	(1)	(2)	(3)
VARIABLES	Q	Q	Q
I	-3.400*	-0.223**	-0.414***
	(-1.99)	(-2.31)	(-3.08)
P	-15.893*	-3.911***	-4.348***
	(-1.83)	(-3.80)	(-3.12)
G	0.014*	0.003***	0.004*
	(1.93)	(2.59)	(1.78)
D	0.073	0.005	0.027
	(0.59)	(0.21)	(0.80)
O	0.178	0.651***	0.424**
	(0.23)	(4.61)	(2.13)
Constant	262.191***	122.856***	150.773***
	(3.09)	(9.60)	(7.08)
Observations	78	1,193	386
Number of id	39	476	149
R-squared	0.501	0.222	0.311

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

5. Discussion and Conclusion

5.1 Main Finding

This study aims to explore the impact of technological innovation output on the firm value of

technology innovation small and medium-sized enterprises. The results show the following main trends:

First, in terms of technological innovation output, the number of intangible assets and patents has a negative impact on the firm value of technology innovation small and medium-sized enterprises. This shows that although an increase in the number of intangible assets and patents by a company may reflect its investment in technology development and innovation, these increases may not be effectively translated into improvements in market competitiveness or capital efficiency.

In enterprises with different years of establishment, intangible assets have a negative impact on the enterprise value of enterprises with different years of establishment, especially for enterprises with less than ten years of establishment. This may reflect the weak position in resource allocation and market competition of enterprises with a shorter establishment year.

6. Implication and Suggestions for Future Research

6.1 Implication

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.

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.

6.2 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.

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Authors contributions

Liu Zichang was responsible for the research design and the revision. Liu Zichang was responsible for the data collection. Liu Zichang drafted manuscript, and Dr. Nik Hadiyan Binti Nik Azman made the revision. All authors read and approved the final manuscript.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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