Research Article

Research on Technological Innovation Investment, Financing Constraints, and Corporate Financial Risk: Evidence from China

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Technological innovation is the source of generating new momentum. In the context of the financing constraints generally existing in China, it is particularly important to explore the impact of technological innovation investment on corporate financial risk, which also provides a risk identification perspective and development direction for enterprises. Based on the data of China's small and medium-sized listed companies from 2010 to 2019, and from the perspective of moderating effect of financing constraints, this paper uses multiple regression analysis method to test the impact mechanism of technological innovation investment on corporate financial risk and the moderating effect of financing constraints in both. The results show that technological innovation investment can significantly reduce corporate financial risk, while financing constraints can significantly improve the level of financial risk. Financing constraints play a moderating role in technological innovation investment and financial risk. Heterogeneity test found that, compared with large-scale enterprises, small-scale enterprises' technological innovation investment has a more significant impact on financial risk, and the moderating effect of financing constraints is also greater. Compared with private enterprises, state-owned enterprises' technological innovation investment has less impact on financial risk, and the moderating effect of financing constraints is not significant.

1. Introduction

China's 14th Five-Year Plan emphasizes the need to use scientific and technological innovation to generate new development momentum, and to support many SMEs to become important birthplaces of innovation. SMEs are not only an important force in China's social development, but also the source of technological innovation. However, there is a big gap between SMEs in China and those in developed countries in terms of innovation ability, resource allocation and management system [1]. With the increasingly fierce market competition, it is particularly important for enterprises to enhance their technological innovation ability if they want to achieve rapid development, stabilize their market position and maintain their core competitiveness. At the same time, companies also need to consider the set-up cost, process quality, delivery quantity and batch size to minimize the total cost of the entire supply chain, so as to

improve the efficiency of technological innovation [2], especially in the global warming scenario, the development of new energy-saving green technology is more conducive to reducing carbon emissions in the process from production to sales and transportation [3]. From early investment in R&D, selection and training of scientific and technical staff, specialized equipment or experiment to later patent application and commercialization, there is always uncertainty in the process [4]. This uncertainty may be reflected in the enterprise's R&D, production, operation, inventory systems [5] and supply chains, etc., but will eventually be presented in the form of financial risks. Some scholars solve environmental problems and operational risks by using old products as recyclable items or second-generation fuels [6]. In particular, in the environment of financing constraints prevailing in China, this will not only increase the risk of enterprise capital chain fracture and raise the cost of using capital, but also reduce the innovation investment

opportunities and financial performance of enterprises, and hinder the growth and development of enterprises [7]. Even, excessive financing constraints will also inhibit enterprises' R&D investment [8]. Especially when enterprises lack endogenous financing and need to finance from the capital market, due to information asymmetry, moral hazard, adverse selection, etc., the cost of exogenous financing of enterprises rises, resulting in the cost and benefit mismatch of R&D projects, further increasing the possibility of financial risks. Therefore, it is a question worth exploring how technological innovation investment in SMEs affects the financial risk of firms in the context of financing constraints. The paper also goes on to examine how the above relationships change under firm heterogeneity.

In order to answer the above questions, this paper selects listed companies on the SMB of SZSE from 2010–2019 as the research objects, and empirically tests the relationship between technological innovation investment and financial risk and the mechanism of their roles using multiple regression methods, and also introduces financing constraints as a moderating variable. The main contributions are as follows: (1) the technological innovation investment is associated with the corporate financial risk to enrich the theory of enterprise risk management and innovation management. (2) Introducing financing constraints as a moderating variable, we explore the role of financing constraints in the relationship between technological innovation investment and financial risk to provide new perspectives and ideas for reducing and controlling financial risk. (3) By dividing the scale and nature of the enterprises, the differences between technological innovation investment, financing constraints, and the impact mechanism of financial risks are compared and analyzed, so as to provide policy recommendations for improving the construction of the national scientific and technological innovation system.

2. Literature Review

2.1. Literature Review of Technological Innovation Investment. Since the innovation theory was put forward, technological innovation investment has become a hot research topic among scholars. Technological innovation is a series of innovative processes, such as designing, manufacturing, and producing new products and services, adhering to the corporate philosophy [9]. At present, domestic and foreign scholars' research on technological innovation investment is mainly based on the following perspectives: From the perspective that technological innovation investment affects the development of enterprises, companies' innovative R&D activities effectively increase their total factor productivity [10]. The construction of a complete evaluation system of technological innovation investment from the aspects of innovation resource input, innovation output, technology density, innovation effect, market realization, and innovation propensity is beneficial to the realization of efficient management of technological innovation [11]. Technological innovation results are the decisive factors that enable enterprises to outperform their competitors in the long term [12, 13], and different industries should invest in R&D

timely according to their own characteristics, not only increase the technological innovation investment to bring long-term sustainable benefits, but also try to reduce the significant reduction of R&D expenses on the current corporate performance [14]. At the same time, the enterprise's technological innovation investment has effectively expanded the staff size and increased the proportion of indirect production staff such as sales, technology, and management, but inhibited the employment of direct production staff [15]; From the perspective of policy effects, the R&D achievements of an enterprise often spill over to other enterprises in the same industry or other industries, making it impossible for firms to obtain the full residual benefits of innovation activities and reducing the enthusiasm of enterprise R&D investment [16, 17]. In view of this, in order to overcome the spillover effects, financing constraints, and risks of innovation activities, the government needs to formulate relevant industrial policies to compensates for the ensuing costs, so that the level of firms' technological innovation investment will be close to the socially optimal level [18]. Industrial policy has two sides. It stimulates real high-tech enterprises to increase technological innovation input and output, but also causes "fake high-tech enterprises" to cater to policy requirements in order to obtain policy preferences, and their innovation activities have not increased substantially [19]. Meanwhile, the tax deduction policy for R&D expenses has a significant positive correlation with innovation investment of high-tech enterprises, while tax collection and administration has a significant negative correlation with it [20]. Some studies recommend that policy makers discourage nonrenewable energy sources and increase the use of renewable energy sources to reduce consumption and territory-based emissions, which can support the development of eco-friendly energy technologies and sustainable development of the energy environment [21]. From the perspective of financial development and supervision, the academic circle has paid much attention to the issue of financialization in recent years, and has also begun to explore its impact on technological innovation investment. Some scholars believe that the capital allocation of nonfinancial enterprises is unreasonable, and they invest too much in the financial or real estate industry, while the funds for R&D equipment updating or product service innovation are obviously insufficient, which is not conducive to technological innovation [22, 23]. Excessive financial speculation will consume corporate resources and energy, and the resulting reservoir effect cannot even offset the crowding out of corporate innovation resources [24]. However, venture capital support enables enterprises to make full use of innovation resources spillover from the industry, reduce the risk level, alleviate financing constraints and participate in healthy and efficient market competition, which have positive effects on technological innovation [25]. The results and discussion may be presented separately, or in one combined section, and may optionally be divided into headed subsections. In particular, in green finance, technological innovation, and green product development have a significant positive impact on the overall green growth performance of the country [26].

2.2. Literature Review of Corporate Financial Risk. The definition of financial risk is divided into two main categories: narrow meaning and broad meaning. Financial risk in a narrow meaning refers to the risk that an enterprise is unable to pay its debts due to a shortage of funds. While financial risk in a broad meaning refers to the risk of financial distress or even collapse due to changes in the internal and external environment, which leads to the breakage of the enterprise's capital chain. Research on financial risk covers the following aspects: in the context of China's structural deleveraging, corporate leverage will inevitably lead to financial risk, and deleveraging is essentially a process to control the deterioration of financial risks [27]. However, the lack and backwardness of macrolevel short-term financial risk indicators have seriously affected the precise positioning of structural deleveraging in China and hindered the objective evaluation of short-term financial risk in the real economy. After relevant scholars revised the indicators, the overall short-term financial risk in the real economy in China showed a downward trend, mainly to improve debt paying ability at the expense of reducing asset liquidity [28]. At the financing level, the implementation of the "the Belt and road" initiative and the lower interest rates on loans have enabled enterprises to choose debt financing for investment activities, thus increasing the financial risk of enterprises [29]. In addition, enterprises increase their financial leverage and reduce their debt paying ability through large-scale debt financing, which results in an increase in the financial risk level of enterprises [30]. However, financial risk is less likely to occur in companies with more institutional owners and disclosure of more CSR information [31]. Dr. Sarkar addresses the issue of payback by offering appropriate credit periods to end customers from a retailer's perspective, thereby increasing overall corporate profits and the ability to resist financial risk [32]. At the investment level, based on the trend of financialization and the increasingly severe background of "turning from reality to emptiness" of enterprises, the relationship between the degree of financialization of enterprises and financial risk is significantly positive [33]. For GEM enterprises, the larger the proportion of senior management with financial experience, the higher the investment efficiency and the lower the financial risk [34]. Moreover, corporate social responsibility as well as age and size have a positive impact on corporate financial performance, financial inclusion and financial stability, and can also increase the power to resist financial risk [35].

The main contributions of the scholars are shown in Table 1.

2.3. Review. Most of the current research on technological innovation investment is reflected in enterprise development, policy effect, and financial development, while the exploration on financial risk focuses on optimizing capital structure, investment and financing, in which most scholars have explored the factors affecting financial risk, such as corporate social responsibility, financial leverage, retailer payback period and other factors. At present, there is no research on the mechanism of the impact of technological

innovation investment on financial risk based on the moderating effect of financing constraints, and the research on the moderating effect of financing constraints in the relationship between the two is also in the blank. Therefore, based on the perspective of the moderating effect of financing constraints, this paper tries to establish a research framework on technological innovation investment, financing constraints, and financial risks and make an empirical analysis to fill in the existing research gaps.

3. Theoretical Analysis and Research Hypotheses

3.1. Technological Innovation Investment and Corporate Financial Risk. Technological innovation is not only the basic premise for an enterprise to maintain its market share and improve its core competitiveness, but also the guarantee for improving its profitability, growth ability, and financial performance [25]. The level of technological innovation investment is also positively correlated with the future profitability, and this effect is significantly weakened over time [36]. The disclosure of research and development information can enable investors to have a more comprehensive understanding of corporate information, ease information asymmetry, and reduce the probability of agency problems, thus improving the level of corporate risk taking [37]. Technological innovation, as a catalyst for firms to maintain sustained competitive advantage, has a direct or indirect impact on macroeconomic growth and firm performance [38]. If an enterprise wants to achieve sustainable development, it must pay attention to R&D investment and innovation, reasonably arrange the investment amount according to its own situation, and combine short-term interest with long-term interests [39]. When there is a preferential tax policy, enterprises should weigh the cost of innovation with tax incentives to avoid unproductive innovation affecting the efficiency of enterprise operations [40]. It is necessary to improve technological innovation capabilities and focus on R&D efficiency, and the combination of CSR and technological innovation strategies can help improve corporate financial performance [41]. The performance of technological innovation investment shows that technological innovation investment can effectively improve the performance of the enterprise, which reflects the reduction of risk. Professor Qiang Wang also believes that encouraging corporate technological innovation and accelerating energy transition would be a successful new way of thinking about controlling financial risk [42]. After the above analysis, we believe that technological innovation investment is beneficial for reducing corporate financial risk. Accordingly, hypothesis 1 is proposed.

> H1: technological innovation investment is significantly negatively correlated with corporate financial risk

3.2. Financing Constraints and Corporate Financial Risk. The main sources of funding for corporate technology innovation investment are both internal surplus and external

TABLE 1: Comparison between the contributions of different authors.

Author (s) name	Technological innovation investment	Corporate financial risk	Financing constraints	Moderating effect	Heterogeneity analysis
Xiao et al. [10]	√				√
Rong [11]	√				
Greenwald and Stiglitz [18]	√	√	√		
Yang and Rui [19]	√				√
Abbasi et al. [21]	√				
Li and Yan [25]	√	√	√	√	
Talebzadehhosseini and Garibay [26]	√		√		
Zhao and Zhu [27]		√			
Wang et al. [28]		√			√
Cao et al. [29]		√	√		
Tarighi et al. [31]		√			√
Sarkar et al. [32]		√	√		
Xia et al. [33]		√	√		
Ramzan et al. [35]		√	√		
This paper	√	√	√	√	√

financing. A quality financing system has a high tolerance for innovation trial and error and better supports technological innovation [43]. Financing constraints generally exist in enterprises. Compared with large enterprises, small and medium-sized enterprises have higher financing constraints due to their small scale, low cash flow level, and high risk level. When financing constraints exist, firms take out bank credit or resort to shadow banking. Further contractually agreed interest charges are paid, leading to higher debt levels and financing costs, which increases the financial risk of the firm [44]. At this point, the asset liability ratio increased, the enterprise's financing ability and debt-paying ability continued to decline, and the intensity of financing constraints gradually increased [45]. Financing constraints could inhibit enterprise innovation. When the institutional environment improves, financing constraints are improved, and the inhibition effect on technological innovation is weakened [46], which reduces enterprise financial risk. In particular, financing constraints are more likely to impede corporations' ability to adjust their business operations to cope with exogenous shocks during the COVID-19 pandemic, which leads to a further increase in financial risk [47]. After the above analysis, we think that the greater the financing constraint the greater the financial risk of the corporation. Accordingly, hypothesis 2 is proposed.

> H2: there is a significant positive correlation between financing constraints and corporate financial risk

3.3. The Moderating Effect of Financing Constraints. Financing is one of the sources of funding for corporate R&D activities. Higher financing constraints may increase corporate financing costs, reduce corporate solvency, and increase financial risk [48]. Technological innovation requires a large and stable investment, joint R&D with other corporations requires even more liquidity in order to transform external knowledge into technological innovation outputs; Therefore, financing constraints may inhibit corporate technological innovation investment [49].

Enterprises with active investment in innovation are more likely to cause operational risks with the strengthening of financing constraints [50]. Financing constraints are not only due to the imbalance in financial markets, but also the cognitive factors of entrepreneurs [51], which further affect the decision-making of enterprise innovation activities. Short-term credit constraints have a greater impact on SMEs at this time, forcing owners to use the additional cash flow to cover the increase in the firm's working capital, thus harming long-term assets [52]. However, due to the lack of relevant empirical research, it is necessary to further explore how financing constraints affect the relationship between technological innovation investment and financial risk. When firms engage in innovative activities, higher financing constraints will enhance their R&D uncertainty and generate negative signals. After the above analysis, we think that the more severe the financing constraint a corporation faces, the less the technological innovation activity reduces the financial risk. Accordingly, hypothesis 3 is proposed.

> H3: financial constraints play a moderating role between technological innovation investment and corporate financial risk

Combining the above analysis, the theoretical model of this paper is constructed as shown in Figure 1.

4. Research Design

4.1. Sample Selection and Data Sources. In the paper, we selected the data of Shenzhen small and medium-sized board listed companies from 2010–2019 as the research sample and conducted the following screenings: (1) Excluding ST and *ST companies; (2) Excluding financial companies; (3) Excluding data missing samples. After the above processing, we finally obtained 3199 observations. In addition, because we considered the effect of outliers on the robustness of the study findings, we chose to apply a Winsor2 shrinkage of 1% above and below to all continuous variables. The variable

data were obtained from the CSMAR and RESSET databases, and the statistical software was Stata 16.0.

4.2. Model Design.

Firstly, we use model (1) to test the relationship between technological innovation investment and financial risk. In the model, $Z\text{-Risk}_{i,t}$ denotes the financial risk of the "i-th" firm in year "t," $\text{RDR}_{i,t}$ is the corresponding technological innovation investment, and also includes the control variables and the residual term ε.

$$Z - \text{Risk}_{i,t} = \beta_0 + \beta_1 \text{RDR}_{i,t} + \beta_2 \text{Size}_{i,t} + \beta_3 \text{Age}_{i,t} + \beta_4 \text{DFL}_{i,t} + \beta_5 \text{OC}_{i,t} + \beta_6 \text{POR}_{i,t} + \text{Ind} + \text{Year} + \varepsilon_{i,t}. \tag{1}$$

Secondly, we use model (2) to test the relationship between financing constraints and financial risk. $\text{SA}_{i,t}$ denotes the financing constraint of the "i-th" firm in year "t."

$$Z - \text{Risk}_{i,t} = \beta_0 + \beta_1 \text{SA}_{i,t} + \beta_2 \text{Size}_{i,t} + \beta_3 \text{Age}_{i,t} + \beta_4 \text{DFL}_{i,t} + \beta_5 \text{OC}_{i,t} + \beta_6 \text{POR}_{i,t} + \text{Ind} + \text{Year} + \varepsilon_{i,t}. \tag{2}$$

To test whether there is a moderating role of financing constraints in the relationship between technological innovation investment and financial risk. We refer to the moderating effect analysis method of Wen [53], which centralizes the explanatory and moderating variables. Next, the hierarchical regression is performed: firstly, the regression of Risk on c_RDR and c_SA is done, as shown in model (3); secondly, the regression is done again by adding the interaction term Interact, and the regression coefficient of the interaction term is tested, and if it is significant, the moderating effect is significant, as shown in model (4). In models, c_RDR and c_SA denote decentralized RDR and SA.

$$Z - \text{Risk}_{i,t} = \beta_0 + \beta_1 c\_\text{RDR}_{i,t} + \beta_{21} c\_\text{SA}_{i,t} + \beta_3 \text{Size}_{i,t} + \beta_4 \text{Age}_{i,t} + \beta_5 \text{DFL}_{i,t} + \beta_6 \text{OC}_{i,t} + \beta_7 \text{POR}_{i,t} + \text{Ind} + \text{Year} + \varepsilon_{i,t}, \tag{3}$$

$$Z - \text{Risk}_{i,t} = \beta_0 + \beta_1 c\_\text{RDR}_{i,t} + \beta_{21} c\_\text{SA}_{i,t} + \beta_3 \text{Interact}_{i,t} + \beta_4 \text{Size}_{i,t} + \beta_5 \text{Age}_{i,t} + \beta_6 \text{DFL}_{i,t} + \beta_7 \text{OC}_{i,t} + \beta_8 \text{POR}_{i,t} + \text{Ind} + \text{Year} + \varepsilon_{i,t}. \tag{4}$$

4.3. Variables Selection.

The explained variable is corporate financial risk (*Z-risk*), which is measured by using the Z-score model proposed by Altman [54], Z-score = (1.2 × working capital + 1.4 × retained earnings + 3.3 × earnings before interest and tax + 0.999 × sales income)/total assets + 0.6 × total market value of shares/total liabilities, a higher Z-score indicates less financial risk.

The explanatory variable is technological innovation investment (RDR), which is defined as the ratio of R&D input to operating revenue with reference to the studies of Li and Yan [25], Chen et al. [55] and Yu and Chi [56].

Moderator is the financing constraint (SA). The methods to measure financing constraints mainly include single-indicator methods (such as dividend payout ratio, change in dividend per share, interest coverage multiple, etc.) and multiple-indicator methods (such as SA index, FC index, WW index and KZ index). This paper refers to the SA index of Ju et al. [57] to measure the financing constraints, and the calculation formula is: SA = 0.043 × size^2 – 0.737 × size – 0.04 × Age. In the formula, size is the natural logarithm of the total assets of the business in millions of yuan, and Age indicates the number of years the business has been in operation. SA is negative and the larger the absolute value indicates the more severe financing constraints on the firm.

Referring to the studies of Gong and Wang [44], Li et al. [58], Pan and Fang[59], and Hao [4], the following control variables are selected: Enterprise scale (Size), Operating life (Age), Financial leverage (DFL), Ownership concentration (OC), Revenue scale (POR), industry (Ind) and Year. In addition, Both Z-risk and SA are composite indicators, which are measured by a large number of single indicators combined. Therefore, it is not advisable to select too many control variables (e.g., return on equity (ROE), growth capacity (TobinQ), etc.), which is mainly aimed at avoiding the effect of multicollinearity. See Table 2 for details.

4.4. Descriptive Statistics.

The descriptive statistical results in Table 3 show that with a sample size of 3199, the minimum Z-score of corporate financial risk(Z-risk) is 1.88, the maximum value is 39.92, the average value is 7.31 and the standard deviation is 6.37, indicating that there are significant differences among different levels of corporate financial risk. The minimum value of technological innovation investment (RDR) is 0.07, the maximum value is 25.87, the mean value is 4.88 and the standard deviation is 4.23. It can be seen that technological innovation investment varies greatly among different enterprises. The minimum
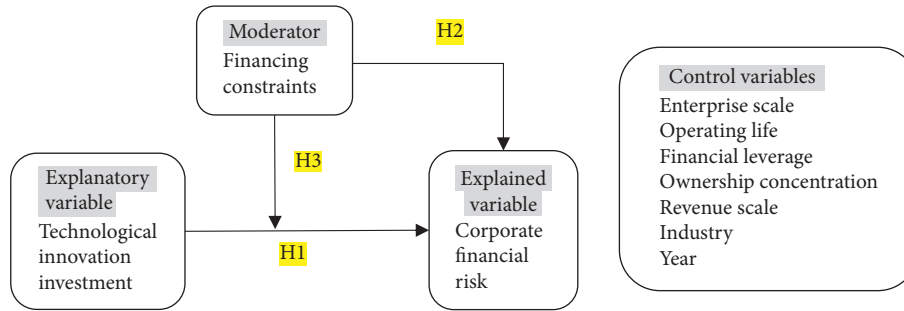
FIGURE 1: Theoretical model.

value of SA index of financing constraint is −4.44, the maximum value is -3.16, the mean value is −3.72 and the standard deviation is 0.23, which indicates that the sample enterprises have different degrees of financing constraint. The values of each control variable are within a reasonable range. In the control variables, the minimum value of enterprise scale (Size) is 5.88, the maximum value is 12.2, the mean value is 8.09, and the standard deviation is 0.92, indicating that there is a large gap in enterprise scale, which provides empirical evidence for further empirical analysis. The minimum value of operating life (Age) is 5 years, the maximum value is 32 years, the mean value is 15.26 years, and the standard deviation is 5.51. The above indicates that the span of operating life of the sample enterprises is 5–32 years. The minimum value of financial leverage (DFL) is 0.52, the maximum value is 3.26, the mean value is 1.13, and the standard deviation is 0.36, indicating that the sample enterprises are subject to different degrees of debt pressure, easy to cause financial risks. The minimum value of ownership concentration (OC) is 24.03, the maximum value is 86.27, the mean value is 55.9 and the standard deviation is 14.16. The minimum value of revenue scale (POR) is 19.16, the maximum is 24.26, the mean is 21.37, and the standard deviation is 1.04. The above indicates that the values of all control variables are within a reasonable range.

4.5. Correlation Analysis.

We conducted Pearson correlation tests to discern the presence of multicollinearity between the variables, and the results are shown in Table 4. In the main effect, RDR is significantly and positively correlated with Z-risk (correlation coefficient is 0.240 and significant at 1% level). It indicates that the higher the RDR, the higher the Z-risk and the lower the financial risk. The hypothesis H1 above is tentatively supported. Moderator SA is positively correlated with the Z-risk (correlation coefficient is 0.083 and significant at 1% level), indicating that the greater the SA index score is, the greater the Z-risk is. This indicates that the smaller the financing constraints the lower the financial risk, which initially verifies the previous hypothesis H2 and is also consistent with the actual situation of Chinese enterprises. Other control variables are also significantly correlated with the Z-risk, indicating that the selection of control variables has theoretical significance. For example, enterprise scale is significantly and negatively correlated with Z-risk (correlation coefficient: −0.332), operating life is significantly and negatively correlated with Z-risk at the 10% level (correlation coefficient:−0.031), financial leverage is significantly and negatively correlated with Z-risk at the 1% level (correlation coefficient: −0.305), ownership concentration is significantly and positively correlated with Z-risk at the 1% level (correlation coefficient: −0.066), and revenue scale is significantly and negatively correlated with Z-risk at the 1% level (correlation coefficient: −0.372). In order to obtain more reliable evidence, it is necessary to control other variables for multiple regression analysis.

5. Empirical Results

5.1. Technological Innovation Investment and Corporate Financial Risk.

In order to verify the correctness of the main effect, the impact mechanism of technological innovation investment on financial risk is tested by using model (1), and the test results are shown in Table 5 (1). The results show that there is a significant positive correlation (correlation coefficient is 0.227) between technological innovation investment (RDR) and financial risk (Z-score) at the level of 1%, that is, the greater the technological innovation investment, the greater the Z-score, and the lower the financial risk of the enterprise. H1 is verified.

5.2. Financing Constraints and Corporate Financial Risk.

In order to test whether H2 is correct or not, multiple regression analysis is performed on financing constraints and financial risks through model (2), and the results are shown in Table 5 (2). The results show that the SA is significantly positively correlated with the Z-score at the level of 1%, and the correlation coefficient is 14.445, that is, the larger the SA is, the greater the Z-score is, the smaller the financing constraint is, the smaller the financial risk is, and the financing constraints is significantly positively correlated with the financial risk, H2 is verified.

5.3. The Moderating Effect of Financing Constraints.

In order to verify the impact of financing constraints on technological innovation investment and corporate financial risk, the moderating effect is tested using models (3) and (4). The results are shown in Table 5 (3) and (4). The results show that technological innovation investment and financing constraints after centralization still maintain the same relationship with financial risk as in the previous section. After further adding the interaction (Interact = c_RDR $*$ c_SA), the main

TABLE 2: Description and definition of variables.

Variable category	Variable symbol	Variable name	Variable definition
Explained variable	Z-risk	Financial risk	(1.2 × working capital + 1.4 × retained earnings + 3.3 × earnings before interest and tax + 0.999 × sales income)/total assets + 0.6 × total market value of shares/total liabilities
Explanatory variable	RDR	Technological innovation investment	R&D input/operating revenue
Moderator	SA	Financing constraints	$0.043 \times \text{size}^2 - 0.737 \times \text{size} - 0.04 \times \text{age}$
	Size	Enterprise scale	Natural logarithm of total assets at the end of the period
	Age	Operating life	Year-year of establishment of the enterprise +1
	DFL	Financial leverage	(Net profit + income tax expense + finance expense)/(net profit + income tax expense)
Control variable	OC	Ownership concentration	Total shareholding of top five shareholders
	POR	Revenue scale	Natural logarithm of main business income
	Ind	Industry	Industry dummy variable
	Year	Year	Annual dummy variable

TABLE 3: Descriptive statistical results of variables.

Variable	N	Mean	sd	Min	Max
Z-risk	3199	7.31	6.37	1.88	39.92
RDR	3199	4.88	4.23	0.07	25.87
SA	3199	-3.72	0.23	−4.44	−3.16
Size	3199	8.09	0.92	5.88	12.2
Age	3199	15.26	5.51	Five	32
DFL	3199	1.13	0.36	0.52	3.26
OC	3199	55.9	14.16	24.03	86.27
POR	3199	21.37	1.04	19.16	24.26

TABLE 4: Pearson correlation coefficient test.

	Z-risk	RDR	SA	Size	Age	DFL	OC	POR
Z-risk	1							
RDR	0.240***	1						
SA	0.083***	0.039**	1					
Size	−0.332***	−0.037**	−0.163***	1				
Age	−0.031*	−0.045**	−0.969***	0.094***	1			
DFL	−0.305***	−0.141***	−0.058***	0.162***	0.043**	1		
OC	0.066***	−0.143***	0.116***	−0.053***	−0.087***	−0.128***	1	
POR	−0.372***	−0.217***	−0.153***	0.870***	0.086***	0.162***	−0.017	1

Note. ***, **, and * are significant at 1%, 5% and 10%, respectively, the same in the following.

effect is significantly positive at the level of 1% (correlation coefficient is 0.225), and the interaction coefficient is also significantly positive at the level of 1% (correlation coefficient is 0.502). The two coefficients have the same sign and have a positive moderating effect. It indicates that the SA index of financing constraint will strengthen the relationship between technological innovation investment and financial risk, i.e., the financial risk of an enterprise will be lower with the increase of technological innovation investment under the condition of smaller financing constraint. H3 is verified.

6. Robustness Testing

6.1. Explanatory Variable Substitution. Based on the research of Duan and Tian [60] and Tian and Wu [61], the ratio of R&D input to total assets is used to measure the

technological innovation investment (RDA). Models (1), (3), and (4) are used to perform regression analysis on the substitution of explanatory variables.

The regression result in Table 6 (1) shows that the technological innovation investment is significantly positively correlated with the Z-score at the level of 1% (the correlation coefficient is 39.256), indicating that the technological innovation investment significantly reduces the financial risk of the enterprise, H1 is robust. In Table 6 (3) and (4), model regression results show that, after centralized treatment of RDA and SA, both of them are significantly positively correlated with the Z-score of financial risk at the level of 1%, and the interaction between them is also significantly and positively correlated with the Z-score at the level of 1% (the correlation coefficient is 83.594), indicating that the SA index of financing constraints has a positive

TABLE 5: Regression results of main effects and regulatory effects.

Variable	(1) Z-risk	(2) Z-risk	(3) Z-risk	(4) Z-risk
RDR	0.227*** (7.86)			
SA		14.445*** (7.72)		
c_RDR			0.236*** (8.23)	0.225*** (7.85)
c_SA			15.002*** (8.10)	15.059*** (8.16)
Interact				0.502*** (4.59)
Size	−0.877*** (−3.58)	−0.231 (−0.97)	−0.742*** (−3.05)	−0.741*** (−3.06)
Age	0.041** (2.03)	0.600*** (7.82)	0.635*** (8.35)	0.631*** (8.33)
DFL	−3.403*** (−12.43)	−3.622*** (−13.31)	−3.375*** (−12.45)	−3.336*** (−12.34)
OC	0.026*** (3.70)	0.015** (2.14)	0.021*** (2.96)	0.021*** (3.06)
POR	−1.064*** (−4.90)	−1.430*** (−6.84)	−0.913*** (−4.23)	−0.894*** (−4.15)
_cons	36.202*** (9.54)	84.583*** (13.28)	23.066*** (5.61)	22.738*** (5.54)
Ind	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	3199	3199	3199	3199
r2_a	0.335	0.335	0.349	0.353
F	23.719	23.675	24.785	24.89

TABLE 6: RDA regression results of robustness test.

Variable	(1) Z-risk	(3) Z-risk	(4) Z-risk
RDA	39.256*** (6.62)		
c_RDA		37.574*** (6.39)	34.341*** (5.80)
c_SA		13.993*** (7.52)	13.783*** (7.42)
CRDACSA			83.594*** (4.03)
Size	0.021 (0.09)	0.148 (0.61)	0.084 (0.35)
Age	0.037* (1.81)	0.590*** (7.74)	0.579*** (7.61)
DFL	−3.399*** (−12.35)	−3.391*** (−12.43)	−3.390*** (−12.45)
OC	0.025*** (3.48)	0.019** (2.73)	0.020*** (2.81)
POR	−1.999*** (−9.12)	−1.856*** (−8.51)	−1.793** (−8.22)
_cons	48.977*** (13.13)	36.754*** (8.90)	36.108*** (8.76)
Ind	Control	Control	Control
Year	Control	Control	Control
N	3199	3199	3199
r2_a	0.332	0.343	0.346
F	23.338	24.209	24.216

moderating effect between technological innovation investment and corporate financial risk, H2 and H3 are robust.

6.2. Explained Variable Substitution.

Referring to the results of variable selection by Zhang and Sun [62] and Hao [4], this paper uses a modified Z-score that is more suitable for measuring the financial risk of Chinese listed companies to replace the original Z-score.

The regression result of model (1) in Table 7 shows that the technological innovation investment and the modified Z-risk are significantly positive at the 5% level (the correlation coefficient is 0.023), that is, the higher the technological innovation investment is, the larger the modified Z-risk is and the smaller the financial risk is, H1 is robust. The regression result in model (2) indicates that the SA is significantly positively correlated with the modified Z-risk at the level of 1% (the correlation coefficient is 2.116), indicating that the smaller the financing constraints, the smaller the financial risk of the enterprise, H2 is robust. Regression results of models (3) and (4) show that, after centralized processing of technological innovation investment (c_RDR) and modified Z-risk, the two are significantly positively correlated at the level of 10% (correlation coefficient is 0.020), and the interaction is significantly positively correlated with modified Z-risk at the level of 1%, indicating that SA plays a positive

moderating effect in the relationship between technological innovation investment and corporate financial risk, i.e., the smaller the financing constraints, the lower the financial risk level with the increase of technological innovation investment. H3 is robust.

6.3. Lagged One-Period Explanatory Variable.

Since there is a lag in the impact of technological innovation investment on enterprise financial risk, the RDR is delayed by one stage, and the regression results are shown in Table 8.

The regression results of model (1) in the table show that the technological innovation investment of the lagging period (LRDR) is still positively correlated with the Z-score of financial risk at 1% level (the correlation coefficient is 0.198), indicating that the greater the technological innovation investment of the lagging period is, the greater the Z-risk is and the smaller the financial risk is. It is assumed that H1 is robust. Models (3) and (4) the regression results show that the first step regression coefficient of the lag issue of technology innovation investment (Lc_RDR) and financing constraints (c_SA) coefficients after centralized treatment is positive, and all significant at 1% level. The interaction coefficient in the second step is 0.387, which is significant at 1% level, and the coefficient sign is the same as LRDR, indicating that financing constraint has a significant moderating effect on the relationship between technological innovation investment and financial risk. It is assumed that H2 and H3 are robust.

TABLE 7: Revised Z-risk regression results for robustness test.

Variable	(1) Modified Z-risk	(2) Modified Z-risk	(3) Modified Z-risk	(4) Modified Z-risk
RDR	0.023** (2.04)			
SA		2.116*** (2.93)		
c_RDR			0.024** (2.15)	0.020* (1.80)
c_SA			2.173*** (3.01)	2.193*** (3.04)
Interact				0.182*** (4.26)
Size	−0.272*** (−2.87)	−0.200** (−2.18)	−0.252*** (−2.66)	−0.252*** (−2.66)
Age	0.017** (2.21)	0.100*** (3.37)	0.103*** (3.49)	0.102*** (3.45)
DFL	−1.289*** (−12.18)	−1.310*** (−12.47)	−1.285*** (−12.16)	−1.271*** (−12.05)
OC	0.009*** (3.33)	0.008*** (2.84)	0.008*** (3.04)	0.009*** (3.14)
POR	−0.087 (−1.04)	−0.118 (−1.46)	−0.065 (−0.77)	−0.058 (−0.69)
_cons	6.789*** (4.63)	13.503*** (5.49)	4.837*** (3.01)	4.718*** (2.95)
Ind	Control	Control	Control	Control
Year	Control	Control	Control	Control
N	3199	3199	3199	3199
r2_a	0.209	0.21	0.211	0.215
F	12.89	12.971	12.869	13.012

Through the above robustness tests, which showed that the regression models constructed in this study effectively measured the relationship between technological innovation investment and financial risk as well as the moderating effect of financing constraints, the research results have some reference value. Through the above robustness tests, which showed that the regression models constructed in this study effectively measured the relationship between technological innovation investment and financial risk as well as the moderating effect of financing constraints, the research results have some reference value. In particular, the regression models can be used by enterprises to explore the impact of other factors on financial risk when identifying and controlling financial risk, which is helpful for enterprises to quickly determine the source of risk and then implement corresponding risk prevention measures.

7. Heterogeneity Testing

To further investigate whether the presence of firm heterogeneity affects the main findings, firm size and nature variables are introduced. In order to maintain consistency, the explained variable is still Z-risk.

7.1. Heterogeneity of Different Enterprise Scales. Firstly, the sample enterprises are classified into two categories according to the median of total assets. Enterprises with total asset size greater than the median are taken as 1, which is classified as large-scale enterprises, and vice versa as 0, which is classified as small-scale enterprises. The test results are shown in Table 9. For large-scale enterprises, the coefficient of technological innovation investment is significantly positive at the 1% level (the coefficient is 0.148), indicating that technological innovation investment can significantly increase the Z-score of financial risk of large-scale enterprises and reduce the financial risk. Secondly, the coefficient of the interaction term is significantly positive at the level of 5%, and the sign is the same as the technological innovation investment after centralization (the coefficient is 0.398, and significant at the level of 1%), indicating that the moderating effect of financing constraints is significant. For small-scale enterprises, the main effect regression results are consistent with the previous, and the moderating effect of financing constraints is significant. In contrast, the financial risk of small-scale enterprises is greatly affected by the technological innovation investment, and the moderating effect of financing constraints on both is stronger. The reason is that small-scale enterprises face many uncertainties in their production and operation due to their limited sources of funds. The weak risk tolerance makes them more severely constrained in financing, which is easy to cause financial fluctuations and risks to those enterprises.

TABLE 8: Lag RDR regression results of robustness test.

Variable	(1) Z-risk	(3) Z-risk	(4) Z-risk
LRDR	0.198*** (5.66)		
Lc_RDR		0.209*** (6.08)	0.206*** (5.98)
c_SA		19.714*** (8.30)	19.861*** (8.37)
Linteract			0.387*** (2.79)
Size	−1.052*** (−3.46)	−0.982*** (−3.28)	−0.994*** (−3.32)
Age	0.035 (1.43)	0.817*** (8.40)	0.818*** (8.42)
DFL	−3.364*** (−9.90)	−3.310*** (−9.88)	−3.282*** (−9.81)
OC	0.035*** (4.13)	0.029*** (3.41)	0.029*** (3.45)
POR	−1.067*** (−4.00)	−0.881*** (−3.34)	−0.863*** (−3.27)
_cons	35.967*** (6.71)	19.089*** (3.37)	18.800*** (3.32)
Ind	Control	Control	Control
Year	Control	Control	Control
N	2338	2338	2338
r2_a	0.336	0.355	0.357
F	19.463	20.795	20.659

7.2. Heterogeneity of Different Enterprise Nature. According to the division of enterprise nature, the enterprise nature is state-owned with 1, otherwise with 0. The heterogeneity test results are shown in Table 9, and the technology innovation investment are statistically significant, with the conclusion consistent with the previous. However, there are significant differences in the moderating effect of financing constraints under different enterprise natures. The regression coefficient of the interaction term of state-owned enterprises is 0.448, but not significant, indicating that the financing constraints of state-owned enterprises cannot significantly affect the relationship between technological innovation investment and financial risk. The results were tested for robustness by replacing and lagging the explanatory variable and the results were robust. In contrast, private enterprises' financing constraints have a significant moderating effect. The reason is that the state-owned enterprises have more preferential policies, diversified financing channels, rich resources for scientific innovation, and strict supervision of financial decisions, which makes the state-owned enterprises less constrained in financing and does not significantly affect the relationship between technological innovation investment and financial risks, which is in line with the actual situation in China. Therefore, the state should set more accurate and efficient differentiation policies according to the nature and scale of enterprises when formulating policies related to technological innovation investment.

8. Conclusions and Recommendations

8.1. Conclusions. Based on the sample of Shenzhen small and medium-sized listed companies from 2010 to 2019, this paper explores the impact mechanism of technological innovation investment on financial risk and the moderating effect of financing constraints. The research conclusions are as follows: (1) Technological innovation investment is significantly negatively correlated with corporate financial risk, i.e., the greater technological innovation investment, the lower corporate financial risk. (2) The financing constraint is significantly positively correlated with the financial risk of the enterprise, i.e., the more serious the financing constraint the enterprise faces, the higher the financial risk. (3) In the whole sample, the moderating effect of financing constraints is significant. That is, the smaller the financing constraints, technological innovation investment can reduce the financial risk of enterprises more. (4) Further dividing the scale and nature of enterprises, the study found that, compared with large-scale enterprises, the impact of technological innovation investment on the financial risk of small-scale enterprises is more obvious, and the moderating effect of financing constraints is also greater. Compared with private enterprises, state-owned enterprises' technological innovation investment has less impact on financial risk, and the moderating effect of financing constraints is not significant.

8.2. Recommendations. Through the above theoretical analysis and empirical test, the following policy recommendations are put forward: (1) The government should commit to financial reform, innovate financial products and services, improve and promote the development of new industries such as virtual financial supermarkets. They could also speed up the construction of social credit system, effectively improve the financing constraints in the innovation activities of the real economy, and avoid causing financial risks to enterprises. (2) We should actively promote inclusive policies (including increasing financial subsidies for enterprises' technological innovation projects and developing new innovation bonds) to encourage enterprises to carry out technological innovation activities and establish innovative supervision mechanisms in a timely manner, which will not only ease the capital pressure of enterprises, but also effectively reduce financial uncertainty and help shape the sustainable development capacity of the real economy. (3) From the perspective of enterprise heterogeneity, the government should establish incentive policies to support technological innovation of enterprises based on different scales and different enterprise natures. At the same time, the government should increase the accuracy of information disclosure of enterprises, formulate classification criteria of scale and other natures, implement differentiated incentive policies, accurately, fundamentally solve the problem of innovation investment, and effectively control the financial risks of enterprises. Private enterprises should actively introduce state-owned capital, which helps optimize the business environment for them and alleviate the financing constraints. Both state-owned enterprises and

TABLE 9: Results of heterogeneity test.

Variable	Large enterprise		Small enterprise		State-owned		Private	
	Z-risk	Z-risk	Z-risk	Z-risk	Z-risk	Z-risk	Z-risk	Z-risk
RDR	0.148***		0.398***		0.126*		0.243***	
	(5.34)		(7.48)		(1.91)		(7.28)	
c_RDR		0.156***		0.348***		0.174***		0.234***
		(5.59)		(6.01)		(2.66)		(7.05)
c_SA		0.940		23.308		21.911***		15.060***
		(0.28)		(1.38)		(4.03)		(7.23)
Interact		0.280**		0.420**		0.448		0.492***
		(2.38)		(2.04)		(1.60)		(3.98)
N	1600	1600	1599	1599	425	425	2774	2774
r2_a	0.316	0.318	0.323	0.325	0.367	0.395	0.341	0.357
F	12.748	12.476	13.502	13.211	7.142	7.591	22.133	22.975

Note. Due to space limitation, only the results of the second step of the main effect and hierarchical regression are listed. The estimation results of control variables and constant terms are omitted, and the industry and year are controlled simultaneously. In addition, the results of the robustness tests are available from the corresponding authors upon request.

private enterprises should actively fulfill their corporate social responsibility, hence improving their credibility and recognition and enhancing their anti-risk capability.

8.3. Theoretical Contributions. The theoretical contributions of this study are mainly in the following three aspects. First, it explores the influence mechanism of technological innovation investment on corporate financial risk, which provides a new perspective for scholars' research on financial risk, and they can add corporate life cycle theory to continue exploring the influence mechanism under different life cycles. Second, based on the financing constraint perspective, we analyze its moderating effect on the main effect, which also provides scholars with regression analysis methods for moderating variables. Third, it is clarified that the effect of technological innovation investment on corporate financial risk is different under the conditions of different enterprise size and nature, and the moderating effect of financing constraints also has differences, which provides reference for the application of subsequent studies or regression methods.

8.4. Research Limitations and Future Prospects. The research limitations of this paper are reflected in the following two points. First, this paper only explores the moderating role of financing constraints on the independent and dependent variables, and fails to fully explore the moderating or mediating effect of other variables. Therefore, in the future, scholars can take this as an entry point to explore the impact of variables such as innovation atmosphere, corporate social responsibility, and corporate information disclosure quality on the mechanism of this study; they can also explore the impact of corporate technological innovation on risk in the innovation ecosystem. Second, the research data are all secondary data, lacking questionnaire data to support the evidence. Future research can combine secondary data and questionnaire data to more accurately calculate the impact of technological innovation investment on corporate financial risk under the financing constraints scenario.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Acknowledgments

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