

# Diversified Financing, Financing Constraints and Firm Innovation Investment

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**Abstract:** Taking Chinese listed companies from 2007 to 2021 as samples, this paper uses panel fixed effect regression model to explore the effect and mechanism of diversified financing on corporate innovation investment. The results show that: external borrowing financing intensity, bond financing intensity, seasoned equity offerings financing, retained earnings ratio and corporate innovation investment are significantly negatively correlated at least at the level of 10%, while equity placement financing and corporate innovation investment are not significantly correlated. Further research shows that: financing constraint is one of the important mechanisms that external borrowing financing intensity, bond financing intensity, seasoned equity offerings financing, and retained earnings ratio affect corporate innovation investment.

**Keywords:** External borrowings, bonds, seasoned equity offerings, retained earnings, corporate innovation.

## 1. INTRODUCTION

In the past decade, the post financial crisis has led to slow economic growth in the world. In particular, the impact of the COVID-19 in the past two years has worsened the economy of countries around the world and made it difficult for most enterprises to operate. In 2021, although the economic growth of all countries is fast, it is based on the low base growth in 2020. The economic growth of the United Kingdom, Germany, the United States and Japan has been slow in recent 10 years, hovering between - 2% and 2% for a long time. Affected by the COVID-19 epidemic, there was a negative growth of about 5% in 2020. China's economy has always maintained a growth rate of about 7%. Affected by the epidemic in 2020, the economic growth rate was only 2.73%<sup>1</sup>. As the global economy has been hit hard, business operation has become more and more difficult, and financing is also subject to various constraints, especially for SMEs. Therefore, it is particularly important to adopt various financing strategies scientifically and reasonably.

Innovation, as an important aspect of the company's investment decision, has an important impact on the company's

core competitiveness and is one of the important driving forces for the company's sustainable development. In 2016, the 13<sup>th</sup> Five Year Plan for National Economic and Social Development of the People's Republic of China put forward the concept that innovation is a new driving force for development. The R&D expenditure of the whole society increased from 1.42 trillion yuan in 2015 to 2.21 trillion yuan in 2019, and the intensity of R&D investment in 2019 reached 2.23%. Basic research funds nearly doubled, reaching 133.6 billion yuan in 2019. The turnover of technology market contracts doubled, exceeding 2.2 trillion yuan in 2019. In the past five years, the government work report will emphasize innovation every year. The government work report in 2021 mentions "innovation" 43 times, while the government work report in 2022 mentions "science and technology" 16 times, and "innovation" 39 times. Science, technology and innovation have become the focus of the government's work, as well as the hot topics discussed by enterprises, media and scholars.

To sum up, both government departments, enterprise practitioners and scholars pay close attention to corporate innovation, and diversified financing and financing costs are also important issues they pay attention to. It is important and necessary to discuss the impact of diversified financing on corporate innovation investment. This paper explores the impact and mechanism of diversified financing on corporate innovation investment using a panel fixed-effects regression model with a sample of Chinese listed companies from 2007 to 2021. The results show that external borrowing financing intensity, bond financing intensity, additional financing, and retained earnings ratio are significantly and negatively related to corporate innovation investment at least at the 10%

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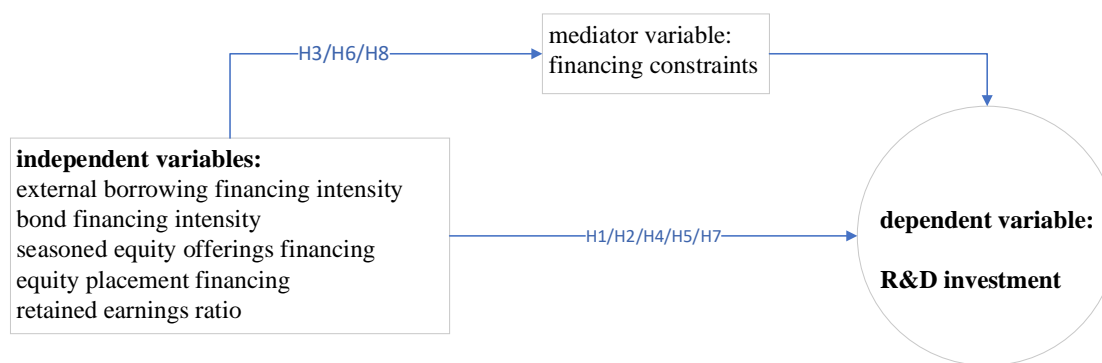


Fig. (1). Theoretical framework.

level, while allotment financing is not significantly related to corporate innovation investment. Further research shows that financing constraints are one of the important mechanisms by which the independent variables affect the dependent variables. The study of moderating effect model found that the proportion of the first largest shareholder's shareholding and firm performance play an important moderating role.

The marginal contributions of this paper are as follows: First, according to the empirical test results of the impact of diversified financing methods on corporate innovation investment, it can provide scientific diversified financing decisions for listed companies in financing difficulties, and then achieve sustainable development of companies. Secondly, according to the empirical test results of the impact mechanism of diversified financing on corporate innovation investment, it can straighten out how diversified financing affects corporate innovation investment, and then provide scientific decisions on how to improve corporate innovation investment.

The theoretical framework of this paper is shown in Fig. (1).

## 2. LITERATURES REVIEW AND HYPOTHESES

### 2.1. Literatures Review

Relevant scholars at home and abroad have studied the influencing factors of corporate innovation, and have achieved fruitful results. In general, the research is mainly conducted from the aspects of company characteristics, senior management characteristics, external governance, industry environment, macro policy environment, etc.

Company characteristics mainly include ownership structure, cash holding level, corporate governance level, Choi, Lee, and Williams (2011) Taking Chinese companies as a sample, the study finds that the innovation performance of foreign joint ventures is higher, state-owned equity has a positive impact on lagging corporate innovation, insider ownership has a negative impact on corporate innovation, and equity concentration has no significant impact on corporate innovation. Evgeny and Berardino (2012) through theoretical model and empirical test, it is concluded that the expected degree of competition affects the company's cash holding level, and then affects the company's innovation. The cash holding level of competitors will negatively affect the company's cash holding level. Sapra, Subramanian, and Subramanian (2014) constructs a theoretical model of the impact of corporate

internal governance and external governance on corporate innovation, and empirical tests show that the relationship between external acquisition pressure and innovation is U-shaped. Chakraborty, Rzakhanov, and Sheikh (2014) shows that the companies protected by anti- takeover clauses have lower innovation level, especially in low technology enterprises.

In terms of executive characteristics, Chemmanur, Kong, Krishnan, and Yu (2019) found that the quality of senior management is an important determinant of enterprise innovation, and various aspects of management quality have different effects on the innovation of young enterprises. In addition, companies with higher management quality participate in more exploratory innovation strategies. Lin, Lin, Song, and Li (2011) empirically tests the role of management incentives and CEO characteristics in corporate innovation activities. The results show that the existence of CEO incentive plan increases the innovation effort and innovation performance of enterprises; Compared with profit based performance indicators, sales based performance indicators in incentive plans are more conducive to enterprise innovation; The CEO's education level, professional background and political connection are positively related to the company's innovation efforts. Cho, Halford, Hsu, and Ng (2016) show potential and unobservable company and manager characteristics explain that a large part of the changes in the company's innovation productivity The impact of potential management characteristics on enterprise innovation is less than that of potential enterprise characteristics After two different manager company separation samples, the average change of innovation productivity has no significant difference. Sunder, Sunder, and Zhang (2017) found that the CEO's interest in flying aircraft was significantly positively correlated with better innovation results. Ting, Wang, Yang, and Tuan (2021) found that managers with scientific and engineering backgrounds have a significant positive impact on enterprise innovation. Hirshleifer, Low, and Teoh (2012) show that companies with overconfident CEOs have greater volatility in returns, invest more in innovation, obtain more patents and patent citations, and achieve greater innovation success.

External governance is mainly manifested in institutional investors, bank credit, external audit institutions, supply chain upstream and downstream. Chemmanur, Loutskina, and Tian (2014) found that companies supported by corporate venture capital (CVC) are younger, riskier and less profitable than those supported by independent venture capital

(IVC). However, from the perspective of patent results, they are more innovative. Benfratello, Schiantarelli, and Sembenelli (2008) found that the development of the banking industry has a significant positive impact on corporate innovation, especially for companies in high-tech sectors and small companies that rely more on external financing. Amore, Schneider, and Žaldokas (2013) found that US interstate bank deregulation has a significant positive impact on the quantity and quality of innovation activities, especially for companies that are highly dependent on external capital and close to banks.

In terms of industry environment and macro policy. Aghion, Bloom, Blundell, Griffith, and Howitt (2005) constructs a theoretical model of product market competition, and uses the radical policy reform of the United Kingdom as a tool for the change of product market competition. The empirical study finds that there is a significant inverted U-shaped relationship between product market competition and patents. Ayyagari, Demircuc-Kunt, and Maksimovic (2011) found that access to external financing was significantly positively correlated with corporate innovation, and highly educated managers, foreign competition and corporate innovation were positively correlated. Shen, Fu, Pan, Yu, and Chen (2020) finds that the new crown epidemic had a negative impact on company performance, especially in the tourism and restaurant sectors. Some scholars have also found that trade policy uncertainty and geopolitical risk have a significant impact on firm performance and financial decisions (Shen & Hou, 2021; Shen, Liang, Li, Liu, & Lu, 2021).

To sum up, there have been studies on the influencing factors of corporate innovation investment from the perspectives of corporate characteristics, senior management characteristics, external governance, industry environment, macro policy environment, etc., although there are also a few studies on its impact on corporate innovation from the perspectives of cash holdings, loans, equity financing, etc. However, this paper intends to integrate a variety of financing methods and explore their common impact on corporate innovation from the perspective of diversified financing, which enriches and deepens the relevant research results.

## 2.2. Hypotheses

The higher the external borrowing ratio or bond financing level of the company, the more it can ease the financing difficulties faced by the company, reduce the financing constraint level of the company, and improve the long-term investment input of the company, including the innovation input of the company. Among the company's loans, long-term loans can provide a source of funds for the company's long-term investment, while short-term loans provide financial support for the company's daily operations. If the external borrowing ratio is high, the company will be able to use more long-term funds, and will be able and willing to invest in projects with long term, high risk but high returns, such as mergers and acquisitions, innovation (Yazdanfar & Öhman, 2015). Therefore, the more abundant the long-term capital, the higher the possibility of the company's innovation investment. If there is no long-term fund as a guarantee, the company will boldly choose long-term investment projects,

which will inevitably lead to greater pressure on the company's capital chain, and even the risk of capital chain breakage (Cole & Sokolyk, 2018).

On the contrary, according to the signaling theory, the higher the proportion of external borrowing or the bond financing ratio of the company, it may mean that the company is short of cash flow at present, resulting in a lower probability of the company continuing to borrow or issue bonds for financing, and a higher level of financing constraints. Therefore, the higher the external borrowing ratio or bond financing ratio of the company, the higher the financing constraint level of the company, reducing the investment level of the company's innovation.

To sum up, this paper proposes the following competitive assumptions:

H1a: The proportion of external borrowing has a significant positive impact on the company's innovation investment.

H1b: The proportion of external borrowing has a significant negative impact on the company's innovation investment.

H2a: The proportion of bond financing has a significant positive impact on the company's innovation investment.

H2b: The proportion of bond financing has a significant negative impact on the company's innovation investment.

H3: The proportion of external loans and the proportion of bond financing affect the company's innovation investment through financing constraint intermediary variables.

In addition to external borrowing and bond financing, external financing of the company also includes equity financing, namely, additional issuance or rights issue. Compared with borrowing and bond financing, the cost of equity financing is generally higher. Since equity financing does not require the payment of dividends at the end of each year, and shareholders will not easily withdraw their capital, equity financing does not require the company to repay the principal and interest in a short term. The long-term and sustainability of equity financing makes it easy for the company to invest in projects with long cycle and high risk. Equity financing does not require asset mortgage or guarantee, nor will it lead to financial difficulties. It is an important source of funds for mergers and acquisitions or innovation. Additional issuance or allotment of shares is an important way of equity financing for companies. Generally speaking, after additional issuance or allotment of shares, the funds for new projects will be readily available.

On the contrary, according to the signaling theory, the additional issuance or allotment of shares sends a signal of the company's capital shortage to external stakeholders. It is precisely because of the capital shortage that the company raises funds through various financing methods to provide security for daily operation and long-term investment. The additional issuance or allotment of shares indicates that the company faces a higher level of financing constraints, thus reducing the company's long-term investment level.

To sum up, this paper proposes the following competitive assumptions:

H4a: seasoned equity offerings financing has a significant positive impact on the company's innovation investment.

H4b: seasoned equity offerings financing has a significant negative impact on the company's innovation investment.

H5a: equity placement financing has a significant positive impact on the company's innovation investment.

H5b: equity placement financing has a significant negative impact on the company's innovation investment.

H6: seasoned equity offerings financing or equity placement financing affects the company's innovation investment through the financing constraint intermediary variable.

In addition to external financing, internal financing is also an important source of funds for excellent enterprises. According to the pecking order theory of financing, the cost of endogenous financing is low. Compared with other investments, the company's innovation investment has a long cycle and high risks. Therefore, the required rate of return is also high and the internal financing cost is low, which improves the rate of return on investment and becomes an important source of funds for the company's innovation investment. The cycle of R&D and innovation is long, and the time required for commercialization is also long. Therefore, it is difficult to accurately measure the innovation income. External investors such as creditors do not like to invest funds in innovation projects. Compared with external financing, the retained earnings do not require the company to pledge, nor do they need to improve the quality of information disclosure. The more retained earnings, the less capital pressure and the lower level of financing constraints of the company in the next year, and the more likely it is to invest in innovative projects with long cycle and high risk.

On the contrary, according to the signaling theory, the higher the retained earnings ratio, the more abundant the free capital of the enterprise, which means that the company is in a rapid development period and needs more capital for daily operation and investment, which means that the higher the level of financing constraints faced by the company, the capital for long-term investment may not be sufficient.

To sum up, this paper draws the following competitive assumptions:

H7a: The retained earnings ratio has a positive impact on the company's innovation investment.

H7b: The retained earnings ratio negatively affects the company's innovation investment.

H8: The retained earnings ratio affects the company's innovation investment through the financing constraint intermediary variable.

### 3. RESEARCH METHODOLOGY

#### 3.1. Data Source and Model Design

This paper intends to select Chinese listed companies from 2007 to 2021 as a sample. The sample selection steps are as follows: First, exclude bank financial listed companies; Second, exclude the companies listed in the current year and warned by ST or \*ST; Third, remove the missing samples of independent variables, dependent variables, control variables, etc. A total of 33362 companies from 4334 listed companies were obtained - annual sample observations.

The sample data are mainly from the Guotai'an database (CSMAR) and WIND database. The continuous variables in the independent variables, dependent variables and control variables may have extreme values. In order to eliminate the impact of extreme values on the results of empirical research, this paper uses the winsor command to shrink the tail of continuous variables at 1% and 99% levels.

In order to verify the assumptions H1 \*, H2 \*, H4 \*, H5 \* and H7 \*, this paper proposes to use model (3-1) for panel regression. The research results mainly focus on the coefficients and significance in front of each independent variable.

$$rdp_{i,t} = \alpha_0 + \alpha_{11} * outdebt_{i,t} + \alpha_{12} * bond_{i,t} + \alpha_{13} * zfyfes_{i,t} + \alpha_{14} * pgyes_{i,t} + \alpha_{15} * retain_{i,t} + \alpha_2 * size_{i,t} + \alpha_3 * mb_{i,t} + \alpha_4 * shrcr1_{i,t} + \alpha_5 * analysis_{i,t} + \alpha_6 * djgnum_{i,t} + \alpha_7 * ip_{i,t} + \alpha_8 * big4_{i,t} + \alpha_8 * dual_{i,t} + \alpha_9 * attend_{i,t} + \alpha_{10} * dagree_{i,t} + \alpha_{11} * state_{i,t} + \alpha_{12} * year_{i,t} + \alpha_{13} * ind_{i,t} + \mu \tag{3-1}$$

In the model, rdp is a dependent variable, representing the company's innovation investment, which is measured by dividing R&D expenses by total assets. The main independent variable is diversified financing, which mainly includes external borrowing financing intensity (outflow), bond financing intensity (bond), whether to issue additional shares (zfyfes), whether to allot shares (pgyes), retained earnings ratio (retain), etc. The control variables mainly include company size, market value to book ratio, shareholding ratio of the largest shareholder, number of analysts tracked, number of meetings of the Board of Directors+the Board of Supervisors+the General Meeting of Shareholders, shareholding ratio of institutional investors, whether it is one of the four major audit institutions, whether the chairman and general manager are in one position, whether independent directors are absent from meetings, whether independent directors express objections, whether it is a state-owned enterprise, annual dummy variable, and industry dummy variable.

In order to verify the impact mechanism of diversified financing on the company's innovation investment, verify H3, H6 and H8. This paper intends to use models (3-2) and (3-3) and combine them with model (3-1) for inspection:

$$fc_{i,t} = \alpha_0 + \alpha_{11} * outdebt_{i,t} + \alpha_{12} * bond_{i,t} + \alpha_{13} * zfyfes_{i,t} + \alpha_{14} * pgyes_{i,t} + \alpha_{15} * retain_{i,t} + \alpha_2 * size_{i,t} + \alpha_3 * mb_{i,t} + \alpha_4 * shrcr1_{i,t} + \alpha_5 * analysis_{i,t} + \alpha_6 * djgnum_{i,t} + \alpha_7 * ip_{i,t} + \alpha_8 * big4_{i,t} + \alpha_8 * dual_{i,t} + \alpha_9 * attend_{i,t} + \alpha_{10} * dagree_{i,t} + \alpha_{11} * state_{i,t} + \alpha_{12} * year_{i,t} + \alpha_{13} * ind_{i,t} + \mu \tag{3-2}$$

$$rdp_{i,t} = \alpha_0 + \alpha_{11} * outdebt_{i,t} + \alpha_{12} * bond_{i,t} + \alpha_{13} * zfyfes_{i,t} + \alpha_{14} * pgyes_{i,t} + \alpha_{15} * retain_{i,t} + \alpha_{16} * fc_{i,t} + \alpha_2 * size_{i,t} + \alpha_3 * mb_{i,t} + \alpha_4 * shrcr1_{i,t} + \alpha_5 * analysis_{i,t} + \alpha_6 * djgnum_{i,t} + \alpha_7 * ip_{i,t} + \alpha_8 * big4_{i,t} + \alpha_8 * dual_{i,t} + \alpha_9 * attend_{i,t} + \alpha_{10} * dagree_{i,t} + \alpha_{11} * state_{i,t} + \alpha_{12} * year_{i,t} + \alpha_{13} * ind_{i,t} + \mu \tag{3-3}$$

In models (3-2) and (3-3), fc represents financing constraints.

## 3.2. Variable Definition and Calculation

### 3.2.1. Corporate Innovation (Dependent Variable)

According to the research from Sapra et al. (2014), This paper intends to use the proportion of R&D expenses in total assets as a measure of the company's innovation investment. It is easy to ignore the problem of scale when measuring innovation input directly by taking logarithm of R&D expenditure, so it is more appropriate to use proportional value to measure innovation input of a company.

### 3.2.2. Diversified Financing (Independent Variable)

This paper divides the common financing methods of companies into internal financing and external financing. Among them, it mainly includes external borrowing financing intensity (outbound debt), bond financing intensity (bond), whether to issue additional shares (zfyces), whether to allot shares (pgyes), retained earnings ratio (retain).

### 3.2.3. Financing Constraints (Intermediary Variable)

Financing constraint means that the external financing cost is higher than the internal financing cost due to information asymmetry or agency problems. There are many calculation methods for financing constraints in existing literature, mainly including FC, KZ, SA, WW and other four main methods. This paper intends to use FC method to measure financing constraints (Hadlock & Pierce, 2010).

### 3.2.4 Other Variables

This paper controls the variable company size, market value to book ratio, shareholding ratio of the largest shareholder, number of analysts tracked, number of meetings of the Board of Directors+the Board of Supervisors+the General Meeting of Shareholders, shareholding ratio of institutional investors, whether it is the four major audit institutions, whether the chairman and general manager are in one position, whether independent directors are absent from meetings, whether independent directors express objections, whether it is a state-owned enterprise, annual dummy variable, and industry dummy variable.

See Appendix Table 1 for calculation description of all variables

## 4. FINDING AND CONCLUSION

### 4.1. Descriptive Statistics

The descriptive statistical analysis results of all variables in this paper are listed in Appendix Table 2. The mean value of the dependent variable company's innovation input (rdp) is 0.0340, the minimum and maximum values are 0 and 0.229 respectively, the median is 0.0280, and the standard deviation is 0.0420, indicating that the difference of rdp among samples is not very large, but a few companies have more innovation input. The mean value of the independent variable external borrowing financing intensity is 0.119, the minimum and maximum values are 0 and 0.522 respectively, the median is 0.0740, and the standard deviation is 0.134. The average bond financing ratio (bond) is 0.0130, the minimum and maximum values are 0 and 0.170 respectively, the medi-

an is 0, and the standard deviation is 0.0350. The mean value of additional issuance financing (zfyces) is 0.0990, the minimum and maximum values are 0 and 1 respectively, the median is 0, and the standard deviation is 0.298, indicating that 9.9% of the samples adopt additional issuance financing. The average value of pgyes is 0.0030, the minimum value and maximum value are 0 and 1 respectively, the median is 0, and the standard deviation is 0.0550, indicating that 0.3% of the samples have adopted the issue financing. The mean value of retained earnings is 0.707, the minimum and maximum values are -0.800 and 1 respectively, the median is 0.766, and the variance is 0.307. The mean, maximum and minimum of the above variables are basically consistent with the actual situation.

### 4.2. Panel Fixed Effect Regression Analysis of Diversified Financing and Innovation Investment

Table 1 shows the results of panel fixed effect regression analysis of five financing methods on the company's innovation investment. Column (1) shows the regression results of external borrowing financing intensity and the company's innovation investment. The external borrowing financing intensity and the company's innovation investment are significantly negatively correlated at the level of 1%. More importantly, the regression coefficient has significant economic implications. When the external borrowing financing intensity increases by 1 unit of standard deviation, the company's innovation input will decrease by 0.4%, which is about 1.6% of the average rdp. Column (2) shows the regression results of bond financing intensity and corporate innovation investment. The proportion of bond financing is significantly negatively correlated with corporate innovation investment at the level of 1%. More importantly, the regression coefficient has significant economic implications. When the bond financing intensity increases by one unit of standard deviation, the company's innovation input decreases by 10% on average, which is about 1.01% of the average rdp. Column (3) shows the regression results of the seasoned equity offerings financing and the company's innovation investment. The seasoned equity offerings financing and the company's innovation investment are significantly negatively correlated at the level of 5%.

More importantly, the regression coefficient has significant economic implications. Compared with the sample without seasoned equity offerings financing, for each unit standard deviation increase in seasoned equity offerings financing, the company's innovation input decreases by 0.1% on average, which is about 0.88% of the average rdp. Column (4) shows the regression results of equity placement financing and corporate innovation investment, and there is no significant correlation between equity placement financing and corporate innovation investment. Column (5) shows the regression result between the retained earnings ratio and the company's innovation investment. The retained earnings ratio and the company's innovation investment are significantly negatively correlated at the 10% level. More importantly, the regression coefficient has significant economic implications. For each unit standard deviation increase in the retained earnings ratio, the company's innovation input decreases by 0.3% on average, which is about 2.71% of the average rdp. The above results support the hypothesis H1b, H2b, H4b, H7b.

**Table 1. Regression Analysis of Panel Fixed Effect between Diversified Financing and Innovation Investment.**

variables	(1)	(2)	(3)	(4)	(5)
	<b>rdp</b>	<b>rdp</b>	<b>rdp</b>	<b>rdp</b>	<b>rdp</b>
outdebt	-0.004*** (-3.047)				
bond		-0.010*** (-2.809)			
zfyas			-0.001** (-2.372)		
pgyes				0.002 (1.202)	
retain					-0.003*** (-6.340)
size	0.000 (1.350)	0.000 (0.906)	0.000 (0.491)	0.000 (0.501)	0.000 (0.613)
mb	-0.004*** (-5.174)	-0.004*** (-5.111)	-0.004*** (-5.334)	-0.004*** (-5.113)	-0.005*** (-5.707)
shrcr1	-0.010*** (-5.874)	-0.010*** (-5.889)	-0.010*** (-5.784)	-0.010*** (-5.886)	-0.011*** (-6.156)
analysis	0.001*** (2.609)	0.002*** (2.751)	0.001*** (2.726)	0.002*** (2.772)	0.001*** (2.675)
report	-0.001 (-1.516)	-0.001 (-1.569)	-0.001 (-1.510)	-0.001 (-1.572)	-0.001 (-1.486)
djgnum	-0.000 (-0.845)	-0.000 (-0.938)	-0.000 (-0.645)	-0.000 (-0.996)	-0.000 (-0.733)
ip	-0.000 (-0.149)	-0.000 (-0.161)	-0.000 (-0.172)	-0.000 (-0.124)	-0.000 (-0.211)
big4	-0.000 (-0.045)	0.000 (0.073)	0.000 (0.057)	0.000 (0.048)	0.000 (0.072)
dual	-0.000 (-0.226)	-0.000 (-0.178)	-0.000 (-0.211)	-0.000 (-0.194)	-0.000 (-0.212)
attend	-0.000 (-0.523)	-0.000 (-0.535)	-0.000 (-0.544)	-0.000 (-0.545)	-0.000 (-0.512)
dagree	0.001** (2.353)	0.001** (2.325)	0.001** (2.382)	0.001** (2.335)	0.001** (2.230)
state	0.001 (0.894)	0.001 (0.794)	0.001 (0.799)	0.001 (0.822)	0.001 (0.907)
Constant	0.016*** (2.669)	0.018*** (3.123)	0.020*** (3.559)	0.021*** (3.591)	0.022*** (3.837)
Ind and Year	controlled	controlled	controlled	controlled	controlled
Observations	33,362	33,362	33,362	33,362	33,362
Overall_R2	0.129	0.129	0.129	0.129	0.130
F value	158.711	158.652	158.555	158.378	160.025

Note: \*, \*\* and \*\*\* in the table indicate correlation at 10%, 5% and 1% significance levels respectively. The value of t statistic variable is in parentheses.

**Table 2. Results of Financing Constraint Impact Mechanism (Loan Financing/Bond Financing Intensity).**

variables	(1) fc	(2) rdp	(3) rdp	(4) fc	(5) rdp	(6) rdp
outdebt	6.613*** (62.142)	-0.004*** (-3.047)	-0.006*** (-3.482)			
bond				3.937*** (12.825)	-0.010*** (-2.809)	-0.003 (-0.590)
fc			-0.002*** (-19.462)			-0.002*** (-22.842)
Control variables	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
N	33,362	33,362	33,362	33,362	33,362	33,362
Adj-R2	0.296	0.129	0.426	0.206	0.129	0.426
F value	451.013	158.711	515.443	279.431	158.652	515.016
Sobel test	Z=-18.94, ***			Z=-10.45, ***		
Goodman-1 (Aroian) test	Z=-18.94, ***			Z=-10.44, ***		
Goodman-2 test	Z=-18.94, ***			Z=-10.46, ***		
Proportion of total effect that is mediated	0.69718504			0.71315614		
Ratio of indirect to direct effect	2.3023467			2.4862172		
Bootstrap 1000 times	r(_bs_1), Z=-19.34, *** r(_bs_2), Z=-27.82, ***			r(_bs_1), Z=-12.12, *** r(_bs_2), Z=-4.34, ***		

Note: \*, \*\* and \*\*\* in the table indicate correlation at 10%, 5% and 1% significance levels respectively. The value of t statistic variable is in parentheses.

### 4.3. Mechanism Test of the Impact of Diversified Financing on Innovation Investment

How do the intensity of external borrowing and bond financing affect the company's innovation investment? According to the previous analysis, financing constraints may be one of the mechanisms that diversified financing methods affect the company's innovation investment. Table 2 shows the test results of the financing constraint influence mechanism when the external borrowing financing intensity and bond financing intensity are independent variables. Columns (1) to (3) are the test results of external borrowing financing strength. The results of column (1) show that the financing intensity of external loans is significantly positively correlated with the level of corporate financing constraints at 1%, indicating that the higher the financing intensity of external loans, the higher the level of corporate financing constraints. The result of column (2) shows that the external borrowing financing intensity is significantly negatively correlated with the company's innovation investment at the level of 1%, which is consistent with the result of the above main regression model. Column (3) is the result when the external borrowing financing intensity and financing constraints are included in the model at the same time, which shows that the external borrowing financing intensity is significantly negatively correlated with the company's innovation investment at the level of 1%, and the financing constraint level is significantly negatively correlated with the company's innovation investment at the level of 1%. Combined with the results of columns (1),

(2) and (3), it is shown that financing constraint is one of the mechanisms that the external borrowing financing intensity affects the company's innovation investment, and financing constraint plays a part of the intermediary role. The Z values of Sobel, Goodman-1 and Goodman-2 tests are Z=-18.94, Z=-18.94 and Z=-18.94 respectively, indicating that the partial intermediary effect of financing constraints is significant at the 1% level. The adjustment ratio of financing constraints to the total effect is 0.69718504, and the proportion of indirect effect to direct effect is 2.3023467. Finally, the Bootstrap cycle method of 1000 times is used to retest the intermediary effect, avoiding the Sobel test's positive too distribution hypothesis. The Z value of the indirect effect r(ind\_eff) is -19.34, and the Z value of the direct effect r(dir\_eff) is -27.82, indicating that financing constraints play a part of the intermediary role in the impact of external borrowing financing intensity on the company's M&A scale, supporting the hypothesis H3 in this paper.

Columns (4) to (6) are the test results of bond financing intensity. The results of column (4) show that the bond financing intensity is significantly positively correlated with the corporate financing constraint level at the level of 1%, indicating that the higher the bond financing intensity is, the higher the corporate financing constraint level will be. The results of column (5) show that the bond financing intensity is significantly negatively correlated with the company's innovation investment at the level of 1%, which is consistent with the results of the above main regression model. Column (6) is the result when the bond financing intensity and fi-

ancing constraint are included in the model at the same time. It shows that the bond financing intensity is negatively correlated but not significant with the company's innovation investment, and the level of financing constraint is significantly negatively correlated with the company's innovation investment at the level of 1%. Combined with the results of columns (4), (5) and (6), it is shown that financing constraint is one of the mechanisms that external borrowing financing intensity affects the company's innovation investment, and financing constraint plays a completely intermediary role. The Z values of Sobel, Goodman-1 and Goodman-2 tests are  $Z=-10.45$ ,  $Z=-10.44$  and  $Z=-10.46$ , respectively, indicating that the full intermediary effect of financing constraints is significant at the 1% level. The adjustment ratio of financing constraints to the total effect is 0.71315614, and the ratio of indirect effect to direct effect is 2.4862172. Finally, the method of Bootstrap circulation 1000 times is used to retest the intermediary effect, avoiding the Sobel test's assumption of positive too distribution. The Z value of the indirect effect  $r(ind\_eff)$  is -12.12, and the Z value of the direct effect  $r(dir\_eff)$  is -4.34. This shows that financing constraints play a completely intermediary role in the bond financing intensity's impact on the company's innovation income, supporting the hypothesis H3 in this paper.

When the seasoned equity offerings financing and retained earnings ratio are independent variables, the results are similar to Table 2, Due to the length of the paper, the results are not listed in the table, if necessary, you can ask the results for the author.

### 5. CONCLUSION AND RECOMMENDATION

Taking Chinese listed companies from 2007 to 2021 as samples, this paper uses panel fixed effect regression model to explore the effect and mechanism of diversified financing on

corporate innovation investment. The results show that: external borrowing financing intensity, bond financing intensity, seasoned equity offerings financing, retained earnings ratio and corporate innovation investment are significantly negatively correlated at least at the level of 10%, while equity placement financing and corporate innovation investment are not significantly correlated. Further research shows that financing constraint is one of the important mechanisms for diversified financing to affect firm innovation investment.

According to the empirical conclusions of this paper, we mainly put forward suggestions and enlightenment from the following aspects: First, external borrowing financing, bond financing, additional issuance financing, and retained earnings ratio will significantly negatively affect the innovation investment of companies, which conforms to the signaling theory and is not conducive to long-term investment of companies. Therefore, listed companies should not only consider the benefits of these financing when financing through the above methods, It is also necessary to sort out the disadvantages brought about by these financing, so as to prevent the disadvantages brought by financing from outweighing the advantages and damaging the overall interests of the company. In a word, after weighing the advantages and disadvantages, if the advantages outweigh the disadvantages, the relevant financing proportion can be increased. Second, various financing methods have brought relief to the company's capital pressure on the surface, but may bring pressure to the company's future financing, that is, they may enhance the company's financing constraint level, thus affecting the company's financial decision-making behavior, and thus affecting the company's overall interests. By easing the financing constraints, we can solve the problems brought by various financing methods in this paper, and then improve the benefits brought by various financing methods.

### APPENDIX

Table 1. Variable Definition.

variables	Calculation Description
rdp	The innovation investment is the company's R&D expenses divided by total assets.
outdebt	External borrowing and financing intensity. The sum of short-term borrowings and long-term borrowings at the end of the year divided by total assets.
bond	The bond financing intensity is measured by dividing the bonds payable at the end of the year by the total assets.
zfyes	Whether additional shares are issued or not is a dummy variable. If additional shares are raised in the current year, the value is 1. Otherwise, the value is 0.
pgyes	Allotment is a dummy variable. The value of raising funds through allotment in the current year is 1, otherwise it is 0.
retain	The retained earnings ratio is used to measure the remaining capital of the company in the current year, that is, the amount of endogenous financing. It is measured by 1 minus the dividend payment rate.
fc	Financing constraints are to be measured by FC method.
size	The company size is calculated by taking logarithms of total assets.
mb	Market to book ratio: the market value of the stock divided by the owner's equity.
shrcl	The shareholding ratio of the largest shareholder, the proportion of the number of shares held by the largest shareholder in the number of circulating shares.
analysis	The number of analysts who have tracked and analyzed the company.



djgnum	The number of meetings of the board of directors, the board of supervisors, and the general meeting of shareholders.
ip	The shareholding ratio of institutional investors is the number of shares held by institutional investors divided by the total number of outstanding shares.
big4	Whether there are four major audit institutions. If it is one of the four major audit institutions, the value is 1; if it is not, the value is 0.
dual	Two functions are integrated into one. The chairman and general manager are integrated, and the value is 1; otherwise, the value is 0.
attend	Whether the independent director is absent from the board meeting, if not, the value is 1; if there is, the value is 0.
dagree	Whether the independent directors have objections. The value of no objection is 1, and the value of objection is 0.
state	If it is a state-owned enterprise, the value is 1 if it is a state-owned enterprise; otherwise, the value is 0.
ind	Industry dummy variable.
year	Year dummy variable.

**Table 2. Descriptive Statistical Analysis Results of Variables.**

Variables	Observations	mean	S.D.	mix	25%	median	75%	max
rdp	33362	0.0340	0.0420	0	0	0.0280	0.0470	0.229
outdebt	33362	0.119	0.134	0	0	0.0740	0.209	0.522
bond	33362	0.0130	0.0350	0	0	0	0	0.170
zfyas	33362	0.0990	0.298	0	0	0	0	1
pgyes	33362	0.0030	0.0550	0	0	0	0	1
retain	33362	0.707	0.307	-0.800	0.611	0.766	0.911	1
size	33362	22.11	1.303	19.74	21.16	21.92	22.85	26.16
mb	33362	0.617	0.243	0.116	0.433	0.617	0.799	1.156
shrcr1	33362	0.354	0.150	0.0880	0.235	0.334	0.456	0.750
analysis	33362	1.482	1.181	0	0	1.386	2.485	3.784
djgnum	33362	2.709	0.370	1.792	2.485	2.708	2.944	3.584
ip	33362	0.0380	0.135	0	0	0	0	0.714
big4	33362	0.0620	0.241	0	0	0	0	1
dual	33362	0.278	0.448	0	0	0	1	1
attend	33362	0.0310	0.173	0	0	0	0	1
dagree	33362	0.947	0.224	0	1	1	1	1
state	33362	0.331	0.470	0	0	0	1	1

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**AUTHOR'S CONTRIBUTIONS**

Four authors make equal contributions to this paper.

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