R & D investment, short-term loan and long-term investment and enterprise performance

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Abstract: Based on the panel data of Shanghai and Shenzhen A-share listed companies from 2012 to 2019, this paper explores the relationship between R & D investment, short loan and long-term investment and enterprise performance, and examines the impact of the interaction between R & D investment and short loan and long-term investment on enterprise performance. The results show that the impact of R & D investment on enterprise performance has a lag effect, which is not a simple linear relationship; Short term loan and long-term investment are negatively correlated with enterprise performance, and short term loan and long-term investment will weaken the positive effect of R & D investment on enterprise performance. In this paper, the group discussion of state-owned enterprises and non-state-owned enterprises further found that compared with state-owned enterprises, R & D investment has a stronger negative correlation with the performance of non-state-owned enterprises in the current period, and the interaction with short-term loan and long-term investment can significantly inhibit the positive relationship between R & D investment and enterprise performance.

1. Introduction

Innovation is the primary driving force leading development and a necessary choice for actively building a modern power. In recent years, China is also striving to build an innovative country to promote the healthy development of the national economy and enhance the competitiveness of enterprises. However, compared with the United States and other developed countries, China's innovation ability is still lacking. Actively promoting "mass entrepreneurship and innovation" is an effective way to improve innovation ability. With the increase of national support for innovation, more and more enterprises realize the influence of innovation on enterprises, have increased innovation investment and formulated positive innovation development strategies, so as to improve the comprehensive strength of enterprises and expand market share. However, problems also follow. Innovation activities are not achieved overnight. It requires a lot of capital investment for a long time and has the characteristics of high risk. Due to the inherent characteristics of innovation activities, those operators with risk aversion tendency may be unwilling to bear the reduction of short-term business performance caused by innovation investment and resist innovation. However, once the innovation activity is successful, the enterprise will form a competitive advantage, have the opportunity and time to expand market share, quickly occupy the market and improve financial performance. It can be seen that the innovation investment of enterprises has a great impact on enterprise performance.

When enterprises carry out innovation activities, they are first faced with the problem of funds. China's financial repression is high, and the unique background of market-oriented reform also makes China's debt maturity structure different from developed countries. The proportion of long-term debt in developed countries is high, but not in China, which is dominated by short-term debt. The capital sources of enterprises are mainly bank loans. In order to avoid risks and strengthen liquidity management, banks and other financial institutions tend to issue short-term loans [1]. Short term borrowing is also favored by enterprises because of its low financing cost and easy access [2]. By

sorting out the financial data of listed companies, as shown in Figure 1, from 2012 to 2019, the proportion of short-term debt continued to be higher than the proportion of short-term assets, and the proportion of long-term assets continued to be higher than the proportion of long-term liabilities. The trend has not decreased. A reasonable debt maturity structure should be that short-term liabilities basically support the acquisition of short-term assets and long-term liabilities basically support long-term asset activities. However, as shown in the figure, short-term liabilities should not only support short-term assets, but also meet the needs of enterprises for long-term assets. It shows that listed companies have serious problems of short-term loan and long-term investment.
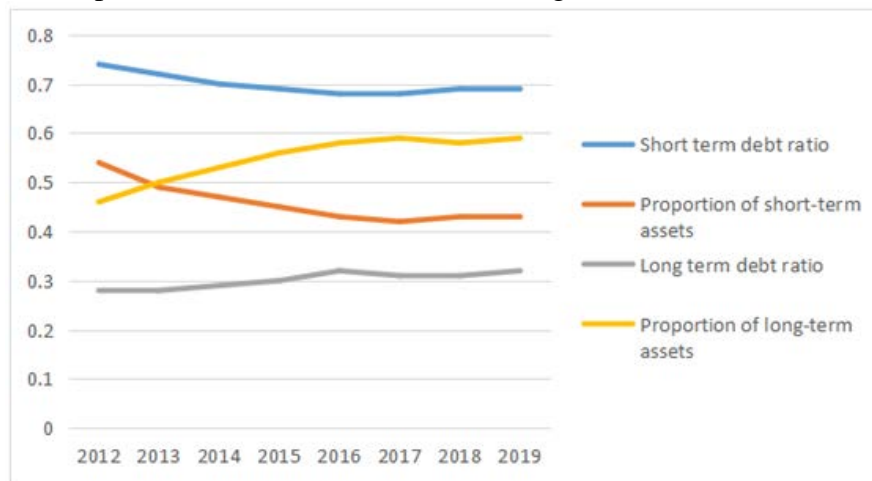

Figure 1. Maturity mismatch between debt and assets of Chinese listed companies (2012-2019).

This paper attempts to explore the relationship between R & D investment, short-term loan and long-term investment and enterprise performance. Although scholars have done a lot of research on the relationship between R & D investment and enterprise performance, there are different opinions and no unified conclusion. Is there a positive correlation between them? Negative correlation? Or non-linear relationship? It is found that short-term loan and long-term investment can interact with R & D investment by affecting the relationship between R & D investment and enterprise performance. So what impact will short-term loan and long-term investment have on enterprise performance? Promote or inhibit? There is no unanimous conclusion. This paper will start further discussion on these problems.

2. Literature review and research hypothesis

2.1 R & D investment and enterprise performance

However, there is no consistent conclusion on the correlation between the two. The promotion theory believes that R & D investment is conducive to the improvement of enterprise performance. For example, Chen Xiaoli (2021) [5] used the data of listed companies to make an empirical analysis, which shows that enterprises carrying out technological innovation can improve production and operation efficiency, help accumulate experience and expand thinking, so as to enhance comprehensive strength, accelerate the growth of operating income and significantly improve enterprise performance. Li Lin (2021) [6] took China's A-share listed companies from 2013 to 2018 as the research sample to investigate the relationship between them from short-term and long-term aspects. In the short term, R & D activities can reduce production and management costs and improve profits; In the long run, continuous innovation activities will help to increase the confidence and preference of management and improve the core competitiveness of enterprises. Griliches (1981) [7] first pointed out that according to the data analysis of large American enterprises, there is a significant relationship between the market value of enterprises and the market value of "intangible" capital. Using 157 companies in the United States from 1968 to 1974 as a sample, we do find a positive role between the two. Wakelin (2001) [8] empirically analyzed 170 companies in the UK. The research found that

the R & D return rate of innovative enterprises is much higher than that of non innovative enterprises. The R & D expenditure of enterprises plays a positive and important role in the productivity of enterprises. Inhibition theory points out that R & D investment hinders the growth of performance or reduces enterprise efficiency. Innovation activities belong to a class of projects with long investment period and high risk. A large amount of capital investment may make the enterprise have no surplus capital to invest in projects with high return on assets, reducing the income of the enterprise. Uncertainty theory holds that the relationship between R & D investment and enterprise performance is not clear. Ming Liang Yeh (2010) [9] found an inverted U-shaped relationship between R & D intensity and enterprise performance by analyzing 301 it and electronic companies listed on Taiwan Stock Exchange. Li Jianying (2015) [10] studied the data of Listed Companies in Beijing, Tianjin and Hebei, which showed that the R & D investment of that year was negatively correlated with the current operating performance of the enterprise, and there was a lag effect. The R & D investment lagging for 1-3 periods was significantly positively correlated with the enterprise performance. Wang Juncai (2008) [11] research shows that there is no significant positive correlation between R & D investment and enterprise performance, and R & D intensity has a lag effect on enterprise performance. Zheng Haiyuan (2018) [12] taking companies listed on the gem as an example, the empirical results show that there is a lag effect between R & D investment and enterprise performance of companies listed on the gem. Innovation investment is significantly positively correlated with the current performance of enterprises, and reaches the maximum in the lag period.

This paper believes that the existence of lag effect is determined by its R & D characteristics. It takes a period of time to convert R & D achievements into enterprise productivity. The payback period of innovation activities is long and there are many uncertain factors. It may not promote enterprise performance in the short term, and the impact of R & D investment on enterprise performance in the current period may be negative. However, with the passage of time, the products produced by enterprises through R & D activities are better than those of competitors, and they cannot be surpassed in the short term, which will form a temporary market monopoly until competitors produce similar or higher-level products. During this period, enterprise performance will continue to improve.

Therefore, this paper puts forward the following assumptions:

H1: R & D investment is negatively related to the current enterprise performance, but the lag effect of R & D investment will promote the improvement of enterprise performance.

2.2 Short term loan and long term investment and enterprise performance

Combined with the research at home and abroad, it is found that there are two views on the relationship between short-term loan and long-term investment and enterprise performance. Some scholars have shown that compared with long-term debt, short-term debt has low financing cost and has the advantages of effectively alleviating financing constraints and reducing enterprise costs. Kahl (2015) [13] studied the US capital market and found that since commercial paper began trading in the 1970s, enterprises have used commercial paper to fund capital investment to reduce financing transaction costs, indicating that short-term debt is sometimes used as a bridge for long-term financing. It also points out that short-term debt is more significant in companies issuing new securities, indicating that short-term loan and long-term investment can promote the company's performance. In fact, it is the result of independent selection combined with its own characteristics. Zhong Kai (2016) [14] studied and analyzed that China has the characteristics of single financing channel, high degree of financial inhibition and imperfect legal system. Short term loan and long-term investment are more represented as an alternative financing method, which is different from that of developed countries such as the United States.

For China, an important principle that enterprises must follow in setting capital structure is the matching of debt and asset maturity. Xiao Zuoping (2011) [15] pointed out that long-term and short-term debts have very different effects on companies. Short term debt can prevent debtors from plundering creditors, reduce the degree of information asymmetry, restrain managers and prevent over investment and underinvestment; Long term debt can prevent creditors from reducing interest rates and depriving value, keep managers under control and prevent their blind expansion. D'mello and

Mercedes Miranda (2010) [16] empirical research results show that companies with long-term debt will reduce the amount of cash available to management, thereby reducing over investment. MEG Adachi Sato (2019) [17] using the enterprise data of 10 developing countries from 1991 to 2013, it is found that the longer the debt maturity, the smaller the fluctuation of enterprise operating performance in the future, showing a negative correlation. According to the theory of debt maturity structure, the matching of debt maturity and asset maturity cannot only reduce the debt agency cost of enterprises, but also help to reduce the liquidity risk. Improper debt maturity matching may endanger the financial security of the enterprise itself, lead to the rupture of the capital chain and the risk of bankruptcy. Liu Xiao guang (2019) [18] Based on the panel data of Listed Companies in China from 2000 to 2015, the analysis pointed out that under the condition of fixed enterprise leverage ratio, short-term debt and long-term use will not only worsen enterprise performance, but also increase corporate debt risk. The reason is that enterprises have high short-term debt and long-term use, which will increase the test of investment payback period. In the long run, the higher the probability of capital turnover difficulties, the easier it is to pay high interest costs to "borrow new and repay old". Once the capital chain breaks, it will fall into financial difficulties. Ma Hong (2018) [19] research shows that the company's use of short-term debt to support long-term R & D investment will aggravate the internal financial instability of the enterprise and increase the sensitivity to changes in the external economic environment. Hou Gui sheng (2018) [20] analyzed the data of listed companies and pointed out that short-term loan and long-term investment, as an alternative financing method, weakened the governance effect of long-term and short-term debt funds on enterprises. It does not reduce the financing cost, but intensifies the liquidity risk of enterprises. Zhong Kai (2016) analyzed A-share listed companies from 2004 to 2014 and pointed out that the negative effects caused by short-term loan and long-term investment, such as inefficient investment, increased operational risk and increased cost of financial distress, will offset the positive effects brought by reducing financing costs and are not conducive to the improvement of enterprise performance.

Therefore, this paper puts forward the following assumptions:

H2: there is a negative correlation between short-term loan and long-term investment and enterprise performance.

2.3 Negative adjustment of short-term loan and long-term investment

The development of China's financial market lags behind and is slow. The equity market and bond market have developed only in recent years, so banks have always been in the leading position of the financial market. Due to the narrow external financing channels and limited profitability of enterprises, bank loans have become the main source of funds for enterprises. Deng Kebin (2014) [21] pointed out that the financing constraints of Chinese enterprises are exogenous to the market, largely due to the excessive intervention of the government in the market, and most commercial banks are state-owned and in a monopoly position for a long time. Therefore, China's banks are positioned as credit rationers rather than suppliers. It shows that even if the enterprise has high-quality investment projects, it is difficult to obtain funds at normal cost. However, if the successful R & D of innovation activities is conducive to the enterprise's good development prospects and belongs to a long-term high-quality investment project, it should be supported by long-term credit funds to meet the impairment of the future value of current assets. However, according to the actual observation of the debt maturity matching of enterprises (as shown in Figure 1 above), there are a large number of phenomena of using short-term loans to support long-term activities such as innovation, that is, short-term loans and long-term investment. The reason is that innovation activities have inherent limitations such as long cycle, high risk and long payback period, which increases the constraints of innovation financing. Moreover, China's financial market is highly restrained, and banks are in an advantageous position. They tend to issue short-term loans for the sake of controlling default risk and performance evaluation [22].

This paper holds that if enterprises carry out innovation activities and use a large number of short-term loans; first, we will often face the phenomenon that short-term loans have expired or are about to expire. The payback period of investment in innovation activities is long and cash flow cannot be obtained in the short term, which will increase the debt pressure of enterprises, increase financial risks

and reduce financial performance. Moreover, too frequent bank lending will increase the operating costs and innovation risks of enterprises, and have an adverse impact on the continuous innovation activities of enterprises. And once R & D fails, it will not only lose human and material resources, but also have a great impact on enterprise performance. Second, the maturity mismatch of loans and debts weakens the governance mechanism of long-term and short-term loans to enterprises. Enterprises may focus on dealing with enterprise liquidity risk and capital liquidity, and have no time to take into account the efficiency investment with long-term strategic significance, which will affect the formation of enterprise core competitiveness and future development potential.

Therefore, this paper puts forward the following assumptions:

H3: short-term loan and long-term investment will inhibit the correlation between R & D investment and enterprise performance.

3. Sample design and research data

3.1 Sample selection and data source

This paper selects the financial data of Shanghai and Shenzhen A-share listed companies from 2012 to 2019. The innovation investment, short-term loan and long-term investment, enterprise performance and other financial indicators are from guotai'an CSMAR China financial database. Based on previous relevant studies, this paper processes the original data as follows: ① eliminate the observed values of listed companies whose stocks are marked as St, * ST and other stocks by the CSRC. ② Exclude samples with asset liability ratio greater than 1. ③ Exclude the sample companies in the financial industry, because these industries basically do not involve innovation investment. ④The sample companies with missing main variables are excluded. In order to control the influence of extreme values and outliers on the data, all continuity variables are winterized at the upper and lower 1% level. After the above processing, a total of 14568 panel data of 1821 sample companies were finally obtained.

3.2 Variable selection and definition

3.2.1 Explained variable - Enterprise Performance

At present, ROA, roe and Tobin'q are widely used to measure enterprise performance. However, due to the weak effectiveness of China's stock market and poor stock liquidity, Tobin Q value is not used as an indicator to measure enterprise performance. In this paper, ROA (total assets net interest rate) is used to measure corporate performance, and ROE (net assets net interest rate) is used as the explanatory variable in the robustness test.

Explanatory variable - R & D investment

Based on the research of Zhang Zhaoguo (2014) [23], this paper uses the ratio of R & D expenses to operating income to measure R & D investment. Represented by the letter R & D.

Adjustment variable - short-term loan and long-term investment

This paper adopts the method of Zhong Kai (2016) and uses the balance sheet and income statement to determine the proxy variable of short-term loan and long-term investment, which is expressed by the letter SFLI. That is, "cash expenditure from investment activities such as the purchase and construction of fixed assets, intangible assets and other long-term assets - (current increase in long-term loans + current increase in equity + net cash flow from operating activities + net cash recovered from the sale of fixed assets, intangible assets and other long-term assets)", and then divided by the total assets at the beginning of the period for standardized treatment. The increase of long-term borrowings in the current period is: long-term borrowings in the current period + noncurrent liabilities due within one year - long-term borrowings in the previous period.

Control variables

In the selection of control variables, referring to the previous literature, this paper selects enterprise asset scale (asset), proportion of intangible assets (Wuxing), proportion of fixed assets (Guding), enterprise asset liability ratio (Lev), capital intensity (CI), enterprise age (age) and the shareholding

proportion of the largest shareholder (Top1). At the same time, this paper also controls the fixed effect of individual and year. See Table 1 for the definition of variables in this paper.

Table 1. Variable definition.

variable	Variable name	explain
Enterprise performance	ROA	Net profit / total assets
R & D investment	RD	R & D expenses / operating income
Short term loan and long term investment	Sfli	[cash expenditure from investment activities such as the purchase and construction of fixed assets, intangible assets and other long-term assets - (current increase in long-term loans + current increase in equity + net cash flow from operating activities + net cash recovered from the sale of fixed assets, intangible assets and other long-term assets)] / total assets at the beginning of the period
Enterprise asset scale	asset	Natural logarithm of total assets
Proportion of intangible assets	wuxing	Intangible assets / total assets
Proportion of fixed assets	guding	Fixed assets / total assets
Asset liability ratio	lev	Total liabilities / total assets
Capital intensity	ci	Net fixed assets / number of employees
Enterprise age	age	Natural logarithm of (Observation Year - time to market + 1)
Shareholding ratio of the largest shareholder	top1	Shareholding ratio of the largest shareholder (%)
Nature of enterprise	state	1 for state-owned enterprises and 0 for non-state-owned enterprises.
industry	industy	Dummy variable.
particular year	year	Dummy variable.

3.3 Model construction

This paper uses panel data. In terms of econometric model selection, this paper passes the Hausman test and selects the two-way fixed effect model. The specific model is as follows:

This paper constructs a model (1) to verify the relationship between R & D investment and enterprise performance and the relationship between short-term loan and long-term investment and enterprise performance.

$$ROA_{i,t} = \beta_0 + \beta_1 RD_{i,t-j} + \beta_2 Sfli_{i,t} + \beta_3 X' + L_i + Y_i + \varepsilon_{i,t} \tag{1}$$

Build a model (2) to verify the regulatory effect of short-term loan and long-term investment on R & D investment and enterprise performance.

$$ROA_{i,t} = \beta_0 + \beta_1 RD_{i,t-j} + \beta_2 Sfli_{i,t} + \beta_3 RD_{i,t-j} * Sfli_{i,t} + \beta_4 X' + L_i + Y_i + \varepsilon_{i,t} \tag{2}$$

Where I represents the ith company, T represents the T year, j = 0, 1, 2, indicating the impact on the performance of enterprises lagging behind for 1-2 periods. X 'represents the vector composed of multiple control variables, and II and Yi represent individual fixed effect and year fixed effect respectively.

4. Empirical analysis

4.1 Benchmark regression analysis

4.1.1 Descriptive statistics and correlation coefficient

Table 2 presents the descriptive statistical results of each variable. It can be seen from the table that the maximum and minimum values of enterprise performance are 0.184 and -0.164 respectively, and the standard deviation is 0.048, indicating that there is little difference between enterprise performance. The R & D investment of each enterprise is relatively low, indicating that the R & D investment is only 0.109, but the R & D investment of each enterprise needs to be balanced, which means that the R & D investment of each enterprise needs to be strengthened. The maximum value of short-term loan and long-term investment is 0.266, the minimum value is -1.416, and the standard deviation is 0.221, indicating that some enterprises have serious phenomenon of short-term loan and long-term investment, which needs to be paid attention to. Generally speaking, listed companies should pay attention to R & D and try their best to reduce debt maturity mismatch.

Table 2. Descriptive statistics of variables.

variable	sample size	average	standard deviation	minimum value	Maximum
ROA	14568	0.038	0.048	-0.164	0.184
RD	14568	0.007	0.020	0.000	0.109
Sfli	14568	-0.093	0.221	-1.416	0.266
asset	14568	32.338	1.874	28.873	38.042
wuxing	14568	0.047	0.052	0.000	0.334
guding	14568	0.218	0.166	0.002	0.708
lev	14568	0.433	0.201	0.053	0.860
ci	14550	577080.724	933674.246	13945.420	6349517.780
age	14568	3.438	0.912	1.000	4.755
top1	14568	34.459	14.864	8.720	74.960

The Pearson test results between the main variables are described in Table 3. Enterprise performance (ROA) and R & D investment (R & D) are significantly negative at the level of 1%, indicating that there is a negative effect on enterprise performance at the initial stage of R & D investment. Whether there is a lag effect needs to be further tested. Short loan long investment (SFLI) and enterprise performance (ROA) are significantly negative at the level of 1%. It indicates that short-term loan and long-term investment may deteriorate enterprise performance.

Table 3. Correlation test of main variables.

	ROA	RD	Sfli	asset	wuxing	guding	lev
ROA	1						
RD	-0.085***	1					
Sfli	-0.343***	0.073***	1				
asset	0.00200	-0.00300	-0.046***	1			
wuxing	-0.0130	-0.030***	-0.0100	0.00900	1		
guding	-0.058***	-0.098***	0.060***	0.067***	0.079***	1	
lev	-0.328***	-0.082***	0.139***	0.554***	-0.047***	0.029***	1
ci	-0.055***	-0.071***	0.00600	0.310***	-0.00300	0.564***	0.153***
age	-0.099***	0.083***	-0.014*	0.376***	0.00300	0.047***	0.354***
top1	0.109***	-0.136***	-0.021**	0.234***	0.025***	0.094***	0.105***
	ci	age	top1				
ci	1						
age	0.152***	1					
top1	0.141***	0.00100	1				

Note: * * *, * * and * represent significance levels of 0.01, 0.05 and 0.10 respectively.

4.1.2 Fixed effect regression results and analysis

Table 4 shows the regression results of R & D investment lagging behind one period and two periods. The regression coefficient between R & D investment and enterprise performance in the current period is -0.233, which is significantly negative at the level of 1%. It shows that the R & D investment of the enterprise may be included in the expenditure in the current period by the accounting standards, and the part included in the expenditure has a negative correlation with the current operating performance of the enterprise. After a lag of one to two periods, the regression coefficient with enterprise performance shows that 0.104 and 0.306 are significantly positive at the level of 10% and 5% respectively. It shows that there is a lag effect in the impact of R & D investment on enterprise performance. The lag effect reached its maximum in the second phase, indicating that it takes a certain time from the start of innovation activities to the production of benefits. The hypothesis H1 is verified, and there is a nonlinear relationship between R & D investment and enterprise performance. The regression coefficients of short-term loan and long-term investment on enterprise performance are -0.04, -0.038 and -0.035 respectively, which are significantly negative at the level of 1%. It shows that short-term loan and long-term investment will deteriorate enterprise performance and have an adverse impact on enterprise development. It verifies the hypothesis that short-term loan and long-term investment are negatively correlated with enterprise performance. For the control variables, there is a significant positive correlation between enterprise asset scale and enterprise performance at the level of 5%. The proportion of intangible assets and fixed assets are negatively correlated with enterprise performance.

Table 4. Impact of R & D investment on Enterprise Performance.

ROA	Current model 1.1	Lag phase I 1.2	Lag two phases 1.3
RD	-0.233***	0.104*	0.306**
	(0.035)	(0.054)	(0.123)
Sfli	-0.040***	-0.038***	-0.035***
	(0.002)	(0.002)	(0.002)
Control variable	Control	Control	Control

Note: * * *, * * and * represent significance levels of 0.01, 0.05 and 0.10 respectively; the data in parentheses is the value of T.

Table 5 shows the impact of the intersection of R & D investment and short-term loan and long-term investment on enterprise performance, and regresses the R & D investment in one lag period and two lag periods. The regression coefficients of the intersection of R & D investment in the current period and the first lag period are negatively correlated with enterprise performance at the level of 1%, and the regression coefficients are -2.201 and -2.206 respectively. Although the relationship with the second lag period is not significant, it is still negatively correlated. It shows that the relationship between short-term loan and long-term investment on R & D investment and enterprise performance is negative from the current investment period. With the passage of time, the negative impact weakened, which should be attributed to the gradual positive effect of R & D investment on enterprise performance. Hypothesis H3 is verified.

Table 5. Negative adjustment of short-term loan and long-term investment.

ROA	Current model 2.1	Lag phase I 2.2	Lag two periods 2.3
RD	-0.319***	-0.281***	-0.231***
	(0.033)	(0.036)	(0.036)
Sfli	-0.032***	-0.034***	-0.035***
	(0.002)	(0.002)	(0.002)
RD× Sfli	-2.201***	-2.067***	-1.870
	(0.317)	(0.391)	(4.104)
Control variable	Control	Control	Control

Note: * * *, * * and * represent significance levels of 0.01, 0.05 and 0.10 respectively; the data in parentheses is the value of T.

4.2 Further analysis

4.2.1 Enterprise heterogeneity analysis

It can be seen from table 6 that compared with state-owned enterprises, non-state-owned enterprises have a greater negative impact on enterprise performance in the current period of R & D investment, with a correlation coefficient of -0.337, 0.247 percentage points higher than state-owned enterprises. And R & D investment (RD) × SFLI) and lag phase I (rd_ lag) × the interaction between SFLI) and short-term loan and long-term investment is also more significant on enterprise performance, with correlation coefficients higher than 1.011 and 0.176 respectively, and the negative correlation is stronger. The reason is that state-owned enterprises generally have the support of the state, have stronger government background and government relations than non-state-owned enterprises, and are more likely to obtain "credit support" from banks and other financial institutions. However, non-state-owned enterprises are more subject to "credit discrimination", and have less credit funds and higher financing costs. The phenomenon of short-term loan and long-term investment is also more serious.

Table 6. Heterogeneity analysis of innovation investment,
short-term loan and long-term investment and enterprise performance.

	ROA		
	Full sample	state-owned enterprise	Non state owned enterprises
RD	-0.322***	-0.090***	-0.337***
	(0.034)	(0.031)	(0.025)
Sfli	-0.029***	-0.030***	-0.024***
	(0.002)	(0.002)	(0.002)
RD×Sfli	-2.082***	-1.324***	-2.335***
	(0.452)	(0.177)	(0.149)
RD_lag× Sfli	-0.270	0.307	-0.483**
	(0.537)	(0.238)	(0.209)
Control variable	Control	Control	Control

Note: * * *, * * and * represent significance levels of 0.01, 0.05 and 0.10 respectively; the data in parentheses is the value of T.

4.3 Robustness test

The purpose of robustness test is to ensure the stability of regression results. This paper uses ROE (net profit / net assets) instead of ROA as a measure of enterprise performance. Use Rd (R & D expenses / total assets) as the measurement index of R & D investment. Using the fixed effect regression model, it can be seen from table 7 that the regression coefficient between R & D investment and enterprise performance in the current investment period is -1.02, which is significantly negative at the level of 1%. In the first phase of lag, there is a significant positive correlation, indicating that there is still lag effect between the two, which verifies the hypothesis H1. Short term loan and long-term investment are significantly negatively correlated with enterprise performance at the level of 1%, assuming H2 is true. Table 7 also regresses the cross multiplication terms of R & D investment and short-term loan and long-term investment. The regression coefficients in the current investment period and the lag period are -10.55 and -4.431 respectively, which are significantly negatively correlated at the level of 1%. Hypothesis H3 is verified. It shows that the results of each hypothesis are robust.

Table 7. Robustness test.

ROE	Current period	Lag phase I	Lag two periods
RD	-1.020[***]	0.682[***]	0.666
	(0.150)	(0.204)	(0.860)
Sfli	-0.063[***]	-0.075[***]	-0.075[***]
	(0.004)	(0.005)	(0.005)
RD×Sfli	-10.550[***]	-4.431[***]	4.354
	(1.393)	(1.646)	(7.107)
Control variable	Control	Control	Control

Note: * * *, * * and * represent significance levels of 0.01, 0.05 and 0.10 respectively; the data in parentheses is the value of T.

5. Research conclusion and Enlightenment

This paper analyzes the panel data of Shanghai and Shenzhen A-share listed companies from 2012 to 2019. Firstly, through the empirical analysis of R & D investment and enterprise performance, it shows that R & D investment is negatively correlated with enterprise performance in the current period, but this effect is only reflected in the current period, there is a two-phase lag effect, and it is significantly positively correlated with enterprise performance. The reason is that the R & D investment may be included in the expenditure in the current period by the accounting standards. The part included in the expenditure will have a negative impact on the enterprise performance, but the benefits generated by several lag periods compensate the R & D expenditure. It also shows that the time period from capital input to product output is longer, which is basically greater than one accounting year. The research results of this paper are different from Zheng Haiyuan's (2018) research on GEM data. The research shows that there is a significant positive correlation between R & D investment and enterprise performance in the current period, and there is a lag effect. Secondly, it analyzes the relationship between short-term loan and long-term investment and enterprise performance, and examines the adverse consequences of debt maturity mismatch on enterprise performance. Finally, this paper brings R & D investment and short-term loan and long-term investment into a unified framework to analyze the impact of their interaction on enterprise performance. As a long-term investment project, innovation activities will increase the degree of short-term loan and long-term investment and deteriorate enterprise performance in China's financial market. In the current period of R & D investment and the two lag periods, the interaction items of both are significantly negative at the level of 1%. Further analysis shows that the performance is more obvious in non-state-owned enterprises.

In view of the conclusions of this paper, the suggestions are as follows: (1) the descriptive statistical results in Table 2 show that the R & D intensity of listed companies is generally low. Although R & D activities have the characteristics of long cycle and high risk, as the primary driving force leading the development of enterprises, enterprise management should take a long-term view and strive to enhance the competitiveness of enterprises. They should not only focus on the growth of short-term benefits and ignore long-term high-quality investment projects. (2) China should further improve the bank credit rationing mechanism and expand external financing channels. Private enterprises and other non-state-owned enterprises play an important role in China's innovation driven development strategy, and we should increase investment in its innovation. Try to alleviate its financing difficulties and high financing costs, so as to avoid the alternative financing mode of short-term loan and long-term investment.

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