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Financing Structure and Corporate Innovation of Science and Technology Enterprises—Empirical Evidence from China's Listed Companies

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Abstract: *Science and technology innovation boosts the enterprises' development and also contributes to enhancing national comprehensive strength. This paper mainly discusses the relationship between financing structure and corporate innovation. We select science and technology enterprises in the Chinese A-share market from 2016-2020 as research samples and empirically test the impact of corporate financing structure on innovation inputs. The results of the multiple linear regression reveal that equity financing significantly promotes enterprises' investment in R&D innovation, while debt financing presents a significant inhibitory effect. This paper may have theoretical value and practical significance for science and technology enterprises to conduct R&D innovation.*

Keywords: *Corporate Innovation, Equity Financing, Debt Financing, Multiple linear regression*

1. Introduction

With the development of the Internet of Things, cloud computing, and artificial intelligence technologies, a new round of technological revolution is approaching. Scientific and technological innovation has gradually become the focus of the world. The Fifth Plenary Session of the 19th CPC Central Committee pointed out that it was necessary to adhere to the central position of innovation in the overall situation of China's modernization and made science and technology self-reliance and self-improvement the strategic support of national development. Nowadays, the world situation is complicated and changeable, and China faces a downward trend of economic growth. Therefore, insisting on scientific and technological innovation is of great significance to the prosperity of the state.

Compared with traditional manufacturing and service companies, science and technology enterprises have a higher demand for technological innovation. Currently, the core technology of many Chinese products is still monopolized by foreign countries. Achieving technological innovation and independent R&D requires sufficient funding. Since the impacts of different financing methods vary, it is vital to explore the influence mechanism of financing structure on the innovation ability of science and technology enterprises.

2. Literature Review

The study of corporate financing structure began with the MM theory of Modigliani et al. (1958) [1], and later developed the pecking order theory and the trade-off theory, which have become the two mainstream theories of modern capital structure research.

According to the source of funds, corporate finance can be divided into endogenous and exogenous finance. Most scholars believe that endogenous financing is the main source of funding for firms' innovation inputs. Himmelberg and Peterson (1994)[2] investigated 179 small firms in high-tech industries. They claimed that internal finance should be an important determinant of R & D expenditures. Using the data from Danish companies, Bloch (2005)[3] argued internal funds were important in explaining R&D investments. Drakos and Bekiris (2010)[4] confirmed that endogenous financing did promote firm growth, while external equity financing did not have a significant relationship with firm performance. Brown et al. (2009)[5] stated that exogenous equity financing had a significant effect on innovation investment in young high-tech firms as well as endogenous financing.

Previous studies have shown that financing structure has an effect on enterprise innovation. However, scholars have not reached a unanimous conclusion. By analyzing empirical data from 2006 to 2010 in

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China, Li et al.(2013)[6] pointed out that government subsidies most significantly increased firms' innovation investment, with equity financing having the next highest impact. Besides, Debt financing had an insignificant effect on firms' innovation investment. Through a study of A-share technology firms, Guo and Tian (2018)[7] found that equity financing had a significantly negative effect on corporate innovation, while debt financing had a positive promotion effect. Sun and Xiao (2016)[8] claimed that for enterprises in China's strategic emerging industry, equity investment was positively related to innovation investment, and debt financing was negatively related to innovation investment. Wang and Zhang (2020)[9] studied China's A-share enterprises, and the result was the same.

The variability of the samples mainly accounts for the differences in the conclusions above. Different industries and different stages of the enterprise life cycle influence the results.

Therefore, the contribution of this paper is as follows.

(1) Due to the differences between the samples, there is no consistent conclusion on the relationship between corporate financing structure and innovation capability in academia. This paper complements and improves the literature on financing structure and innovation capability to a certain extent.

(2) Current literature mainly focused on the impact of corporate financing structure on business performance, using financial performance to measure enterprises' innovation ability. However, few articles studied the relationship between financing structure and corporate innovation capability. In terms of indicator selection, this paper adopts the ratio of total R&D expenditure to operating revenue as the explanatory variable to measure the innovation capability of enterprises, which has novelty to a certain extent. In terms of the research sample, this paper takes science and technology enterprises as the research sample. Therefore, the paper may provide a reference for science and technology companies to adjust their financing structure and achieve innovation capability improvement.

3. Theories and Hypotheses

According to industrial organization theory, innovation investment is characterized by high conversion cost, high risk, and positive externality. High conversion cost is reflected in the fact that R&D innovation requires a large amount of capital and manpower, and innovation activities are difficult to bring intuitive benefits in a short period of time. High risk is embodied in the low rate of R&D results and value uncertainty. Investment funds may not necessarily produce R&D results, and the value of intangible assets generated by R&D is difficult to estimate. Positive externality refers to the fact that the benefits of new technologies and services generated by innovation may not be captured alone.

Due to information asymmetry, exogenous financing is prone to moral hazard and adverse selection. External investors may not fully grasp the R&D situation of enterprises and obtain effective information. Debt financing has a lower cost of capital compared with equity financing and is tax deductible. However, enterprises have to pay the corresponding interest on the maturity date, increasing financial risk. Moreover, exogenous financing has more constraints. Only enterprises that meet certain conditions can issue bonds. Since banks need to evaluate all aspects of the enterprises' credit rating and solvency, it is challenging for high-tech enterprises to use intangible assets as collateral.

Endogenous financing is risk-resistant and low-cost compared to exogenous financing. Myers and Majluf (1984)[10] proposed the theory of preferential financing. They claimed that the cost of endogenous financing was relatively low and firms consider endogenous financing first when raising capital. The use of endogenous financing as a financing tool does not reduce the cash flow of the company and does not require the payment of financing costs. From a cash flow perspective, the payment of dividends is based on profitability and operational needs. Enterprises have no fixed pressure to repay the capital, and the financial risk is low. Therefore, equity financing is more conducive to companies investing stable and continuous cash flow in innovative R&D projects.

Therefore, we propose the following hypotheses:

H1: For science and technology firms, debt financing inhibits firms' investment in innovation.

H2: For technology-based firms, equity financing promotes firms' investment in innovation.

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4. Research Design

4.1 Data Sources and Samples

4.1.1 Data sources

This paper takes China's listed companies in science and technology as the research object. According to the 2012 edition of the industry classification of the Securities Regulatory Commission, all A-share enterprises in the information transmission, software, and information technology service industry and scientific research and technology service industry from 2015 to 2020 are selected to establish a linear regression model. The relevant enterprise data are mainly obtained from the wind database and the annual statements of each company.

4.1.2 Samples

To make the data more scientific and accurate, the sample data of the regression model are processed as follows.

1) Excluding ST and *ST listed companies.

2) Excluding companies with abnormal financial data or unable to provide complete financial data.

3) Considering the outlier problem caused by the difference of sample companies, we use the Stata 15 winsorize command to truncate the top and bottom 1% of the data.

4.2 Variable Definition and Description

4.2.1 Dependent variable

Regarding the metrics of innovation, Keller preferred the number of patents and R&D funding input as the criteria [9]. Maiti and Singh argued that innovation could be measured from two perspectives: production input (R&D funding input) and output (number of patent applications, new product sales revenue) [10]. In summary, regarding the measurement of enterprise innovation, the number of patents, R&D investment, and new product output are the most common indicators.

The output value of new products is vulnerable to various factors in the market. Additionally, the granting of patents has a certain lag compared to the application of technology. Therefore, in the regression modeling of this paper, the ratio of total R&D expenditure to operating revenue is used as the explanatory variable to measure the innovation capability of enterprises.

4.2.2 Independent variables

1) Equity financing: Equity financing is a financing method in which the shareholders of an enterprise are willing to give up part of their ownership of the enterprise and bring in new shareholders by way of capital increase of the enterprise; while making the total equity increase. In this paper, the value of the sum of equity and capital surplus is taken as the scale of equity financing and divided by the total assets to eliminate the scale effect.

2) Debt financing: Debt financing is a way to obtain financial support by borrowing from external economic units through certain channels and methods. In this paper, the ratio of the sum of long and short-term loans and bonds to total assets is selected to measure the indicator.

4.2.3 Control Variables

This paper selects board size, equity concentration, return on net assets, government subsidies, and firm size as control variables.

1) Board size: The board of directors can determine the future direction of the company and the investment in R&D. The smaller the size of the board, the more voice each director has. In this paper, the number of board members is chosen to reflect the size of the board.

2) Equity concentration: The degree of equity concentration reflects the decision-making power of major shareholders, which in turn affects the company's investment in innovation. The sum of the shareholdings of the top ten shareholders is selected to measure this indicator.

3) Return on net assets: The profitability of an enterprise attracts investors to invest. Excellent profitability gives corporate managers positive expectations for the company's future growth, which in turn influences the investment in R&D. The ratio of net profit to net assets is used to measure this

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indicator.

4) Government subsidies: The government's support plays an incentive role in the innovation of the enterprise. This paper uses the natural logarithm of government subsidies to measure this indicator.

5) Company size: Large-scale enterprises are financially abundant and have more strength to make long term capital investments in R&D innovation. In this paper, we use the natural logarithm of asset size to measure the scale of enterprises.

4.2.4 Variable Definition Table

The specific definitions of each variable are shown in Table 1.

Table 1: Variable definition

Attributes	Variable	Symbol	Definition
Dependent variable	Innovation input	RD	R&D expenses as a percentage of operating revenue
Independent variables	Equity Financing	Equityf	(Equity + Capital surplus)/Total assets
	Debt Financing	Debtf	(Bonds payable + short-term loans + long-term loans)/Total assets
	Enterprise scale	Size	Natural logarithm of asset size
Control variables	Board size	Boardscale	Number of Board of Directors
	Shareholding Concentration	Herf	The shareholding ratio of top ten shareholders
	Government Subsidies	Gov	Natural logarithm of government subsidies
	Return on Net Assets	ROE	Net Income / Net Assets

4.3 Models

The following model is constructed to explore the relationship between financing structure and firm innovation.

$$RD_{it} = \beta_0 + \beta_1 Equityf_{it} + \beta_2 Debtf_{it} + \beta_3 ROE_{it} + \beta_4 Gov_{it} + \beta_5 Herf_{it} + \beta_6 Size_{it} + \beta_7 Boardsale_{it} + \varepsilon_{it}$$

where $RD_{it}, Equityf_{it}, Debtf_{it}, ROE_{it}, Gov_{it}, Herf_{it}, Size_{it}, Boardsale_{it}$ denotes innovation input, equity financing, debt financing, return on net assets, government subsidy, equity concentration, firm size, and board size of firm i at time t, respectively, β_0 denotes individual effect, and ε_{it} denotes random disturbance term.

5. Analysis and Results

5.1 Descriptive Statistics and Correlation Analysis

In this paper, descriptive statistical analysis of all variables in 1219 observations was performed using Stata15 software. According to Table 2, the mean value of the ratio of R&D expenses to operating revenue (RD) among technology-based enterprises is 8.03%. The minimum value of RD is 0.18% and the maximum value is 35.85%, which indicates that there is a large difference in the level of innovation investment among different technology enterprises. The mean value of equity financing is 44.28%, while the mean value of debt financing is 10.11%, indicating that technology enterprises are more inclined to carry out equity financing. The amount of government subsidies is uneven and varies among enterprises. In addition, there are huge differences among enterprises in terms of board size, company size, and equity concentration.

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Table 2: Summary statistics

Symbol	Observations	Mean	SD	Minimum	Maximum
RD	1,219	0.080317	0.058679	0.001805	0.358512
Equityf	1,219	0.436534	0.163804	0.113224	0.950335
Debtf	1,219	0.101185	0.092542	0.000467	0.398488
ROE	1,219	7.55226	10.79759	-51.8094	40.8892
Gov	1,219	7.001175	0.5371	4.9498	8.340492
Boardscale	1,219	8.251846	1.625354	5	15
Herf	1,219	55.67393	14.81398	22.32	96.14
Size	1,219	9.45028	0.432739	8.367806	10.64603

To conduct a preliminary analysis of corporate financing structure and innovation capability, correlation analysis was conducted on the main variables. From the Pearson correlation coefficient matrix in Table 3, it can be obtained that equity financing, government subsidies, shareholding, and innovation input of enterprises are positively correlated; while debt financing, return on net assets, enterprise size, and board size are negatively correlated with innovation input. Initially, we verify the correctness of H1 and H2. From the correlation coefficients, the absolute values of the correlation coefficients among the variables are less than 0.7, and it can be concluded that there is no obvious multicollinearity among the variables.

Table 3: Correlation matrix

	RD	Equityf	Debtf	ROE	Gov	Board	Herf	Size
RD	1							
Equityf	0.161***	1						
Debtf	-0.164***	-0.135***	1					
ROE	-0.032	-0.267***	-0.165***	1				
Gov	0.051*	-0.257***	0.034	0.086***	1			
Board	-0.051*	-0.032	0.024	-0.001	0.249***	1		
Herf	0.051*	-0.129***	-0.095***	0.188***	-0.111***	-0.053**	1	
Size	-0.120***	-0.267***	0.067**	0.001	0.665***	0.307***	-0.265***	1

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.2 VIF test

To test for multicollinearity among the variables, variance inflation factor (VIF) tests were further performed on the variables. From Table 4, it can be seen that the VIF values are all less than 10 and pass the VIF variance inflation factor test. This indicates that there is no multicollinearity among the selected variables and the model is stable.

Table 4: Result of VIF test

Variable	VIF	1/VIF
Size	1.95	0.5141
Gov	1.78	0.5627
Equityf	1.32	0.7577
ROE	1.29	0.7768
Herf	1.25	0.8023
Debtf	1.22	0.8229
Boardscale	1.07	0.9316

5.3 Regression Results

The regressions are conducted on the full sample with innovation input as the explanatory variable and the regression results are obtained. According to the first column of Table 5, each additional unit of equity financing will increase the innovation input by 0.034 units, indicating that equity financing of enterprises has a promoting effect on the innovation input of enterprises. Each increase of 1 unit of debt financing will decrease the innovation input by 0.084 units, indicating that there is a negative relationship between the two, and the debt financing of enterprises has a suppressive effect on the innovation input of enterprises. Therefore, hypotheses H1 and H2 are established. Comparing the magnitude of the regression coefficients of equity financing and debt financing, the inhibitory effect of debt financing on

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firms' investment in innovation is stronger than the promotional effect of equity financing. Firms with abundant government subsidies tend to be relatively well-funded and thus invest more money in R&D innovation. Firm size is negatively related to innovation investment, which may stem from the fact that large firms have less competitive pressure due to the scale effect. In addition, the effects of return on net assets and the percentage of top ten shareholders on innovation investment are not significant.

To verify the heteroskedasticity of the model, BP test and White's test are conducted. The p-value in BP test is 0.0003 and the p-value in White's test is equal to 0.0000, both of which are less than 0.05. Therefore, the original hypothesis that the equation does not have heteroskedasticity is rejected. Consequently, we use heteroskedasticity robust standard errors to address heteroskedasticity. The result is shown in the second column of Table 5.

Table 5: Regression results

	(1)	(2)
	Rd	Rd
Equityf	0.034***	0.034***
	(2.985)	(2.899)
Debtf	-0.084***	-0.084***
	(-4.408)	(-4.521)
ROE	-0.000	-0.000
	(-1.566)	(-1.505)
Gov	0.032***	0.032***
	(8.066)	(9.435)
Boardscale	-0.002**	-0.002**
	(-2.238)	(-2.192)
Herf	0.000	0.000
	(0.673)	(0.633)
Size	-0.037***	-0.037***
	(-7.241)	(-6.593)
ROA	-	-
_cons	0.219***	0.219***

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5.4 Robustness Test

Table 6: The result of robustness test

	RD
Equityf	0.035***
	(3.131)
Debtf	-0.083***
	(-4.512)
Gov	0.032***
	(9.410)
Boardscale	-0.002**
	(-2.215)
Herf	0.000
	(0.684)
Size	-0.038***
	(-6.608)
ROA	-0.000 (-1.522)
_cons	0.220***

In order to test the accuracy of the regression results and make the regression results more convincing, this paper replaces the control variable ROE with ROA for empirical analysis. The new regression results are shown in Table 6. According to the regression result analysis, the influence of financing structure on enterprise innovation input remains significant. Equity financing drives innovation investment, and the increase of debt financing still makes enterprises reduce their innovation expenditure. From all the

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analysis above, we may draw the conclusion that equity financing has a significant positive relationship with innovation investment, and debt financing has a significant negative relationship with innovation investment.

6. Conclusion and suggestion

This paper explores the relationship between financing structure and firms' innovation by using data from science and technology enterprises in China's A-share market. The main findings are summarized as follows: Firstly, for current science and technology firms, equity financing facilitates firms' investment in innovation. Secondly, debt financing significantly reduces firms' investment in innovation.

Based on this, this paper gives the following suggestions.

1) Optimize the financing structure of enterprises. The government should improve relevant financing policies and guide enterprises to reduce their reliance on debt financing. By encouraging and advocating equity financing, play the role of equity financing for enterprise innovation. Banks should take into account the nature and scale of enterprises and supply a variety of credit products and financing channels to provide a continuous financial guarantee for innovation investment. Additionally, society should reduce the requirements for short-term financial indicators, create a great social atmosphere for innovation investment, and raise enterprises' awareness of innovation.

2) Lower the financing threshold and achieve fair financing opportunities. Government subsidies have positive effects on enterprises' innovation investment as they can increase enterprises' cash flow. Since government subsidies have the role of information transmission, they can bring more financing opportunities for enterprises. However, the amount of subsidies among enterprises is not fair. State-owned enterprises have fewer financing constraints compared with non-state-owned enterprises. State-owned enterprises are more likely to obtain government subsidies and financing funds. In addition, the difference in size and business capacity also affects the financing of enterprises. Therefore, the government should fully consider the differences in industrial nature and business capacity to relax the financing conditions and provide a relatively fair financing environment.

3) Build a multi-level financial structure system and improve the multi-level capital market. A multi-level capital market assumes risks for investment and financing subjects, which is conducive to alleviating the financing difficulties and thus realizing reasonable allocation of market resources and market efficiency improvement. Therefore, the construction of the stock market should be strengthened to reduce transaction costs and enrich the variety of trading products. In addition, the reform of the stock registration system should be actively promoted to provide startups with opportunities to issue and list their shares; and to provide financing opportunities for enterprises with poor short-term financial situations but long-term profitability. In addition, the construction of the debt market should be continuously strengthened, the regulatory mechanism should be improved, and the level of interest rate marketization should be actively promoted.

References

[1] Modigliani F, Miller M H. The cost of capital, corporation finance and the theory of investment [J]. The American Economic Review, 1958, 48(3): 261-297.
[2] Himmelberg C. P, Petersen, B. C.R. & D. and Internal Finance: A Panel Study of Small Firms in High-Tech Industries [J].Review of economics & statistics.1994, 76(1).38-38.
[3] Bloch C. R&D investment and internal finance: the cash flow effect [J]. Economics of Innovation and New Technology, 2005, 14(3): 213-223.
[4] Drakos A, Bekiris F V. Corporate performance, managerial ownership, and endogeneity: a simultaneous equations analysis for the Athens stock exchange[J]. Research in International Business and Finance, 2010, 24: 24-38.
[5] Brown J. R., Fazzari S. M., & Petersen B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D Boom. The Journal of Finance, 64(1), 151-185.
[6] Li Huidong, Tang Yuejun, Zuo Jingjing. On the Selection of Innovation Financing Resources: Based on the Financing Structure and the Innovation of Listed-company in China [J]. Financial Research, 2013. (2):170-183.
[7] Guo Huiting, Tian Jiaxi. The Impact of Financing Efficiency and Mode on R&D Investment--Based on Data of A-share Information Technology Companies[J]. Friends of Accounting, 2018(17):37-43.
[8] Sun Zao, Xiao Liping. Financing Structure and Innovation—Evidence from A-share of Listing

ISSN 2616-5902 Vol. 5, Issue 11: 120-127, DOI: 10.25236/AJBM.2023.051119

Corporation of Strategic Emerging Industries in China [J]. Economic Theory and Economic Management, 2016(03):45-58.
[9] Wang Xiaoyan, Zhang Ce. Research on the Impact of Corporate Financing Structure on Innovation Efficiency in the Context of Deleveraging: Empirical Evidence from Shanghai and Shenzhen A-share Listed Companies [J]. Financial Theory and Practice, 2020(03):17-25.
[10] Myers S C, Majluf N S. Corporate Financing and Investment Decisions When Firms Have Information that Investors do not Have [J]. Journal of Financial Economics,1984,13(2):187-221.