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Research on the Impact of Capital Structure of Listed Companies on the R&D Investment of Listed Companies on the Beijing Stock Exchange

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Abstract: *On September 2, 2021, the Beijing Stock Exchange officially announced its establishment, providing a channel for "specialized, special and new" enterprises to quickly go public and raise funds. As an important platform for small and medium-sized innovative enterprises to conduct equity financing, the relationship between the capital structure of listed companies and their R&D investment is still lacking in practical research. This paper takes 162 companies that have successfully been listed on the Beijing Stock Exchange since its establishment, and manually collects data to establish a regression model to study the relationship between corporate debt level and R&D investment, in order to provide reference for enterprises preparing for IPO on the Beijing Stock Exchange. The results of the empirical study show that the increase in the proportion of debt in the capital structure of firms will inhibit their investment in R&D, that is, there is a negative correlation between the two. From this point of view, the establishment of the Beijing Stock Exchange will help high-tech enterprises obtain equity financing, reduce corporate financing costs, and invest more funds in the improvement of their own innovation capabilities. This paper hopes that the companies to be listed on the Beijing Stock Exchange should continue to optimize their financing structure, increase investment in scientific research, improve their scientific research teams, and continuously improve their future growth, so as to finally create a real "specialized, special and new" small giant enterprise.*

Keywords: *Beijing Stock Exchange; capital structure; R&D investment; Equity financing; Specialty; IPO*

1. Introduction

As China's economic development has shifted from a high-speed development stage to a high-quality development stage, higher requirements have been put forward for scientific and technological innovation. As an important channel for direct financing of enterprises, the capital market should provide assistance for the technological innovation of manufacturing enterprises. Most of the enterprises declared by the Beijing Stock Exchange are specialized and new "little giant" enterprises in various subdivisions, which is an important part of China's innovation vitality and technological upgrading. Innovation is inseparable from the support of funds, but due to financial indicators and other constraints, small and medium-sized scientific and technological innovation enterprises often fail to meet the listing requirements of the main board, and face the problem of equity financing.

On September 3, 2021, the Beijing Stock Exchange was officially established, and the multi-level capital market jointly built by the three exchanges of Beijing, Shanghai and Shenzhen took shape. As of January 6, 2023, 162 high-tech enterprises have been listed and traded on the Beijing Stock Exchange, providing an important platform for them to improve their capital structure and reduce financing costs through equity financing. The purpose of this paper is to verify whether the change of capital structure can help promote the increase of innovation investment and improve the innovation ability of enterprises on the Beijing Stock Exchange, so as to provide practical suggestions for the improvement of China's registration system, so that high-tech enterprises can better benefit from the reform process of the capital market.

2. Theoretical basis

The study of the capital structure of companies has been going on for more than half a century, and many theories have been formed over a long period of time. With the deepening of research, a relatively

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complete theoretical system including MM theorem, trade-off theory and preferential financing theory has been gradually formed, and this paper will also carry out research based on the above theories.

MM theory is the beginning of modern capital structure theory research. Scholar Miller first proposed the MM theory, arguing that there is no relationship between the capital structure of an enterprise and its enterprise value in the absence of taxes. With the development of MM theory, the value of a leveraged company is equivalent to the sum of the value of a non-leveraged company and the tax shield in the case of government taxation in the real society. However, Li Dan [7] argues that the MM theory does not take into account the cost of financial distress of enterprises, and cannot explain the fact that the debt ratio of most companies is not high in reality.

Considering the interaction between the tax shield effect and the cost of financial distress on the capital structure, Robicek and other scholars consider the interaction between the tax shield effect and the cost of financial distress on the capital structure, and believe that the optimal capital structure of the company exists: that is, when the proportion of corporate debt is low, the tax shield effect of increasing debt financing is greater than the cost of financial distress; However, as debt financing continues to grow, the cost of financial distress gradually outweighs the gains generated by the tax shield effect, which will have a negative impact on the company's value. Therefore, the company should reasonably adjust the proportion of equity financing and debt financing, and try to maintain the optimal capital structure of the company.

The theory of preferential financing holds that due to the existence of transaction costs, companies should first choose internal financing and then external financing, and external financing should also follow the order of debt financing and then equity financing. This is because compared with internal financing, the search cost and information cost required for external financing are significantly higher, so when internal funds are sufficient, internal financing should be chosen first. When the company must choose external financing, if it first conducts equity financing, it will send a message to the outside world that the stock price is overvalued, which will trigger investors to sell a large number of shares and cause the stock to fall. Therefore, when a company makes an external source of financing, it should first choose debt financing to avoid a decline in stock price.

3. Literature review

At present, there are few studies on the capital structure of listed companies on the Beijing Stock Exchange, but scholars at home and abroad have conducted in-depth research on the impact of changes in the capital structure of listed companies on their own R&D investment according to the actual situation of the development of their own national capital market.

Foreign scholars have studied the relationship between capital structure and R&D investment earlier, and generally believe that there is a negative correlation between the two. From the perspective of information asymmetry, Stiglitz and Weiss[3] argue that creditors will limit the innovative R&D activities of enterprises in order to reduce the principal-agent problem caused by information asymmetry. Hosono and Tomiyama [1] argue that compared with the decentralized shareholding structure, the centralized shareholding structure will be more conducive to the large shareholders to increase their own control over the enterprise and reduce the voice of small and medium-sized shareholders, thus forming an authoritarian leadership system and weakening the investment in innovation of the enterprise. Jing Dong and Yan-Nan Gou [2] argue that due to the fixed interest on debt financing, the process of debt repayment will reduce the company's cash flow and increase the probability of financial distress, thereby prompting the company to pay more attention to short-term profitability and reduce spending on long-term R&D investment.

Most scholars believe that the increase in the proportion of debt financing will inhibit the company's R&D investment, but some scholars believe that there is a positive relationship between the two. Lu Canhua[9] takes GEM manufacturing enterprises as a sample, and empirically shows that there is a negative correlation between R&D investment and asset-liability ratio, and a positive correlation with equity financing ratio. Li Haoyang [8] takes A-share listed companies as the research object, establishes a dynamic capital structure change model, and concludes that the increase in the proportion of debt financing will reduce the investment in R&D. However, Liu Xing and Wei Feng[6] found that there is a positive relationship between the asset-liability ratio of state-owned enterprises and their innovation investment in the study of state-owned listed enterprises.

Scholars at home and abroad have come to different conclusions from different perspectives and

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according to the actual situation of the development of China's capital market, but the vast majority of scholars still believe that the increase in debt financing is not conducive to enterprises' investment in R&D. Combined with the theoretical analysis of the financial distress mechanism, the continuous increase in debt will make the company's R&D investment more restricted. Based on theoretical and practical research, this paper makes a hypothesis that the increase in the proportion of debt financing of listed companies on the Beijing Stock Exchange will weaken their investment in R&D.

4. Model design

In this paper, we take the companies that were successfully listed on the Beijing Stock Exchange from November 15, 2021 to January 6, 2023 as the research object, and finally obtain a quarterly financial data sample of 162 listed companies after excluding some companies with a large number of data missing. The relevant data of the listed companies are derived from the Oriental Fortune Choice database, and some of the missing data are manually collected through the company's prospectus declaration draft.

4.1. Description of the variable

4.1.1. Explanatory variables

The explanatory variable selected in this paper is R&D investment. The listing standards of the Beijing Stock Exchange have corresponding minimum R&D investment requirements for companies with different estimated market capitalizations, so the innovation ability of companies to be listed on the Beijing Stock Exchange is one of the important criteria for their successful listing. Combined with the research results of Chen Sikun [4], the level of innovation ability mainly depends on R&D investment and efficiency, and R&D investment is more important. Because the more R&D investment, more excellent R&D personnel can be recruited and more advanced R&D equipment can be purchased, and the efficiency of R&D will also be improved, so the key to improving innovation ability depends on the importance of R&D investment. In summary, this paper selects R&D investment as the explanatory variable, which can better reflect the innovation ability of Beijing Stock Exchange companies.

4.1.2. Explained variable

The explained variable selected in this paper is the asset-liability ratio. Different capital structures will have different impacts on the daily operation, tax costs, investment methods, etc., and will also change the direction and degree of the company's R&D investment. This paper mainly refers to the research method of scholars Zhai Ge and Bai Xiansheng[10], and chooses the asset-liability ratio as an indicator to measure the capital structure of research enterprises more intuitively.

4.1.3. Control variables

In addition to capital structure, many other factors will also affect the intensity of investment in R&D, so this paper selects six control variables based on the research results of Chai Binfeng[5]. The operating income represents the scale of the company, which can more accurately reflect the development scale of listed companies on the Beijing Stock Exchange in the industry; The return on total assets indicates the profitability of the company, and generally speaking, the better the profitability, the higher the company's R&D investment. The company's growth ability is indicated by the revenue growth rate, and companies with good future growth prospects will be more willing to maintain their competitive advantage by strengthening R&D investment; The higher the proportion of the company's industry, the higher the company's requirements for innovation ability, and the more R&D investment there is. Solvency is represented by the current ratio, and the more liquid companies are, the more flexible they are to invest in innovation and less constrained by creditors. Finally, according to the different levels of economic development, this paper divides China into the east and the central and western regions, and uses dummy variables to record the eastern provinces as 1 and the central and western regions as 0. This is because the tax system and innovation support in the more developed regions will be better than those in the less developed regions to varying degrees, and the advantages and disadvantages of the innovation environment will also greatly affect the enthusiasm of the company's R&D investment.

As shown in Table 1, explanatory variables and explained variables, data interpretation of control variables, and processing methods are shown in Table 1.

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Table 1: Variables

The variable belongs	Symbol	Paraphrase	Data processing
Explained variables	RD	R&d investment	Take logarithm of R&D investment
Explanatory variables	LR	Capital structure	Liabilities/total assets
Control variable	REV	Company size	Take the logarithm of operating income
	ROA	Profitability	Net profit/total assets
	GRO	Growth ability	Operating income of this year/Operating income of last year -1
	ITP	Corporate attributes	Intangible assets/total assets
	CUR	Short-term solvency	Current assets/current liabilities
	AREA	Regional development level	The value is 1 for the eastern region and 0 for the central and western region

4.2. Model construction

According to the relevant theoretical basis and practical basis above, the linear regression equation satisfied by the explained variables $Log(RD_t)$ is as follows:

$$Log(RD_t) = \beta_0 + \beta_1 LR + \sum_{i=1}^{n} Controls + \varepsilon$$

Among β_0 is the intercept term of the model,β_1 is the variable asset-liability ratio coefficient,controls represent each control variable,t stands for time change,ε is the error term that follows the normal distribution.

5. Empirical test

5.1. Descriptive statistics

In this paper, descriptive statistics of independent variables are first carried out, as shown in Table 2 below. This paper analyzes the collected data to grasp the general situation of the data. The observation samples are 162 companies that have been successfully listed in Beijing Stock Exchange. According to the statistical description results in the following table, the following conclusions can be preliminarily drawn: As the life cycle and development prospects of the listed companies in Beijing Stock Exchange are quite different, the R&D investment of different companies is also quite different; From the relevant data of financial indicators, it can be seen that some listed companies have low operating income or even losses, but they still achieve listing on the Beijing Stock Exchange, indicating that compared with the main board, the listing standards of the Beijing Stock Exchange are greatly reduced, and the success of listing depends on the future development prospects of enterprises and their core technologies. The regional virtual variable is closer to 1, indicating that most of the enterprises belong to the eastern developed region, indicating that the eastern region is more conducive to incubating "specialized and special new" small giant enterprises with scientific research and innovation potential.

Table 2: Descriptive statistics

Variable name	Mean	Std	Min	Median	Max
RD	13949.27	64465.37	519.15	3781.91	1060545.61
LR	0.334	0.22	0.03	0.296	1.875
REV	162258.45	767605.88	0	38442.05	12100000
ITP	0.043	0.058	0	0.028	0.531
ROA	0.097	0.173	-1.45	0.104	0.612
GOR	0.928	10.94	-1	0.278	264.758
CUR	2.232	4.388	0.027	0.938	39.756
AREA	0.842	0.362	0	1	1

As shown in Table 2 descriptive statistics, the mean, variance, minimum, maximum and median

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values of explanatory variables, explained variables and control variables are described.

5.2. Correlation analysis

Before the regression analysis, the correlation analysis of each variable in the model was carried out to check whether there was any correlation between the variables.

Table 3: Correlation analysis

	RD	LR	REV	ITP	ROA	GOR	CUR	AREA
RD	1							
LR	0.212**	1						
REV	0.201***	0.0720	1					
ITP	0.143**	0.307***	0.106*	1				
ROA	0.246**	0.0880	0.300***	0.219***	1			
GOR	0.258***	0.131**	0.101	0.0100	0.176**	1		
CUR	0.243*	0.140**	0.161**	0.0540	0.383***	0.813***	1	
AREA	0.254***	0.0400	0.140**	0.103	0.419*	0.373**	0.406**	1

Concentrate:*p<0.1, **p<0.05, ***p<0.01

According to the results of correlation regression analysis in Table 3, the correlation coefficients among all variables are less than 0.5, indicating that there is no significant correlation between explanatory variables and control variables, and control variables and control variables in the model, and there is no multicollinearity.

5.3. Regression results and analysis

Table 4: Results of regression analysis

Variable name	Coefficient	Standard error	T-value	P-value
C	12.5785***	0.4135	30.443	0.0000
LR	-0.4967**	0.2362	-2.104	0.0358
REV	0.2759***	0.0214	12.969	0.0000
ITP	-0.5708	0.7287	-0.784	0.4336
ROA	-3.8857***	0.2807	-13.849	0.0000
GRO	0.0076**	0.0036	2.262	0.0242
CUR	0.0021	0.0089	0.224	0.8234
AREA	0.1551	0.1053	1.475	0.1408
R^2	0.3328	Adjusted-R^2	0.3248	
F	41.36	P	0.0000	

Concentrate:*p<0.1, **p<0.05, ***p<0.01

As shown in the results of regression analysis in Table 4, the mean coefficient, standard error, T-value and P-value of explanatory and explained variables and control variables are described.

According to the results were analyzed by regression in Table 4 above, the coefficient of asset-liability ratio of explanatory variable is -0.4967 and is significant at 5% level, indicating that the higher the proportion of debt financing of listed companies in Beijing Stock Exchange will reduce the investment in R&D, and the two show a negative correlation. This result is consistent with the hypothesis made in the literature and verifies the hypothesis.

Other control variables were analyzed. First of all, the coefficient representing the company size is positive and significant at the level of 1%, indicating that larger companies tend to pay more attention to R&D investment, and they hope to obtain technological advantages through R&D to maintain the company's leading position in the field of segmentation. Secondly, contrary to common perception, the profitability of companies listed on the Beijing Stock Exchange is negatively correlated with R&D investment, which is significant at 1%. This can be explained to a certain extent that companies excessively chasing short-term profits may have to sacrifice R&D investment to obtain better financial statements, because R&D investment generally requires a large amount of capital but has a long period of return. Finally, GRO, a company's development capability indicator, has a positive effect on the company's R&D investment. This is because the explosive growth of the company's revenue often comes from the emergence of some popular products with strong market competitiveness, and the birth of such products is inseparable from the support of the company's innovation ability, so the company's R&D

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investment is correspondingly high.

5.4. Robustness test

In this paper, the explanatory variable is replaced from asset-liability ratio to total borrowing ratio (TL) to conduct robustness test. The TL can mainly reflect the company's situation on the liability side.

Table 5: Robustness test

Variable name	Coefficient	Standard error	T-value	P-value
C	12.4986***	0.4125	30.289	0.0000
TL	-1.4967***	0.5062	-2.978	0.0035
REV	0.2747***	0.0203	13.285	0.0000
ITP	-0.4289	0.7248	-0.594	0.5536
ROA	-3.8156***	0.2607	-14.659	0.0000
GRO	0.0086**	0.0035	2.483	0.0134
CUR	0.0051	0.0076	0.667	0.5037
AREA	0.1520	0.1050	1.433	0.1527
R^2	0.3378	Adjusted-R^2	0.3289	
F	42.26	P	0.0000	

As shown in the robustness test in Table 5, the mean coefficient, standard error, T-value and P-value of the explanatory variable and the explained variable as well as the control variable are described.

As can be seen from Table 5 above the results of robustness test, the symbols of the coefficients of the main variables do not change, and the values remain stable on the whole, indicating that the regression model obtained above is more in line with the reality. For the replacement explanatory variable, the value is at the level of 1%, the negative correlation between total borrowing and R&D investment is more obvious. A more reasonable explanation is that the liquidity level of total borrowings is generally lower than that of short-term borrowings but higher than that of total liabilities, while liabilities with strong liquidity will require the company to pay a greater price to obtain, and creditors will also be more stringent constraints on the company, which will inevitably lead to limited R&D investment of enterprises. Therefore, compared with the asset-liability ratio, the absolute value of the total borrowing ratio coefficient is larger and more significant, which accords with the theoretical hypothesis.

6. Conclusions and recommendations

6.1. Conclusion

Taking 162 companies listed on the Beijing Stock Exchange as the research object, this paper studies the impact of the capital structure of the companies listed on the Beijing Stock Exchange on their R&D investment under the registration system, and discusses whether the improvement of the capital structure of small, medium and micro innovative enterprises by the Beijing Stock Exchange can really help them increase their R&D investment. With the help of regression model, the following conclusions can be drawn:

For the companies listed on the Beijing Stock Exchange, the higher the proportion of debt in the capital structure, the more restrained their investment in research and development, showing an obvious negative correlation. For enterprises, lower debt financing and higher equity financing will greatly promote the enthusiasm of companies to invest in research and development.

The establishment of Beijing Stock Exchange is to provide a platform for small, medium and micro innovative companies to carry out equity financing. Its good operation will effectively increase the proportion of equity financing of enterprises, optimize the capital structure, and ultimately help enterprises to better invest in research and development, improve innovation ability, and grow into a real "specialized and new" small giant enterprise. According to the actual data, the proportion of debt financing of listed companies in Beijing Stock Exchange has decreased significantly after listing, which also verifies the objectivity and authenticity of the conclusions drawn in this paper.

6.2. Advice

The conclusion of this paper makes it clear that the capital structure of the companies listed on the

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Beijing Stock Exchange will have an impact on the innovation input, which provides a very important reference for the enterprises to be listed on the Beijing Stock Exchange in China. On the one hand, in order to achieve the listing goal, the company will continuously optimize its capital structure to meet the relevant listing requirements, indirectly promote its innovation and development, and realize the transformation of its financing structure. On the other hand, the transformation of the capital structure will also enhance the research and development capabilities of enterprises, thus improving the overall quality of the listed companies on the Beijing Stock Exchange, so that a group of specialized and special new "little giant" enterprises can stand out and become another important force for the growth of China's real economy. Therefore, based on the above research conclusions, this paper puts forward the following suggestions:

Small and medium-sized innovative enterprises should actively seek equity financing channels and optimize themselves. This requires that it must adhere to the main business, improve the scientific research team, and promote development with innovation. The soul of specialized and special new enterprises is innovation, to increase investment in research and development, and constantly improve the innovation ability and research and development level of enterprises, so as to enhance the growth of enterprises. In a number of "jammed neck" segments, enterprises should occupy an advantage in the market segment through fine production, management and service, accumulate experience for the transformation and upgrading of domestic related industries, and constantly forge expertise to achieve their own high growth, in order to better achieve the goal of listing on the Beijing Stock Exchange.

The government focused on technological innovation enterprises and supported their listing process on the Beijing Stock Exchange. In the face of small and medium-sized innovative enterprises, the government should actively encourage them to conduct direct financing, introduce special support policies, and set up special funds for innovative enterprises to integrate leading enterprises in the field as benchmarks, deepen the coordinated development of industry, university and research with the guidance of experts in the industry, provide listing guidance around the relevant listing process of Beijing Stock Exchange, and support the relevant approval process in the listing process of enterprises.

The capital market should further improve the multi-level capital market system. Under the background that the Science and Technology Innovation Board and GEM have implemented the registration system reform, the establishment of Beijing Stock Exchange will further optimize the adaptability of the registration system in China, make the equity financing channels more smooth, and promote the steady increase of the overall direct financing proportion. In the future, the capital market should further strengthen its support for small, medium and micro high-tech enterprises, strengthen the coordination function between the main board, Beijing Stock Exchange, science and technology board and other markets, and cover enterprises at all levels more comprehensively, so as to meet the financing convenience of enterprises in the whole life cycle of small, medium and micro high-tech zones. In addition, it is necessary to improve the top-level design of the capital market, consolidate the foundation of the basic system, and take the reform of the registration system as an opportunity to optimize the system of listing, investment and financing, delisting, and mergers and acquisitions. Finally, under reasonable supervision and governance, innovative enterprises can be promoted to enter the direct financing market, and capital can effectively help scientific and technological innovation.

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