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The Impact of Financing Structure on Enterprise Innovation — An Empirical Study Based on China's A-share listed Companies

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Abstract: Based on the financial data of A-share listed companies from 2016 to 2020, this paper empirically tests the impact of financing structure on enterprise innovation. The results show that different from the existing research: (1) internal financing has a positive effect on enterprise innovation, that is, it will promote enterprise innovation; (2) External financing has a negative effect on enterprise innovation, that is, it will inhibit enterprise innovation; (3) The inhibitory effect of external financing on enterprise innovation mainly comes from equity financing. In addition, there are some differences in the impact of financing structure on the innovation investment of state-owned enterprises, information technology enterprises and other enterprises. Based on the above theoretical and empirical analysis, this paper provides some suggestions for enterprises to promote enterprise innovation and carry out reasonable financing strategies.

1. Introduction

Based on the current level of China's economic development and enterprise development, it is known that innovation plays a key role in it. Innovation is an inevitable requirement to promote economic leapfrog development and an inevitable choice to advance the progress of enterprises. An enterprise or a country must rely on innovation if it wants to develop continuously. The innovation of an enterprise requires sufficient financial guarantee, and the way to raise funds is particularly important[1]. Enterprises are mainly financed internally through internal funds such as surplus and undistributed profits, and externally through equity and bond financing. The impact of different funding channels on the innovation development of enterprises varies greatly. In this paper, we study the impact of financing structure on corporate innovation for A-share listed companies to contribute to the development of corporate innovation[2].

2. Review of the Literature

Hall (1992) pioneered the study of the relationship between corporate finance and innovation

investment, which caused a strong reaction in academic circles, and since then, the topic of corporate finance structure and innovation investment has been widely studied by later generations.

Hall (2002) analyzed the difference between internal and external financing based on information asymmetry and argued that firms would prefer internal financing to fund innovation investment; Qingquan Tang and Xin Xu (2010) analyzed the difference between internal and debt financing in the context of innovation investment characteristics and argued that firms tend to use internal financing; the empirical analysis of Caijiang Zhang and Lu Chen (2016) showed that internal financing is highly favored by innovative firms[3].

However, some scholars have also reached inconsistent conclusions. Li Huidong et al. (2013) take Chinese listed companies during 2006-2010 as an example and conclude that external financing has a greater impact on innovation investment than internal financing; Wang Jun (2019) empirically analyzes GEM listed companies and concludes that there are significant industry differences in the financing structure of R&D investment[4].

Synthesizing the above literature, scholars at home and abroad have made extensive research in the field of the impact of financing structure on corporate innovation investment, but there are still the following shortcomings: (1) the research objects are too broad. Most of the literature chooses to take the whole listed company as the research object, which is easy to ignore the industry nature resulting in inaccurate results. (2) The research findings are too single. Most of the literature believes that the inhibitory effect of debt financing on enterprise innovation is more obvious due to the higher financing cost of debt financing, which increases the financial risk of enterprises, but debt financing has tax shield effect according to MM theorem[5].

3. Research Hypothesis

3.1. Corporate Financing Structure and Innovation Investment

Internal financing refers to the use of surplus reserves and undistributed profits, etc. for financing, which does not require the payment of related expenses and can be freely accessed by firms at any time. Myers and Majluf (1984) proposed the theory of preferential financing, in which internal financing is relatively low cost and easily becomes the first choice of financing for firms.Brown and Petersen (2009) pointed out that firms usually prioritize internal financing to reduce the business risk as well as bankruptcy risk of the firm and promote the incentive of innovation to a certain extent. Zhang and Li (2019) empirically analyzed that internal financing has a significant positive promotion effect on firms' innovation investment[6]. And in the external environment full of fierce competition, corporate innovation is a commercial secret, which is relied on by enterprises to gain more market share. In order to reduce the risk of leakage, reduce losses, and appropriately curtail the costs in the innovation process, enterprises prefer to raise funds through internal financing. As a result, the theoretical hypothesis H1 is proposed[7].

H1: Internal financing will have an incentive effect on corporate innovation.

External financing refers to enterprises raising funds from other economic agents outside the enterprise in certain ways, mainly including: bank loans, issuing stocks, and corporate bonds. hall (2002) analyzed the difference between internal and external financing based on information asymmetry, and concluded that enterprises would prefer internal financing to finance innovation investment; Chen Mengtao (2020) used the period 2007-2018 Chinese listed companies as an example, and concluded that external financing would inhibit the growth of corporate innovation. As a result, the theoretical hypothesis H2 is proposed[8].

H2: External financing can have a dampening effect on firm innovation.

The main external financing sources can be divided into equity financing and debt financing. Equity financing can cause separation of control to a certain extent, which affects the business

strategy and management policy of the firm and may have a crowding-out effect on the firm's current innovation investment.Franco Modigliani and Mertor Miller (1963) proposed a modified MM theory, in which the value of a debtor firm exceeds the value of a debt-free firm after considering the tax shield effect[9]. As a result, the theoretical hypothesis H3 is proposed.

H3: Equity financing brings a stronger disincentive than debt financing.

3.2. Heterogeneity Analysis

Existing relevant studies have argued that firm heterogeneity, such as firm type and firm receipt of government subsidies, can change the impact of financing structure on firm innovation (Bhattacharya et al.,2014; Atanassov et al.,2015; Kim et al.,2008; Meng Qingbin and Shi Qian , 2017). Drawing on the existing literature, this paper mainly considers the influence of heterogeneity from the perspective of enterprise industry, and believes that companies in different industry types have different responses to the financing structure[10].

According to the industry classification criteria of the SEC, we classify enterprises into information technology enterprises and other enterprises. Due to the industry characteristics of information technology firms, they require a large amount of capital for research and innovation, or more than ten times that of other firms, and have a long R&D cycle. Therefore, information technology firms are less affected by the financing structure. As a result, the theoretical hypothesis H4-2 is proposed.

H4: The degree of impact of changes in financing structure on R&D innovation differs between high-tech firms and other firms.

4. Econometric Model Setting and Variable Description

4.1. Model Setup

To test the previous hypotheses H1 to H3, the following econometric models are constructed in this paper, respectively.

$$R\&D_{i,t}=c_{1\,i,t}+\alpha_1 infund_{i,t}+\alpha_2 outfund_{i,t}+\sum_1^j \beta_i controls_{i,t}+\varepsilon_{1i} \quad (1)$$

$$R\&D_{i,t}=c_{2\,i,t}+\alpha_3 Ldebt_{i,t}+\alpha_4 equity_{i,t}+\sum_1^j \beta_i controls_{i,t}+\varepsilon_{2i} \quad (2)$$

Where R&D denotes the proportion of R&D investment of the company, infund denotes the proportion of internal financing, outfund denotes the proportion of external financing, controls denotes the control variables in the model, mainly ROA, asset size, leverage level, current ratio, government subsidies, etc.; c_{1i} and ε_{1i} denote the constant and residual terms in the regression, respectively. In testing hypotheses H1 to H3, if the above hypotheses hold, the estimates of α_1 and α_2 should be significant in the empirical results, and the coefficients should be positive and negative, respectively.

Regarding the heterogeneity test, i.e., to test the research hypotheses H4-1 and H4-2, the experimental results are analyzed by comparative subsample regression, and the research model is similar to model (1) and model (2), and the existence of heterogeneity is analyzed by comparative subsample empirical results obtained according to the categorical variables.

4.2. Variable Description

The relevant variables involved in the model setting are defined or explained as follows.

1) Core variables

In this paper, the R&D investment ratio of enterprises is chosen to measure the degree of innovation of enterprises, i.e., the ratio of enterprise R&D investment expenses to sales revenue as a proxy variable for enterprise R&D. In the selection of variables of financing structure, this paper refers to the criteria of domestic and foreign scholars' classification of different channels of enterprise financing (Huidong Li et al., 2013; Brown etal., 2009; Cleary et al., 2007), and evaluates the composition of enterprise financing structure in two dimensions. First, internal financing and external financing are divided and expressed as the ratio of net cash flow from operating activities to total assets (Infund) and net cash flow from financing activities to total assets (Outfund), respectively. Further, the shares from different sources are distinguished in external financing, and the main channels of external financing are currently debt financing and equity financing. In this paper, we measure debt financing and equity financing by the ratio of long-term borrowing to total assets (Ldebt) and the ratio of change in equity to total assets (Equity) of the firm, respectively[11].

2) Categorical variables

In the heterogeneity analysis, we need to divide the types of firms for sub-sample regressions. The main categorical variables selected in this paper are firm ownership and firm industry. The corporate ownership (Noe) classification refers to the classification of the study population into state-owned enterprises and non-state-owned enterprises according to the corporate ownership published in the CSMAR database, with state-owned enterprises taking the value of 1 and non-state-owned enterprises taking the value of 0. The corporate industry (Hnc) classification refers to the classification of the study sample into information technology enterprises and other enterprises according to the industry classification of the SEC, with information technology enterprises taking the value of 1 and other enterprises The value is 1 for information technology enterprises and 0 for other enterprises[12].

3) Control variables

Referring to relevant studies by domestic and foreign scholars (Wang, Yizhong and Song, Min, 2014; Hall et al., 2016; Atanassov et al.,2015; Li, Huidong et al.,2013), we control for relevant variables that affect firms' innovation, investment and financing behavior. In this paper, we mainly selected firm asset size, duration, ROA, leverage level, current ratio, and government subsidies as control variables. In addition, year dummy variables and industry dummy variables are also used for control in this paper. The descriptions and explanations of the main variables in this paper are shown in Table 1.

Table 1. Variable definitions

Variable Type	Variable Symbols	Variable Name	Variable Definition
return to the Yuan	RD	Corporate Innovation R&D	The proportion of enterprise R&D investment cost to main business income
Explanatory variables	Infund	In-house financing	Net cash flow from operating activities as a percentage of total assets
	Outfund	Corporate external financing	Net cash flow from financing activities as a percentage of total assets
	Equity	Corporate Equity Financing	Change in equity as a percentage of total assets, (△Equity + △Capital surplus)/Total assets
	Ldebt	Corporate bond financing	Long-term corporate borrowings as a percentage of total assets
Categorical variables	Noe	Corporate Ownership	Categorical variables, classified according to Wind database, state-owned enterprises take the value of 1, non-state-owned enterprises take the value of 0
	Hnc	Information Technology Enterprise	Classification variable, according to the SEC industry classification, information technology enterprises take the value of 1, other enterprises take the value of 0

Control variables	ROA	Return on Assets	Measuring the efficiency of asset utilization, the enterprise's net profit for the period / average total assets for the period
	Lev	Leverage Level	Total corporate liabilities / total corporate assets
	Size	Asset Size	Natural logarithm of the total assets of the enterprise for the period
	Age	Duration of existence	Duration of the enterprise since its listing to date
	Subsidy	Government Grants	Natural logarithmic value of various forms of government subsidies in the current period
	Lr	Current Ratio	Measure the short-term debt servicing and liquidity of the company, current assets/current liabilities
	Year	Year	Fixed-effects control variables with a time sample of 2016-2020
	Indus	Industry	Fixed-effects control variables that classify industries into 12 categories according to the SEC's 2012 filing

5. Data sources and Descriptive Statistics

5.1. Data Sources

In this paper, in order to study the relationship between corporate financing structure and innovation investment, all listed companies in Shanghai and Shenzhen in China's A-share market are used as research objects, and the proportion of corporate R&D investment is used as a proxy variable for corporate innovation, and the research interval is 2016-2020. To ensure data availability and accuracy, all listed companies are screened in this paper, and financial companies, ST companies, and *ST companies in A-share are excluded, and the total number of research samples is 21950, among which 21,632 are valid samples of R&D. The data sources of company-level variables such as ROA, R&D investment, asset size, quick ratio, etc. are Wind database[13].

5.2. Descriptive Statistics

The mathematical and statistical results of the main variables are shown in Table 2. From Table 2, we find that there is a large gap between the most values of the variables, which means that there is a large gap between different companies; some of the variables are missing due to external reasons such as the time of listing and different degrees of information disclosure of each company, resulting in a final valid sample of less than 21950 items.

Table 2. Descriptive statistics

	(1)	(2)	(3)	(4)	(5)
Variables	Number of samples	Average value	Standard error	Minimum value	Maximum value
RD	21,632	-0.815	84.56	-10,696	1,605
Infund	21,682	0.0633	0.0896	-1.686	2.222
Outfund	21,682	0.0264	0.135	-2.935	2.968
Equity	21,682	0.0413	0.136	-2.149	4.804
Ldebt	21,682	0.0351	0.0689	0	0.846
age	21,950	20.19	6.309	2	65
Size	21,682	21.83	1.499	17.07	28.64
Lev	21,665	41.18	23.74	0.836	1,879
ROA	21,665	7.966	12.32	-744.6	489.1
Lr	21,665	2.551	2.798	0.0278	80.66
Indus	21,950	13.04	4.016	1	18
subsidy	20,853	16.14	1.584	2.536	22.88
Noe	21,950	0.232	0.422	0	1
Hnc	21,950	0.0961	0.295	0	1

6. Empirical Results

The empirical analysis in this paper uses a panel fixed effects model, which has been tested for multicollinearity, within-group correlation, and heteroskedasticity, and is not repeated here due to space limitations in the text[14].

The empirical results on whether a firm's financing structure affects its level of innovative R&D investment are shown in Table 3, where Regression 1 examines the impact of internal and external financing on corporate innovation and Regression 2 examines the impact of different channels of external financing on corporate innovation. According to the regression results we can find that there is a significant positive effect of internal financing on corporate innovation and a significant negative effect of external financing on corporate innovation investment; this empirical result is consistent with our previous hypotheses H1 to H2.

Further, we investigate the impact of different sources of funding on firms' R&D investment in external financing. From the results of regression 3 and regression 4, we can conclude that the inhibitory effect of external financing on firm innovation mainly originates from equity financing (with an impact coefficient of -6.108 for equity financing and -0.921 for bond financing, the impact of equity financing on firm innovation is significant, while the impact of bond financing on firm innovation is not significant)[15]. A possible explanation for this phenomenon is that equity financing causes separation of control to some extent, which affects firms' business strategies and operating policies, and may have a crowding-out effect on firms' current innovation investment. Bond financing, on the other hand, has a tax shield effect, thus increasing firm value and promoting corporate innovation.

Table 3. Relationship between financing structure and firm innovation

	Return(1)	Return(2)
Variables	RD	RD
Infund	0.260***	
	(3.05)	
Outfund	-0.257***	
	(-5.13)	
Equity		-6.108***
		(-12.85)
Ldebt		-0.921
		(-0.85)
Age	0.295***	0.211**
	(2.86)	(2.06)
Size	2.571***	2.571***
	(4.00)	(3.92)
Lev	0.051	0.039
	(1.25)	(0.93)
ROA	1.355***	1.247***
	(21.24)	(22.31)
Lr	-1.063***	-0.716***
	(-4.06)	(-2.75)
Subsidy	-0.798	-0.861
	(-1.52)	(-1.64)
Constant	-57.703***	-53.858***
	(-4.92)	(-4.51)
Time Effect	Yes	Yes
Industry Effects	Yes	Yes
Sample size	20,841	20,841
R2	0.028	0.035

7. Endogeneity Issues

In this paper, we find a close relationship between financing structure and firms' innovation investment, but the empirical results may lead to endogeneity problems due to interactions between variables and omission of variables. Therefore, this paper eliminates the effect of endogeneity by using explanatory variables and control variables (except for fixed-effect variables such as year and industry) treated with a one-period lag. The results of regression (3) and regression (4) show that there is no significant change in the regression results for each of the main variables, as shown in Table 4.

Table 4. Endogeneity test results

	Return(3)	Return(4)
Variables	RD	RD
Infund	0.266**	
	(2.57)	
Outfund	-0.343***	
	(-5.54)	
Equity		-9.158***
		(-15.40)
Ldebt		-1.277
		(-0.98)
Age	0.329***	0.197
	(2.67)	(1.61)
Size	2.924***	2.927***
	(3.73)	(3.67)
Lev	0.084*	0.073
	(1.72)	(1.43)
ROA	1.565***	1.455***
	(21.16)	(22.66)
Lr	-1.086***	-0.472
	(-3.44)	(-1.50)
Subsidy	-0.930	-0.990
	(-1.45)	(-1.55)
Constant	-68.048***	-62.296***
	(-4.77)	(-4.30)
Time Effect	Yes	Yes
Industry Effect	Yes	Yes
Sample size	17,093	17,093
R2	0.035	0.047

8. Heterogeneity Analysis

This part classifies according to industry characteristics, that is, groups regression according to classification variables, to study whether different companies are affected by different degrees of enterprise innovation when facing changes in financing structure.

Listed companies are classified into information technology firms and other firms according to the industry classification of the SEC, and the results of the sub-sample regressions are shown in Table 5. From the results of regression (9) to regression (12), we can find that compared with other enterprises, information technology enterprises are less affected by the level of internal financing and external financing and there is a significant difference between information technology enterprises and other enterprises in terms of external financing, and information technology enterprises are significant for both equity financing and bond financing, which indicates that the

previous hypothesis H4 is more reasonable. The possible reason for this situation is that information technology firms need a lot of investment in research and innovation, and the R&D cycle is long and the R&D expenditure is more stable, so the level of internal financing and external financing has less influence on the innovation investment of firms. In addition, government subsidies have a significant and facilitating effect on innovation investment of IT firms compared with other firms.

Table 5. Financing structure and innovation heterogeneity - nature of industry

Dependent variable RD	Return (9) Information Technology Enterprise	Return (10) Other companies	Return (11) Information Technology Enterprise	Return (12) Other companies
Infund	0.020***	0.331***		
	(5.02)	(3.54)		
Outfund	-0.014***	-0.297***		
	(-6.20)	(-5.33)		
Equity			-0.012***	-7.108***
			(-5.84)	(-13.30)
Ldebt			-0.027***	-0.919
			(-2.84)	(-0.80)
Age	-0.003***	0.303***	-0.003***	0.227**
	(-4.64)	(2.75)	(-5.18)	(2.06)
Size	-0.021***	2.148***	-0.018***	2.523***
	(-5.93)	(3.39)	(-5.06)	(3.52)
Lev	-0.000	0.038	-0.000	0.041
	(-1.40)	(0.90)	(-0.04)	(0.88)
ROA	-0.003***	1.508***	-0.002***	1.382***
	(-9.92)	(21.43)	(-8.59)	(22.45)
Lr	0.006***	-1.252***	0.007***	-0.845***
	(4.85)	(-4.35)	(5.55)	(-2.92)
Subsidy	0.018***	-0.431	0.018***	-0.836
	(6.46)	(-0.81)	(6.44)	(-1.45)
Constant	0.326***	-54.214***	0.269***	-53.796***
	(5.62)	(-5.17)	(4.58)	(-4.16)
Time Effect	Yes	Yes	Yes	Yes
Industry Effect	No	Yes	No	Yes
Sample size	1,761	19,080	1,761	19,080
R2	0.138	0.031	0.134	0.039

9. Conclusion and Policy Recommendations

This paper uses the financial data of A-share listed companies in China from 2016 to 2020 to study the relationship between enterprise financing structure and innovation investment, and then studies the heterogeneity between state-owned enterprises and non-state-owned enterprises, information technology enterprises and other enterprises.

The empirical results of this paper show that: (1) Internal financing will have an incentive effect on enterprise innovation. (2) External financing will have a restraining effect on enterprise innovation. (3) The restraining effect of equity financing is stronger than that of debt financing. (4) The R&D investment of state-owned enterprises and non-state-owned enterprises, information technology enterprises and other enterprises is affected by the financing structure. In view of the above research conclusions, we can get several policy recommendations.

First, enterprises should constantly improve their profitability, increase retained earnings and enable them to carry out internal financing. Internal financing reduces agency problems and risk

transfer risks, which is conducive to the benign development of enterprises.

Second, the government should actively solve the problem of difficult and expensive enterprise financing and promote the facilitation of enterprise debt financing. This will enable more enterprises to raise funds in the form of bank loans, increase the proportion of corporate debt financing, and give play to the tax shield effect of debt financing, so as to reduce financing costs, increase enterprise value, and further promote technological innovation of enterprises.

Third, the response of different enterprises to the financing structure is heterogeneous. Enterprises should make different and reasonable financing decisions according to different ownership and industries. The government should "suit the remedy to the case" and avoid "flooding", "one size fits all" and other behaviors. It should formulate different economic policies for non-state-owned enterprises, information technology enterprises, etc.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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