

Does financing constraints affect firms' R&D?

—Evidence from Chinese listed firms

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ABSTRACT. *R&D investments of enterprises require long-term and sustained support of large amounts of capital. So the access to external financing resources is a key factor affecting R&D investments. This paper discusses the theoretical mechanism of the impact of financial constraints on R&D expenses. Then the panel data of 2095 A-share listed companies in China from 2012 to 2017 is used as a sample for empirical test of the impact of financial constraints on R&D based on the fixed-effect model. The results show that financing constraints have an inhibitory effect on R&D investments of enterprises. Additionally, for non-state-owned enterprises, the impact of financing constraints on R&D expenses is very significant while the impact of financial constraints is not obvious for state-owned enterprises.*

KEYWORDS: *Financial constraints; Firm R&D; Innovation*

1. Introduction

Research and development (R&D) is a series of activities which formulate the innovativeness during developing new products or services or improving existing products and services. A large amount of inflows are required in R&D; however, results of this investment maybe fail to live up to corporates' expectations. Although R&D investment is risky, it is of vital importance for the development of corporates since the lack of R&D could lead to the expelling by the market. Therefore, corporates are likely to choose financing to acquire adequate cash flows for R&D investment. That's why financial constraint becomes a critical question. A firm facing financial constraints will not have the access to further R&D. Financial constraints could be the consequences of insufficient retained earnings, poor credit performance, unfavorable government policies, and recessionary financial market. In this paper, we explore the relation between financial constraints and R&D investment for Chinese listing companies for the period 2012-2017.

The study of this relation between financial constraints and R&D investment is of significance in China. Companies are the core elements of the national innovation system. Increasing the innovation ability of companies can fundamentally improve the competitiveness at the national level. Improvement of the innovative capability

of Chinese companies requires continuous investment in R&D. For corporates, the development depends on R&D investment. Improvement on products and services can help corporates enter the market and occupy the market share quickly, through which profits can be increased and then reinvested in R&D. In this way, corporates can achieve sustainable development. However, financial constraints set inhibition for R&D investment. The lack of cash flows could result in inadequate R&D investment because of low profits and borrowing barriers. Therefore, it is important to understand the relation between financial constraints and R&D investment.

The dataset we used was from the iFinD Data Center, and the sample covered the six-year data of 2095 Chinese listed companies after screening for 2012-2017. We have eliminated companies with missing data on total R&D expenses for six years.

We use SA index to measure financial constraints faced by companies. Multiple controlling variables are used to estimate the impacts of financial constraints on R&D investment. After applying a Fixed Effects model, we find out the adverse effects of financial constraints on a firm's R&D investment. We also analyze this issue under different types of ownership.

The paper is organized as follows. The second section provides hypotheses with basic literature review. Section 3 conducts econometric analysis with model and data description as well as results and robust test. Section 4 concludes and implies the paper.

2. Literature Review

Many scholars have conducted various research about the impact of corporate financing constraints on R&D. Fazzari (1988)[1] pointed out that the significant difference between internal and external financing costs leads to the dependence of corporate investments on internal cash flows. Himmelberg and Petersen (1994)[2] found that although internal funds are the main source of R&D funds, innovative companies cannot rely solely on endogenous financing. External financing is also important to reduce the risk of R&D investments. According to Claessens and Laeven (2003)[3], the higher the financial development level of a country, the faster the development of enterprises that rely more on external financing, which proves that financial development has significantly mitigated financing constraints. Hall and Lerner (2010)[4] stated that due to the uncertainty of income caused by its inherent high risk and the existence of adverse selection and moral hazard, it is difficult for enterprises to obtain effective financial support through external channels for R&D investments.

A few essential factors being taken into consideration for the research of the relationship between financial constraints and R&D investment, we propose two hypotheses.

Hypothesis 1. Financial constraints have a significantly negative effect on R&D investments.

Previous research showed the adverse relationship between financial constraints

and R&D investment in developed countries (Amore et al., 2013[5]; Nanda and Nicholas, 2014[6]). In recent years, several papers have begun to study companies in China that demonstrate the adverse impacts of financial constraints on R&D investment (Guariglia & Liu, 2014[7]; Howell, 2016[8]; Zhang et al., 2019[9]). However, some of them lack updated data of Chinese listed companies so that the current influence of financial constraints cannot be reflected.

Hypothesis 2. The impacts of financial constraints on R&D investment are larger and more significant for non-state-owned enterprises (private-owned enterprises & foreign-owned enterprises) than for state-owned enterprises.

Companies with different types of ownership face different levels of financial constraints. A financing bias exists in China for a long time. It is found that SOEs are less financially constrained (Héricourt & Poncet, 2009[10]; Poncet et al., 2010[11]; Chen & Guariglia, 2013[12]). Allen et al. (2005)[13] discovered that POEs suffer from huge pressure caused by heavy financial constraints. FOEs are less financially constrained compared to POEs (Héricourt & Poncet, 2009; Poncet et al., 2010) since their homeland can provide them with financial supports (Zhang & Liu, 2017).

3. Econometric analysis

3.1 Model

We apply a Fixed Effects model to find out the impacts of financial constraints on a firm's R&D investment. The regression equation of investment in R&D is as follows:

$$R \& D = \beta_0 + \beta_1 SA + \beta_2 ROE + \beta_3 Capex + \beta_4 ROA + \beta_5 Top + \beta_6 Debtstr + \beta_7 Growth + \beta_8 Lev + \beta_9 Oper + \beta_{10} Tobins'Q + \varepsilon_i$$

In our regression, we select a widely used indicator of R&D investment: R&D expenditure scaled by total assets.

The first independent variable, SA, represents financial constraints. The calculating function of it is expressed as following:

$$SA = -0.737 * Size + 0.043 * Size^2 - 0.040 * Age$$

Size is the log of inflation adjusted to book assets, which equals $\ln(\text{assets}/1000000)$. Age is the number of years from the year that the firm has been established to January 1st, 2019.

The measurements of financial constraints are divided into univariate and multivariate indicators. There are three well-known indexes of multi-variables: KZ, WW and SA index. Compared with KZ and WW, SA index consists of completely exogenous size and age variables, so the measurement bias can be avoided. Additionally, the calculation of SA index is simple. The SA index is negative and the larger the absolute value is, the more serious the financing constraint faced by the

company is.

In the regression equation, ROE (return on equity) is the ratio of net profits of the parent company to total equity; Capex (capital expenditure) is cash spent on purchasing fixed assets and intangible assets scaled by total assets; ROA (return on asset) is the ratio of net profits of the parent company to average net assets; Top is the total shareholding ratio of the top ten outstanding shares owners; Debtstr (debt structure) is current liabilities divided by total liabilities; Growth is the year-on-year sales growth rate; Lev (leverage) is the percentage ratio of total liabilities to total assets; Oper (operation) is the current operating revenue scaled by year-end total assets; Tobin's Q is the market value of firm divided by replacement costs, which measures return on investments.

3.2 Data description

The dataset we used was from the iFinD Data Center, and the sample covered the six-year data of 2095 Chinese listed companies after screening for 2012-2017. We have eliminated companies with missing data on total R&D expenses for six years.

Table 1 Basic description of variables

Variable	Mean	S.D.	Min	Max	Definition
R&D	0.0228	0.0218	0	0.4179	R&D expenditure scaled by total assets
SA	3.8831	0.2398	1.4673	5.5620	Financial constraints index
ROE	5.5436	175.0865	-19098.3200	871.5032	the ratio of net profits of the parent company to total equity
Capex	0.2662	0.1585	0	0.8820	cash spent on purchasing fixed assets and intangible assets scaled by total assets
ROA	5.0724	7.4747	-137.5046	119.2770	the ratio of net profits of the parent company to average net assets
Top	31.5782	22.5944	0	101.1714	the total shareholding ratio of the top ten outstanding shares owners
Debtstr	0.8429	0.1615	0	1.1608	current liabilities divided by total liabilities
Growth	0.1648	0.5147	-0.8718	23.9984	the year-on-year sales growth rate
Lev	0.4042	0.2066	0.0079	2.5785	the percentage ratio of total liabilities to total assets
Oper	0.6354	0.4507	0.0035	11.4156	the current operating revenue scaled by year-end total assets
Tobin's Q	19.9210	107.3913	0	9377.0290	the market value of firm divided by replacement costs

ROE (return on equity): also known as the equity net interest rate. $ROE = \text{net profit attributable to shareholders of the parent company} / [(\text{equity attributable to shareholders of the parent company at the beginning of the period} + \text{equity attributable to shareholders of the parent company at the end of the period})/2] * 100\%$

Capex (capital expenditure): CapEx is defined as money spent on activities conducted by a company to purchase, upgrade and maintain fixed assets and intangible assets such as property, equipment, patents and licenses. Supporting new projects or investments often requires Capex. This kind of financial outflow also can help companies increase their operation scope.

ROA (Return on Asset): This variable reflects the level of profit earned by the company using all assets, that is, the average amount of profit that the company can earn for every dollar spent on assets. $ROA = \text{net profit} \times 2 / (\text{initial total assets} + \text{total assets at the end of the period}) * 100\%$

Top (the total shareholding ratio of the top ten outstanding shares owners): This percentage implies the degree of control and strength of power of major shareholders.

Debtstr (debt structure): This indicator reflects the extent to which a company relies on short-term creditors. The higher the ratio, the stronger the company's dependence on short-term funds. It can present how soon the firm must settle debts and whether it has enough money to get out of debts.

Growth (the year-on-year sales growth rate): $SGR = (\text{current sales income} - \text{previous sales income}) / \text{previous sales income}$

Lev (leverage): The leverage is the ratio of total liabilities to total assets, indicating how much of the total assets are financed by borrowing. This indicator is a comprehensive indicator for assessing the company's debt level. $Lev = \text{total liabilities} / \text{total assets} * 100\%$

Oper (operation): $Oper = \text{current operating income} / \text{total assets at the end of the year}$

Tobin's Q: It measures returns on investment. The function of Tobin's Q is to identify the impact of future profit opportunities on investment to distinguish it from the investment changes caused by changes in cash flow. $Tobin's Q = \text{company market value} / \text{company replacement cost}$ (replacement cost = book value of fixed assets + book value of intangible assets)

3.3 Regression results and analysis

Table 2 Regression results

Explanatory Variable	Coefficient			t-statistics		
	(1)	(2)	(3)	(4)	(5)	(6)
SA	-0.0441 (0.0018)	-0.0017 (0.0033)	-0.0504 (0.0021)	-25.34	-0.51	-24.31
ROE	-7.74e-07 (4.97e-07)	-9.98e-06 (4.89e-06)	-5.71e-07 (5.40e-07)	-1.56	-2.02	-1.06
Capex	0.0049 (0.0012)	0.0078 (0.0017)	0.0019 (0.0015)	4.11	4.60	1.25
ROA	3.27e-05 (1.66e-05)	5.34e-05 (3.44e-05)	2.16e-05 (1.97e-05)	1.97	1.56	1.10
Top	3.92e-06 (6.70e-06)	9.23e-06 (9.39e-06)	1.48e-05 (8.07e-06)	0.59	0.98	1.84
Debtstr	0.0020 (0.0008)	0.0034 (0.0013)	0.0015 (0.0011)	2.31	2.62	1.41
Growth	-0.0007 (0.0002)	-0.0016 (0.0005)	-0.0007 (0.0002)	-4.44	-3.45	-3.33
Lev	-0.0014 (0.0009)	-0.0053 (0.0015)	-0.0002 (0.0011)	-1.55	-3.66	-0.19
Oper	0.0114 (0.0005)	0.0071 (0.0006)	0.0121 (0.0006)	24.64	11.00	20.77
Tobin's Q	-3.14e-06 (8.84e-07)	-1.27e-05 (9.18e-06)	-2.96e-06 (9.55e-07)	-3.55	-1.39	-3.10
Observations	12570	3792	8778			
R-squared	0.1620	0.0554	0.1941			

Column (1) of Table 2 shows the overall regression results of these 2095 firms, with the relative R&D expenditure as the explained variable, SA as the main control variable, and the other nine indicators as other explanatory variables. Column (4) shows the t statistic for the different variables in the overall regression.

In general, the R&D investments of enterprises are negatively related to the financing constraints faced by enterprises measured by the SA indicator. This means that financing constraints have an inhibitory effect on R&D, and the impact is very significant. The more serious the financing constraint faced by a company is, the lower R&D investment of this firm is. This result verifies the Hypothesis 1 of this paper. The regression results of other control variables in this econometric model are basically consistent with conclusions of existing literature. Considering that this paper mainly focuses on the internal relationship between financing constraints and R&D investment of firms, the regression results of other variables will not be explained in this paper.

In addition, column (3) and (4) of Table 2 show the regression results of sub-samples of state-owned enterprises (SOEs) and non-state-owned enterprises (POEs & FOEs) respectively. By comparing the results, a significantly negative correlation between R&D expenditures and financial constraints can be seen from the samples

of non-state-owned enterprises even at the significant level of 1%. However, this kind of negative correlation cannot be observed from the regression results of state-owned enterprises. This shows that the financial constraints faced by non-state-owned enterprises have a significant inhibitory effect on the companies' R&D expenditure, while the state-owned enterprises' financing constraints and their R&D investments have no obvious correlation. Hypothesis 2 of this paper has also been well verified.

The interpretation of this result is that China's special institutional background leads to the close relationship between the type of corporate ownership and financial constraints. Due to various interests relationships between the government and state-owned enterprises, the government uses its dominant position in allocating lending resources especially policy loans and government financial subsidies to favor state-owned enterprises in a biased manner for the purpose of helping them ease the financing constraints of their R&D investment, motivated by parentalism (Kornai et al., 2003)[13] or political asylum (Shleifer and Vishny, 1994)[14]. Therefore, the financial constraints faced by state-owned enterprises have little impact on their R&D investments.

4. Conclusion and suggestions

Based on the panel data of 2095 Chinese A-share listed companies from 2012 to 2017, this paper analyzes the impact of financing constraints on corporate R&D investment expenses through theoretical analysis and empirical analysis. The conclusions are as follows: First, there is a clear negative correlation between the financing constraints faced by enterprises and R&D investments. Second, the financial constraints faced by enterprises of various ownership types have different impacts on R&D. The financing constraints of non-state-owned enterprises have obvious restrictive effects on R&D expenses, while the negative correlation is not obvious for state-owned enterprises due to the help of governments.

In order to make firms become the main part of independent innovation, guide them to engage in R&D innovation and increase the intensity of R&D investments, the suggestions are given. Firstly, the mode of large-scale SOEs leading R&D investment should be changed, and small and medium-sized private enterprises should be encouraged to engage in innovation. Moreover, the government is supposed to improve financing environment, broaden financing channels and establish a financing system that suits different firms in order to guide more capital to flow into R&D investments and provide a financial guarantee for China's technological innovation. Additionally, a good financing platform should be built, and more financing channels and financial instruments should be provided for enterprises.

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