Research Investment, Financing Constraints, and Enterprise Competitiveness——An Empirical Research Based on High-tech Listed Companies in China

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Abstract. There is a strong driving force for high-tech enterprises in China to improve their competitiveness of enterprises for moving toward the middle and high end of the global value chain. Because of the high-risk characteristics in the initial stage, they have faced considerable investments in scientific research and severe financing constraints in China compared with western countries. Four thousand ninety-eight balanced panel data from 2016 to 2021 is constructed to conduct empirical research on financing constraints, research investment, and enterprise competitiveness. The TOPSIS method is used to calculate enterprise competitiveness. The panel fixed effect model is adopted to test the intermediary effect of research investment in the mechanism of financing constraints affecting enterprise competitiveness by the soft STATA 15. We have found that financing constraints not only impair enterprises' competitiveness but also significantly reduce research investment at the level of 1%. Furthermore, scientific research expenditure has an intermediary effect, accounting for 1.13% of the financing constraints affecting enterprises' competitiveness. Therefore, financing constraints have directly impacted the enterprises' competitiveness and indirectly affected it through investment in scientific research at the same time. Our empirical conclusions have enriched the research on the financing constraints for enterprise competitiveness and have provided empirical evidence. On the other hand, Our analysis has offered a corresponding empirical basis for the reform to alleviate the financing pressure on high-tech enterprises in China to enhance R&D investment and improve their competitiveness.

Keywords: high-tech enterprises, enterprise competitiveness, financing constraints, research investment

1 Introduction

With the continuous improvement of the competitive position of high-tech enterprises in China, the investment in scientific research of enterprises has also strengthened to gain the advantage of technological innovation and maintain the core competitive advantage of enterprises. On the other hand, compared with the western capital market, the direct financing environment of high-tech enterprises in China is relatively complex and challenging. So, the high-tech enterprises in the initial stage with high risks and significant investment face a large financing constraint environment. Furthermore, the pressure of financing constraints will restrict enterprises' growth, making enterprises meet more significant restrictions in scientific research investment, which is

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not conducive to high-tech enterprises. Some scholars have done a lot of research on financing constraints, mainly focusing on financing constraints restricting enterprises' scientific and technological innovation, performance, and growth. Few scholars have included scientific research expenditure in the relationship between financing constraints and enterprise competitiveness and studied the role of scientific research expenditure in the mechanism of financing constraints affecting enterprise competitiveness. Therefore, the focus of this paper is to check whether there is an intermediary effect of scientific research investment in the mechanism of financing constraints affecting the competitiveness of enterprises. The fixed effect model of panel data is used to test the relationship among financing constraints, scientific research investment, and enterprise competitiveness. Finally, the corresponding conclusions and suggestions are given to summarize the research results.

2 Literature Review and Hypothesis

Some scholars have studied the influence of financing constraints on enterprise performance and enterprise growth:

Li Hongya, Shi Xuegui, and Zhang Yinjie (2014) [1] find that financing constraints restrict the growth of enterprises. Financing constraints limit the development of enterprises "has mainly significantly affected the growth rate of small and medium-sized enterprises in listed manufacturing companies in China. Li Yongmei(2021) [2] and Liang Xiaolin (2019) [3] believe financing constraints hurt corporate performance. Zhong Fengying and Leng Bingjie (2021) [4] believe that financing constraints significantly negatively impact innovation performance. Guo Lili and Xu Shan (2021) [5] find that enterprises tend to turn physical investment into financial investment under high financing constraints, which harms business performance. The above documents all point out that solid financing constraints will affect enterprises' cash flow and strategic management, thus damaging the growth rate and operating performance, so we put forward hypothesis 1.

Hypothesis 1: The increasing financing constraint pressure does not promote enterprise competitiveness.

Some scholars focus on the impact of financing constraints on R&D investment: Lu Xin, Zheng Yangfei, and Li Jianming (2013) [6] point out that financing constraints restrict the investment of R&D in China's high-tech listed companies, Gu Qun and Song Shuran (2013) [7] believe that the financing constraints on R&D funds of high-tech enterprises are much higher than those of other enterprises through empirical research. Meng Liyuan and Song Chuanzhi (2016) [8] believe there is a significant correlation between financing constraints and enterprise investment efficiency, and the investment of enterprises subject to financing constraints needs to be revised. Reducing financing constraints can enable enterprises to obtain more external funds, thus increasing investment in scientific research and enhancing the core competitiveness of high-tech enterprises. So, we put forward hypothesis 2.

Hypothesis 2: Financing constraint pressure will reduce the scientific research expenditure of enterprises.

There have been a lot of studies to empirically research the influence of financing constraints on the competitiveness of enterprises and the power of financing constraints on scientific research expenditure. In addition, some scholars focus on the impact of scientific research expenditure on the competitiveness of enterprises. Li Wenqian et al. (2017) [9], Li Yan et al. (2014) [10], Xie Xiaofang et al. (2009) [11] and Pandit et al. (2011) [12] find that the increase of R&D investment can promote the innovation output of enterprises and thus improve their competitiveness. Tan Liang and Li Chuanzhao (2017) [13] believe it is first necessary to increase research investment to improve enterprises' competitiveness. Liang Laixin, and Zhang Huanfeng (2005) [14] think the correlation between R&D investment and its profitability and development ability is significant. Dai Zhenzhen and Chen Kequn (2019) [15] believe that R&D investment plays an intermediary role in the impact of cash holdings on the competitiveness of enterprises. The above research shows that R&D investment has become a factor that cannot be ignored. Increased investment in scientific research can promote technological innovation in enterprises, thus improving their competitiveness. So, we put forward hypothesis 3

Hypothesis 3: there is an intermediary effect of scientific research expenditure in the influence of financing constraints on the competitiveness of enterprises.

3 Data and model analysis

3.1 Explained variable-enterprise competitiveness

This paper selects high-tech listed companies in the A-share stock market from 2016 to 2021 as our sample enterprises. The samples of ST companies and those with missing data are deleted, and 683 high-tech listed companies have been selected as our sample enterprises. The abnormal values in the data are truncated by WINSORIZE effect at 1%-99% in order to reduce the influence of outliers on the results, constituting balanced panel data with a total of 4098 observations, all of which are from the CSMAR database. We chose Enterprise competitiveness as our explained variables according to the research of Cheng Xiang et al. (2020) [16]. Four indicators are used to construct the evaluation index of enterprise competitiveness: natural logarithm of operating income, return on net assets, the turnover rate of accounts receivable, and current ratio.

The TOPSIS comprehensive analysis method is used to calculate the competitiveness index of enterprises to reduce the influence of human subjective factors, and the specific steps are as follows:

Step 1: we need to standardize all indicators. Since all indicators in the indicator system are positive indicators, so we calculate them according to the following formula:

$$X_{ij} = (x_{ij} - x_{min}) / (x_{max} - x_{min}) \quad (1)$$

Among them, Xij represents the standardized value of sample i under the j index, xij is the original value of each index, and *x*min and *x*max are the maximum and minimum values of each index, respectively.

Step 2: we have to calculate the entropy value Ej of four indicators.

$$E_j = (-1/\ln m)\sum_{i=1}^{m}[(X_{ij}/\sum_{i=1}^{m}X_{ij})\ln(X_{ij}/\sum_{i=1}^{m}X_{ij})] \quad (2)$$

Among them, m means the number of enterprises, we set $\ln(X_{ij}/\sum_{j=1}^{m}X_{ij}) = 0$, when X_{ij}=0 to ensure that the natural logarithmic function is meaningful.

Step 3, we need to calculate the weight Wj of four indicators.

$$W_j = (1-E_j)/[\sum_{j=1}^{n}(1-E_j)] \quad (3)$$

Step 4: we should calculate the comprehensive competitiveness index of COMP.

$$COMP_i = \sum_{j=1}^{n}X_{ij}W_j \quad (4)$$

The comprehensive competitiveness index of the partial enterprises is shown in Table 1. Because of the big gap in the rank each year, we chose the top ten samples in 2021 to list our calculation results. We have found the comprehensive index of our samples fluctuates greatly from 2016 to 2021.

Table 1. Comprehensive index (%) of the partial samples

Code	2016	2017	2018	2019	2020	2021
002252	80.48	48.26	49.30	74.61	80.38	83.20
300357	73.92	74.24	72.01	76.34	76.22	77.15
300333	80.66	75.78	78.09	76.82	75.60	75.68
300127	66.86	74.67	74.89	74.96	74.95	73.24
300468	68.23	25.78	22.49	29.30	42,87	73.01
300519	39.38	75.10	65.13	64.72	75.56	72.92
603023	53.16	62.34	56.45	69.80	68.36	67.54
300046	68.82	18.74	22.4	25.08	24.39	66.02
603005	24.44	30.78	31.78	41.33	44.10	64.52
300183	68.39	48.12	39.91	41.16	49.33	63.69

3.2 Descriptive statistics and correlation analysis of variables

3.2.1 Descriptive statistics of main variables

COMP is the comprehensive competitiveness index, KZ is our key variable which is the financing constraint index, LnR&D is our mediator variable which is the natural logarithm of R&D, lnFCFF is the natural logarithm of free cash flow, lnASSET is the natural logarithm of asset, ER= owner's equity/liabilities, FR means fixed assets ratio, SR= sales expenses/operating income. InFCFF, lnASSET, ER, FR, and SR are the controlled variables according to the research of Yang Fengmin et al. (2019) [17].

Table 2. Descriptive statistics

Variable	Mean	Std.Dev.	Min	Max	VIF
COMP	24.97	10.09	2.06	83.20	
KZ	102.66	212.06	-529.05	597.48	1.47
LnR&D	0.13	1.40	-4.11	3.88	2.28
lnFCFF	0.63	1.57	-3.71	4.57	2.84
lnASSET	3.90	1.18	1.06	7.42	4.03
ER	244.70	268.21	0.98	1505.01	1.71
FR	90.48	10.39	50.15	99.98	1.07
SR	19.97	32.07	0.11	192.71	1.99

The average value of the explained variables' competitiveness is 24.97%, and there is an enormous standard error, which shows that the competitiveness among sample enterprises fluctuates wildly, and the financing constraint of the core variable (KZ) also undulates considerably. The logarithm of the average value of the intermediary variables' R&D expenditure is 12.5 million yuan. The averages of InFCFF, lnASSET, ER, FR, and SR are 0.63 million yuan, 3.90 million yuan, 244.70%, 90.48% and 19.97%, respectively. The control variables fluctuate greatly, especially ER and FR.

Before testing the model in the table 2, we used the VIF to identify multicollinearity problems, the maximum variance expansion factor is 4.03, and the minimum is 1.07, far below 10. Therefore, the possibility of multicollinearity in the regression model is low.

3.**2.2 Correlation statistics of main variables**

From the statistical analysis of the primary variables' correlation in table 3, the correlation coefficient between financing constraint (KZ) and enterprise competitiveness (COMP) is -0.47 and significant at the level of 1%, and the correlation coefficient between financing constraint (KZ) and intermediary variable (LnR&D) is -0.05 and significant at the level of 1%. So, we have preliminarily verified H1 and H2. However, we need to control other variables for multiple regression analysis to explore further the relationship between financing constraints (KZ), research investment (lnR&D), and enterprise competitiveness (COMP).

Table 3. Correlation statistics

Variable	COMP	KZ	LnR&D	lnFCFF	lnASS
COMP	1.00				
KZ	-0.47***	1.00			
LnR&D	0.08***	-0.05***	1.00		
lnFCFF	0.18***	-0.18***	0.57***	1.00	
lnASSET	0.07***	0.01	0.71***	0.75***	1.00

Note: ***, **, * indicate the significance level of 1%, 5%, and 10% respectively

3.3 Model

We have taken the corresponding LR test, F test, and Hausman test, and the test results all refuse to use the original hypothesis of mixed regression at the 1% level. Based on this, we choose fixed effects for all panel spatial econometric models in this paper. We adopt the intermediary effect from model 1 to model 3. COMP is the explained variable, KZ is the key variable, and lnR&D is the mediator variable.

Firstly, we construct Mode 1, which estimates KZ's total effect on COMP.

$$COMP=ß0+ ß1KZ+ß2lnFCFF+ß3lnASSET+ß4ER+ß5FR+ß6SR+η \quad (5)$$

Secondly, we need to evaluate the influence of KZ on the intermediate variable lnR&D, so we build Mode2:

$$lnR\&D =Y0+Y1KZ+Y2lnFCFF+Y3lnASSET+Y4ER+Y5FR+Y6SR+μ \quad (6)$$

Thirdly, we need to measure the direct effects of the core variables (KZ) and the intermediate variables (lnR&D) on COMP Mode3:

$$COMP=Ɛ0+Ɛ1KZ+Ɛ2ln\ R\&D +Ɛ3lnFCFF+Ɛ4lnASSET+Ɛ5ER+Ɛ6FR+Ɛ7SR+η \quad (7)$$

If the coefficients of ß1, Y1, and Ɛ2 are significant, and the value of |Ɛ1| decreases compared with |ß1|, there is a mediating effect that accounts for Y1 Ɛ2/ ß1.

4 Result analysis

From the results of model 1 in table 4, the regression coefficient ß1 of financing constraint (KZ) to enterprise competitiveness(COMP) is -0.0063 and significate at 1%, which shows that financing constraint harms enterprise competitiveness. An increase of 1% in financing constraint(KZ) will reduce the competitiveness of enterprises (COMP) by 0.0063%. Financing constraint is negatively related to enterprise competitiveness. Under the condition that other factors remain unchanged, enterprise competitiveness will decline to some extent with the increase of financing constraint pressure. This result verifies our hypothesis 1.

From the results of model 2 in table 4, the regression coefficient Y1 of financing constraint (KZ) to R&D investment (lnR&D) is -0.0003 and significate of 1%, which shows that the increase of financing constraint pressure will reduce enterprise R&D investment, and financing constraint hurts enterprise R&D. An increase of 1% in financing constraint (KZ) will reduce the R&D research investment of enterprises by 0.03%. The greater the financing constraint pressure, the lower the enterprise R&D expenditure, which verifies hypothesis 2.

From the results of model 3 in table 4, firstly, the regression coefficient Ɛ1 of financing constraints (KZ) on the competitiveness of enterprises is -0.0062***and significant at 1%; secondly, the regression coefficient Ɛ2 of R&D investment on the competitiveness of enterprises is 0.2372* and significate at 10%; thirdly, based on combining model 1 and model 2, we find that

ß1 Y1 and Ɛ2 are significant, and the value of |Ɛ1| is lower than |ß1|. Thus, we have verified hypothesis 3, scientific research expenditure has an intermediary effect in the financing constraints affecting enterprises' competitiveness, and the intermediary effect accounts for Y1 Ɛ2/ ß1=1.13%.

Table 4. Regression results

Variable	Mode1	Mode2	Mode3
	COPM	LnR&D	COPM
KZ	-0.0063***(-8.76)	-0.0003***(-3.28)	-0.0062***(-8.65)
LnR&D			0.2372*(1.68)
lnFCFF	0.6857***(5.16)	0.0437**(2.53)	0.6753***(5.08)
lnASSET	1.6610***(8.87)	0.7868***(32.32)	1.4744***(6.77)
ER	0.0257***(43.55)	-0.0005***(-5.90)	0.0259***(43.49)
FR	0.1572***13.04	0.0004(0.22)	0.1572***(13.03)
SR	-0.0056(-1.11)	0.0071***(10.86)	-0.0072(-1.41)
_cons	-0.7794(-0.57)	-3.4847***(-19.54)	0.0471(0.03)
Year	Y	Y	Y
Industry	Y	Y	Y
N	4098	4098	4098

Note: ***, **, * indicate the significance level of 1%, 5%, and 10% respectively

5 Conclusion

According to the above empirical analysis, we draw the following conclusions: On the one hand, the relief of financing pressure of high-tech enterprises is conducive to promoting enterprise competitiveness. On the other hand, the increase of financing pressure is not conducive to enterprises increasing investment in scientific research, and financing pressure is negatively related to investment in R&D. Finally, scientific research investment has played a part in the intermediary effect in the influence of financing constraints on the competitiveness of enterprises, and the alleviation of financing pressure can also effectively promote scientific research investment of enterprises, improve the output of technological innovation of enterprises, and gain the core competitive advantage of enterprises. Based on the above research results, the following suggestions are put forward: high-tech enterprises should pay attention to the pressure of financing constraints while increasing scientific research expenditure. Relieving the stress of financing constraints directly affects the competitiveness of enterprises and can play some intermediary effects through scientific research expenditure. Our conclusions provide an empirical basis for measures to alleviate the financing pressure of high-tech enterprises in China to improve their competitiveness and enrich the research content of the mechanism of financing constraints affecting high-tech enterprises' competitiveness.

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