The Impact of High-Tech Enterprises' Cash Holdings on R&D Investment

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ABSTRACT

With the convening of the 19th National Congress of the Communist Party of China, our country has firmly implemented the innovation-driven development strategy. As microeconomic entities, enterprises should actively respond to the call of the country to transform economic development patterns and strive to enhance the level of scientific research and innovation. Therefore, it is becoming more and more important to study how to strengthen enterprise innovation and R&D investment. Financing channels have always been one of the important factors affecting enterprises' R&D investment. Previous studies have shown that the funds supporting R&D activities of enterprise are mainly the cash held within the company. Therefore, this paper studies the influence of cash holding level on R&D investment intensity with the samples of China's A-share listed high-tech enterprises from 2014 to 2018. The empirical results show that there is a significant positive correlation between cash holdings of Chinese high-tech enterprises and their R&D input, and the positive effect is more significant in non-state-owned enterprises and enterprises with high degree of marketization. This study expands the relationship between the level of enterprise R&D investment and financing constraints, and deepens the understanding of cash holdings.

Keywords: High-tech enterprises, Cash holdings, R&D investment, Financing constraint.

1. INTRODUCTION

1.1. Research Background

The report of the 19th National Congress of the Communist Party of China points out that building an innovation-oriented country is the key to improving China's comprehensive national strength and the strategic support for building a modern economic system. Compared with the initial stage of reform and opening up, although the innovation ability of Chinese enterprises has been significantly improved, the R&D investment and intensity of enterprises still lag behind the high-speed economic demand.

Due to its own particularity, enterprise R&D is faced with strong financing constraints and cannot be solved by external financing, so it has to rely on the support of internal funds. Only after solving the capital needs of daily operations, enterprises will consider shifting the focus of investment to R&D activities. This leads to the embarrassing situation of underinvestment and backward research and development.

Foreign scholar Aghion (2004) believes that the more cash an enterprise holds, the more it will invest in R&D activities, which are positively correlated. Chinese scholar Lu Xin (2013) also drew the conclusion that cash holding had a significant positive promotion effect on R&D investment based on the research data of high-tech enterprises, and this effect was more obvious for small and medium-sized enterprises and non-state-owned enterprises. As technology-intensive enterprises, high-tech enterprises attach great importance to the input of R&D activities. Therefore, this paper also selects high-tech enterprises as the research object, discusses the insufficient R&D investment of Chinese enterprises from the perspective of internal cash holdings, and analyzes the impact of cash holdings on R&D investment intensity.

1.2. Research Significance

Studying the correlation between corporate cash holdings and R&D investment can provide theoretical support for the management's investment decisions and cash policies. For the regulatory authorities, it is helpful for them to issue laws and regulations related to cash

management and promulgate government subsidy policies for high-tech enterprises. At the same time, further improve the capital market, enhance the rational allocation of resources, and promote more social capital to participate in scientific research and innovation.

2. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

2.1. Related Research on Cash Holdings

2.1.1. Theory of Money Demand

In 1936, Keynes's money demand theory opened the door for us to study cash holdings. The theory divides people's motivation for holding cash into three categories: transaction motivation, prevention motivation and speculation.

2.1.2. Trade-off Theory

Bautnol believes that companies will incur two types of costs in the process of cash management: one is the transaction cost in the financing process, and the other is the storage cost caused by holding cash. He extended the optimal cash holdings model through the inventory model, and then derives the formula for the optimal cash holdings. Kraus's trade-off theory came into being in 1973. He believed that when the marginal benefit of holding cash equals the marginal cost, there is an optimal cash holding of the enterprise.

2.1.3. Financing Priority Theory

This theory was proposed by Myers and Majhif in 1984. They believed that due to the existence of asymmetric information, the threshold for external financing was high. Therefore, in order to reduce capital costs and seize investment opportunities, companies tend to reserve more cash as a precaution. Without sufficient internal accumulation, managers can only be forced to accept higher financing costs or abandon their originally optimistic investment projects, causing unnecessary losses to the enterprise. Financing priority theory believes that companies have a preference for order in financing, with internal capital first, debt financing second, and equity financing the last.

2.1.4. Agency Theory

Agency theory believes that based on the characteristics of "separation of two powers" in modern enterprises, managers are more inclined to proceed from their own interests when making financial decisions, although the results of decisions may harm the interests of governance. Jensen and Meckling proposed the principal-agent theory in 1976, which believes that managers have the risk of allocating company assets

based on personal preferences rather than objective facts, especially for the most liquid cash. This will make the company's decision-making become irrational, or deviate from the optimal goal, and conflict with the economic interests of the governance.

2.2. Research on R&D Investment Intensity

In addition to financing constraints, most scholars believe that the agency problem is the main factor affecting enterprises R&D investment. Hu Haiqing (2016), after studying the investment problems of small and medium-sized technology-based enterprises in China, believes that most listed companies in China have the first category of agency problems, which limits the R&D investment and efficiency of enterprises. Zhang Zongyi (2012) also put forward the same view. He believed that there are two types of inefficient investment, namely, insufficient investment and excessive investment. The former is mainly due to insufficient funds and excessively high external financing costs, while the latter is closely related to the principal-agent problem. As for the source of financing, scholars generally refer to debt financing and equity financing. Singh (2005) believed that R&D investment was significantly negatively correlated with corporate financial leverage. Custev (2009) believed that the two were not simply linear. He found that when the asset-liability ratio was about 60%, liabilities were positively correlated with R&D investment. However, when the ratio of liabilities to assets changes, the two are significantly negatively correlated. Zhai Shuping et al. (2013) argued that the development of finance and the improvement of economic environment could also effectively improve the efficiency of enterprises' R&D investment, especially for state-owned high-tech enterprises, which had a more significant promotion effect.

2.3. Research on the Impact of Corporate Cash Holdings on R&D Investment Intensity

2.3.1. Enterprise Cash Holding and R&D Investment Intensity

Compared with other investment activities such as fixed asset investment, R&D investment has high adjustment costs. On the one hand, it includes the cost of sacking and rehiring due to the fluctuation of cash flow and the time cost of restarting the project. On the other hand, because laid-off workers have access to core company secrets, they risk passing them on to competitors. Considering the characteristics of high investment, high cycle and high risk in R&D activities, the company needs continuous and stable capital investment in every link from initial market research and innovative design to product formation and market input. Once there is a technical bottleneck that is

difficult to break through or the new research is not recognized by the market, the previous investment of the enterprise will become sunk cost, which will be difficult to recover (Liu Lisha, 2016).

Most R&D activities involve the core areas of the enterprise, so it is impossible to convey too much information to the market, which aggravates the degree of information asymmetry between the capital demand side and the supply side. Capital suppliers are skeptical about the success of internal R&D activities, and they will demand higher investment returns as compensation. However, due to the high uncertainty of the return on R&D investment, the input and output are often not proportional to each other, and its future cash flow is difficult to be estimated by conventional methods like other investments. This is undoubtedly a vicious circle for enterprises with financing constraints.

Based on the above reasons, RD-intensive enterprises use less debt, and their internal funds are not completely replaced by external equity financing. The cost of the former is much lower than that of the latter. In this case, the enterprise's R&D investment can only come from its internal cash holdings.

Therefore, this paper proposes the following hypothesis:

Hypothesis 1: Cash holdings of high-tech enterprises are significantly positively correlated with R&D investment.

2.3.2. Property Right Nature, Enterprise Cash Holding and R&D Investment Intensity

In China, government intervention is widespread and policy changes occur from time to time. Compared with private enterprises, state-owned enterprises have obvious advantages in the capital market, and the controlling shareholders of state-owned enterprises belong to the government, whose pledgee has great negotiating power (Wang Xiongyuan et al., 2018). The research of Li Danmeng and Xia Lijun (2008) also confirmed that the R&D input intensity of state-owned holding listed companies was significantly lower than that of non-state-owned holding listed companies.

In the face of the R&D activities, non-state-holding high-tech enterprises have more serious financing constraints than state-holding high-tech enterprises. In order to ensure the continuous supply of funds needed for R&D investment, a large amount of cash reserve is undoubtedly their strategic choice to solve the shortage of funds and ease the financing constraints. However, state-owned holding companies have severe soft budget constraints and tend to seek financial support from Banks controlled by the government, which, to a certain extent, can alleviate the financing constraints faced by state-owned holding companies and reduce the value of

their cash holdings (Yang Xingquan et al., 2009).

Based on the above discussion, this paper proposes the following hypothesis:

Hypothesis 2: The positive effect of cash holding in high-tech enterprises on R&D investment is more significant in non-state-owned enterprises.

2.3.3. Marketization Degree, Enterprise Cash Holding and R&D Investment Intensity

As an important institutional environment, the process of regional marketization will have an impact on the economic behavior of enterprises to a large extent. When the degree of marketization is improved, the transfer of capital from low to high fields can be realized quickly, the allocation of resources will be more optimized, and the awareness of government regulatory departments to perform their duties will be enhanced, with higher regulatory efficiency (Li Yanxi et al., 2012). On the contrary, in regions with low marketization process, enterprises face higher transaction costs and capital costs, which further increases their risk of getting into financial difficulties (Wu Na et al., 2017). Jiang Yawen (2012) believes that in regions with a high degree of marketization, enterprises' investment in R&D and innovation is also at a high level.

First of all, the marketization process has a profound impact on the agency cost of enterprises (Yang Xingquan et al., 2014). In regions with a high degree of marketization, relevant intermediary agencies such as legal system and media, as well as the market for managers and control rights, are more mature, and the degree of information asymmetry between enterprises and external stakeholders is lower, so the first category of agency costs also fall accordingly. In addition, the regions with a high degree of marketization belong to the frontier regions of market development and opening to the outside world, and have accumulated a lot of experience in economic development. The technological innovation level and management level of enterprises are obviously high, while the financing constraints are low. In this case, the cash held by high-tech enterprises will be more invested in R&D activities.

Based on the above discussion, this paper proposes the following hypothesis:

Hypothesis 3: The positive effect of cash holding in high-tech enterprises on R&D investment is more significant in enterprises with high degree of marketization.

3. SAMPLE AND RESEARCH DESIGN

3.1. Sample Selection

In this paper, the high-tech enterprises listed in

Shanghai and Shenzhen A-shares from 2014 to 2018 are selected as the research objects.

The selection of high-tech enterprises is mainly based on the new version of The New Measures for The Identification and Management of High-tech Enterprises issued by China in 2016, combined with the industry classification standards of the 2012 edition of China Securities Regulatory Commission, and the statistical classification of high-tech enterprises in the China Torch Statistical Yearbook. High-tech enterprises are mainly selected from a total of 716 companies in railway, shipping, aerospace and other transportation equipment manufacturing, pharmaceutical manufacturing, instrument and meter manufacturing, printing and recording media reproduction, computer, communication and other electronic equipment manufacturing in six industries.

In addition, the following types of enterprises were excluded: enterprises in the state of ST and ST* from 2014-2018 had abnormal production and operation conditions and faced greater operating risks, which may affect the accuracy of the empirical results; enterprises listed or delisted after 2014; enterprises that fail to disclose their R&D expenditures, the number of patent applications and authorizations, and other financial data required; enterprises with abnormal data.

After screening, 437 high-tech enterprises are finally determined. Among them, 113 are on the Shanghai Stock Exchange and 324 are on the Shenzhen Stock Exchange.

Most of the enterprise data used in this paper are directly obtained from the CSMAR database, and some of the data are indirectly derived from calculations. For the missing data on R&D investment, search in the R&D investment data disclosed in the report of the company's board of directors and sort it out manually. Data that is still unavailable is treated as missing values.

3.2. Research Design

Refer to Lu Xin (2014), Liu Lisha (2016), Ma Li, Zhang Yue (2016) and other related documents. The definition and calculation methods of each variable in this article are shown in Table 1.

In order to test the hypotheses of this article, this article draws on the hypothesis 1 model of Liu Lisha (2016) to study the relationship between cash holdings and corporate R&D investment, and constructs the following regression model:

$$
\begin{aligned}
RD_{i,t} = &\ \beta_0 + \beta_1 CashH_{i,t} + \beta_2 Size_{i,t} \\
&+ \beta_3 Lev_{i,t} + \beta_4 Roa_{i,t} + \beta_5 CashF_{i,t} \\
&+ \beta_6 LHR_{i,t} + \beta_7 Age_{i,t} + \beta_8 Year_{i,t} + \varepsilon_{i,t}
\end{aligned} \tag{1}
$$

The i and t in the model respectively represent the relevant data of enterprise i in period t.

4. EMPIRICAL RESULT

4.1. Descriptive Statistics

Table 2 lists the descriptive statistical results of all variables in this article.

It can be seen that the average R&D ratio of the sample companies is 7.0%, with the median slightly lower than the average, indicating that the R&D investment of most companies does not reach the average level. The cash holding level of most high-tech enterprises is lower than the average, and the cash holding level of different enterprises varies greatly.

Before performing multiple linear regression, check whether the sample has multiple collinearity problems.

Table 3 is the analysis table of pwcorr correlation coefficient of all variables in this paper. It can be seen that the correlation coefficients between the variables are all less than 0.5, and the correlation is low. Therefore, it can be concluded that there is basically no multicollinearity problem in the design of this model.

Table 1. Variable definition table

Variable type	Variable name	Variable symbol	Variable definition
Interpreted variable	R&D investment	RD	Enterprise R&D investment funds/main business income
Explaining variables	cash holdings	CashH	(monetary capital + transactional financial assets)/ending total assets
Control variables	company size	Size	Ln(Total assets at the beginning of the enterprise)
	Solvency	Lev	Asset-liability ratio
	Profitability	Roa	Return on equity
	Cash flow	CashF	Net cash flow/total assets from business activities
	Proportion of the largest shareholder	LHR	The proportion of total equity held by the largest shareholder
	Time to market	Age	2018- Year of company listing
	Annual dummy variable	Year	Variable annual

Table 2. Descriptive statistics of the overall sample

VarName	Obs	Min	P25	Median	P75	Max	Mean	SD
RD	1898	0.00	0.04	0.05	0.08	1.82	0.07	0.08
CashH	1898	0.01	0.11	0.16	0.25	0.78	0.19	0.12
Size	1898	19.03	20.99	21.74	22.45	26.65	21.80	1.16
Lev	1898	0.01	0.21	0.33	0.49	1.35	0.36	0.18
Roa	1898	-2.18	0.04	0.08	0.13	1.73	0.08	0.14
CashF	1898	-0.23	0.01	0.04	0.08	0.37	0.05	0.06
LHR	1898	3.00	21.91	29.82	41.05	88.92	32.33	13.77
Age	1898	0.00	6.00	8.00	15.00	28.00	10.32	6.59

Table 3. Variable pwcorr correlation coefficient test

	RD	CashH	Size	Lev	Roa	CashF	LHR	Age
RD	1							
CashH	0.092***	1						
Size	-0.145***	-0.127***	1					
Lev	-0.180***	-0.265***	0.497***	1				
Roa	-0.070***	0.123***	-0.069***	-0.206***	1			
CashF	-0.066***	0.162***	-0.0270	-0.209***	0.313***	1		
LHR	-0.111***	0.077***	0.0280	-0.038*	0.194***	0.144***	1	
Age	-0.161***	-0.0330	0.496***	0.328***	-0.157***	-0.072***	-0.133*	1

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

4.2. Empirical Analysis

4.2.1. Corporate Cash Holdings and R&D Investment: Consider the Full Sample

Table 4 is the result of regression analysis on the whole sample.

Table 4. Regression results of the model of corporate cash holdings and R&D investment

	(1)	(2)
	RD	RD
CashH	0.067***	0.056***
	(4.21)	(3.48)
Size		0.000
		(0.06)
Lev		-0.067***
		(-5.66)
Roa		-0.051***
		(-3.58)
CashF		-0.101***
		(-3.27)
LHR		-0.001***
		(-4.86)
Age		-0.002***
		(-5.19)
_cons	0.047***	0.122***
	(8.44)	(3.00)
N	1898	1898
r2_a	0.009	0.077
F	4.403	15.374

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

Column (1) is the regression result without adding control variables. It can be seen that there is a significant positive correlation (0.067) between high-tech companies' cash holdings and R&D investment at the level of 0.01 (0.067); column (2) is the result of adding control variables The regression results show that corporate cash holdings have a significant positive correlation with R&D investment at the level of 0.01 (0.056). This result proves the establishment of hypothesis 1 "the cash holdings of high-tech companies are significantly positively correlated with corporate R&D investment".

4.2.2. Corporate Cash Holdings and R&D Investment: Considering the Different Nature of Property Rights

In the property grouping, state-owned enterprises are assigned a value of 1, and non-state-owned enterprises are assigned a value of 0. From the regression results, it can be seen that the coefficient of R&D investment from state-owned enterprises' cash holdings is 0.005, which is not significant; the coefficient of non-state-owned enterprises' cash holdings to R&D investment is 0.068, which is significant at the 1% level. The hypothesis 2 of this article is verified, "the positive effect of high-tech enterprises' cash holdings on enterprise R&D investment is more significant in non-state-owned enterprises."

Table 5. The nature of property rights, the regression results of the model of corporate cash holdings and R&D investment

	(1)	(2)
	RD	RD
	State-owned enterprise	Non-state-owned enterprise
CashH	0.005	0.068***
	(0.24)	(3.42)
Size	-0.002	0.000
	(-1.22)	(0.14)
Lev	-0.030**	-0.078***
	(-2.52)	(-5.20)
Roa	-0.009	-0.074***
	(-0.85)	(-3.59)
CashF	0.015	-0.119***
	(0.47)	(-3.02)
LHR	-0.001***	-0.001***
	(-3.50)	(-3.76)
Age	-0.002***	-0.002***
	(-6.54)	(-3.34)
_cons	0.162***	0.118**
	(4.60)	(2.08)
N	442	1456
r2_a	0.159	0.067
F	8.605	10.503

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

Table 6. Degree of marketization, corporate cash holdings and R&D investment

	(1)	(2)
	RD	RD
	High degree of marketization	Low degree of marketization
CashH	0.062***	0.045*
	(3.09)	(1.76)
Size	-0.002	0.004
	(-0.62)	(1.19)
Lev	-0.073***	-0.038*
	(-4.92)	(-1.92)
Roa	-0.041**	-0.087***
	(-2.43)	(-3.07)
CashF	-0.100***	-0.104*
	(-2.64)	(-1.95)
LHR	-0.001***	-0.000
	(-4.68)	(-1.59)
Age	-0.001***	-0.003***
	(-2.69)	(-5.80)
_cons	0.159***	0.041
	(3.09)	(0.63)
N	1341	557
r2_a	0.071	0.104
F	10.373	6.894

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

4.2.3. Corporate Cash Holdings and R&D Investment: Considering the Degree of Marketization

This paper uses the marketization index compiled by Wang Xiaolu et al. (2016) to measure the degree of marketization in a region. When the marketization process of a province is greater than the median, it is assigned a value of 1, which is defined as a group with a higher degree of marketization, and vice versa It is assigned a value of 0, which is defined as a group with a lower degree of marketization. The 2017 and 2018 marketization indexes use 2016 data instead. From the regression results, it can be seen that the coefficient of R&D investment by cash holdings of companies with a high degree of marketization is 0.062, which is significant at the 1% level; the coefficient of R&D investment by companies with low marketization of cash holdings is 0.045, Only significant at the 10% level. The hypothesis 3 of this article is verified, "The positive effect of high-tech enterprises' cash holdings on enterprise R&D investment is more significant in enterprises with a high degree of marketization."

4.3. Robustness Test
4.3.1. Replace the Explained Variable

In order to further verify the reliability of the results, this article first uses the method of replacing variables to test the robustness of the model regression results. Redefine the explained variable RD as "enterprise R&D investment/total assets at the end of the period", and the definition of the remaining variables remains unchanged and other conditions remain unchanged, and all variables are replaced with data from 2015 to 2019 for regression.

The regression results are shown in Table 7.

Table 7. Replacement variable model

	(1)	(2)
	RD	RD
CashH	0.031***	0.029***
	(5.99)	(5.63)
Size		-0.000
		(-0.64)
Lev		0.011***
		(2.94)
Roa		0.009**
		(2.05)
CashF		0.042***
		(4.34)
LHR		-0.000*
		(-1.89)
Age		-0.001***
		(-6.64)
_cons	0.023***	0.035***
	(14.12)	(2.75)
N	1572	1572
r2_a	0.032	0.084
F	13.878	15.446

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

By regressing the new sample with changed variables, it can be seen that corporate cash holdings and their R&D investment are still significantly positively correlated at the level of 0.01 (0.029), which is the same as the result of the empirical regression model in this paper.

4.3.2. Lagging Explained Variables

In order to alleviate the potential endogeneity, the R&D investment is lagging for a period and the regression is implemented again.

Table 8. Lagging explained variable model

	(1)	(2)
	RD	RD
CashH	0.084***	0.068***
	(4.51)	(3.60)
Size		0.000
		(0.14)
Lev		-0.075***
		(-5.15)
Roa		-0.052**
		(-2.47)
CashF		-0.120***
		(-3.15)
LHR		-0.001***
		(-4.11)
Age		-0.002***
		(-4.23)
_cons	0.052***	0.128**
	(8.44)	(2.58)
N	1464	1464
r2_a	0.011	0.077
F	5.145	13.121

Note: t-values are in parentheses, *, **, *** indicate significant at the level of 0.1, 0.05, and 0.01 respectively.

Table 8 shows the regression results of the lagging explained variable model. It can be seen that the investment of corporate cash holdings on corporate R&D is significantly positively correlated (0.068) at the level of 0.01, which is consistent with the regression results of this article.

5. CONCLUSION

By studying the research and development data of high-tech enterprises listed in A-shares in China during 2014-2018, this paper believes that the cash holding level of high-tech enterprises is significantly positively correlated with R&D investment intensity, and this positive effect is more significant in non-state-owned enterprises and enterprises with high degree of marketization.

In order to promote enterprise innovation and maintain scientific research intensity, enterprises should hold a certain level of cash to prepare for risks. The management should rationally plan the use of funds, strengthen cash management and improve the use

efficiency from the perspective of the company's overall strategy. Enterprises should set up a complete set of special fund reserve system for R&D activities, dedicated to enterprise innovation.

With the increasingly fierce market competition, enterprise managers should keep a cool head and prudently face various investment opportunities. The enterprise should set up a special department to manage the R&D investment and deal with the problems in the process of R&D timely. The department should do a good job in the early stage of research and development investment research, to ensure that the technology or products developed have market demand, the development of the project in line with the company's strategic requirements, select suitable research institutions as partners, to reduce the cost and risk of research and development investment to the greatest extent.

The R&D investment of enterprises is affected by many factors. In addition to focus on the problem of cash supply, efforts should also be made to enhance overall strength and improve operating conditions. Companies with strong comprehensive strength are more capable of resisting potential risks and can deal with financing constraints or sudden capital chain rupture in a better way. And strict internal management and good internal control system is the cornerstone to promote the strength of enterprises.

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