

# The Restriction Mechanism of Environmental Uncertainty on Inefficient Investment: A Moderated Intermediary Model Based on Financing Constraints

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**Abstract:** Investment behavior has always been the focus of enterprise research, but also the difficulty of scholars. Most of the researches on investment behavior have focused on interfering with the business performance of Chinese enterprises. However, the research on inefficient investment mostly focuses on the discussion of internal characteristics of enterprises, ignoring the impact of external environment. Therefore, this paper combines the environmental uncertainty and financing constraints of relevance theory, constructs a moderated intermediary model based on the introduction of excess cash holding theory, and based on the financial data of China's non-financial listed companies from 2008 to 2019, uses the hierarchical regression and bootstrap method to carry out the inspection, and comprehensively explores the impact mechanism of inefficient investment. The results show that: (1) environmental uncertainty has a significant positive impact on financing constraints. (2) Financing constraints have a significant positive impact on inefficient investment. (3) Financing constraints play a mediating role in environmental uncertainty and inefficient investment constraints. (4) Excess cash holdings can adjust the intermediary relationship. From the new perspective of financing constraints, this paper constructs the mechanism of environmental uncertainty and inefficient investment, expands the scope of inefficient investment mode, and has a certain reference significance to improve the investment environment and reduce inefficient investment behavior.

**Keywords:** Environmental uncertainty; Inefficient investment ; Financing constraints; Excess cash holding; A Moderated mediation model

## 1 Introduction

As one of the main driving forces of economic development, investment is directly related to economic stability and enterprise development. From an overall perspective, to further strengthen the supply side structural reform and improve the input-output ratio of enterprises, enterprises need to expand investment and stimulate their own economic vitality; From a local perspective, to promote

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stock regulation with incremental change, enterprises must improve investment efficiency and improve their own capital structure. Therefore, enterprise investment behavior and investment efficiency are directly related to economic stability and social development. Most Chinese enterprises deviate from the optimization of investment efficiency. The existing literature research shows that the inefficient investment behavior of enterprises is very common, which seriously interferes with the operation and development of enterprises [1,2]. In order to clarify the causes and mechanism of inefficient investment in the process of enterprise investment, this paper analyzes the inefficient investment behavior of enterprises from the perspective of external environment.

In the research on the motivation of enterprise inefficient investment, the financing constraint caused by the imperfection of capital market is one of the important causes [2]. Since Myers and Majuf proposed the relationship between financing constraints and insufficient investment, the academic community generally recognized the view that the inefficient investment of companies is affected by financing constraints [3,4]. Lian Yujun and others believe that financing constraints make the average investment efficiency of enterprises lower than the optimal level. [5] Liu Kangbing and others found that financing constraints have a significant negative effect on enterprise investment behavior. [3] Especially when the financing cost and risk of the enterprise rise, the enterprise may give up the current investment behavior and hold cash due to preventive motivation, resulting in insufficient investment. Another important cause is environmental uncertainty. From the internal environment of enterprises, information asymmetry and agency contradiction increase the financing difficulty of enterprises, and the financing difficulty further increases the uncertainty of enterprise investment environment, resulting in the deviation of enterprise investment efficiency from optimization; From the perspective of the external environment of the enterprise, the proposal of the new normal of economy and the new development pattern of "double cycle" also pose new challenges to the enterprise's investment environment. The volatility of the environment is improved, which brings uncertainty risks to the enterprise's investment behavior and investment efficiency. This risk may lead to the increase or decrease of investment efficiency [6], It leads to the deviation of enterprise investment efficiency from optimization and forms enterprise inefficient investment. At the same time, the real option theory also shows that enterprises may delay investment due to the huge fluctuation of the environment, resulting in the decline of enterprise investment efficiency. [7]

There are many literatures on the mechanism of enterprise environmental uncertainty and financing constraints on enterprise inefficient investment, but most of them regard environmental uncertainty and financing constraints as two independent variables and investigate their relationship with corporate inefficient investment separately [3]. With the deepening of research, some scholars have found that there is a certain relationship between environmental uncertainty and financing constraints. Isolated and separate research can no longer reveal their action mechanism and their impact on the essence of inefficient investment [3,8]. It is necessary to comprehensively consider the restriction mechanism of financing constraints on enterprise inefficient investment under environmental

uncertainty. In addition, in the cash demand theory, there is a inextricable relationship between investment and cash flow. Fazzari, Hubbard and Petersen believe that higher financing constraints will cause enterprises to hold cash and reduce investment, resulting in insufficient investment. [9] Geng Chengxuan and others believe that the combined effect of excess cash holdings and environmental uncertainty has a certain restrictive mechanism on the inefficient investment behavior of enterprises. [10] Based on the above theory, this paper uses the panel data of China's non-financial listed companies from 2008 to 2019 to study the restrictive impact of environmental uncertainty on enterprise inefficient investment. Based on the assumption of environmental uncertainty, this paper introduces the intermediary role of financing constraints, and discusses the internal and external influencing factors of enterprise inefficient investment on the basis of considering the regulatory role of excess cash holdings, in order to improve the enterprise investment environment, weaken the enterprise inefficient investment, and reasonably improve the resource allocation efficiency of the whole society.

The marginal contributions of this paper are as follows: first, the macro external environmental uncertainty factors are introduced into the micro level of enterprises, the theoretical framework of environmental uncertainty and enterprise inefficient investment is constructed, the restriction mechanism of environmental uncertainty on enterprise inefficient investment is tested, and the research on the restriction mechanism of both is expanded; Secondly, from the perspective of financing constraints, this paper expounds the restriction mechanism of environmental uncertainty on enterprise inefficient investment, empirically explores the relationship between environmental uncertainty and financing constraints, and expands the influence scope of enterprise inefficient investment constraints; Third, deeply excavate the correlation mechanism between environmental uncertainty and enterprise inefficient investment under financing constraints, establish the organic relationship between the three from the micro perspective of enterprises, and analyze the causes and restriction mechanism of enterprise inefficient investment on the basis of introducing excess cash holdings, which has a certain reference significance for improving enterprise investment environment and reducing enterprise inefficient investment behavior.

## **2 literature review and research hypothesis**

### **2.1 restriction mechanism of environmental uncertainty on Financing Constraints**

Modigliani and Miller believe that there are differences between internal and external financing due to financial frictions in the capital market, resulting in financing constraints. On this basis, Myers and Majluf [11] introduced the information asymmetry theory into the category of financing constraints, and established the financing priority theory under the imperfect capital market. The research shows that information asymmetry not only aggravates the financing constraints of enterprises, but also reduces the transparency of investment performance evaluation. [11]. Both information asymmetry

theory and agency theory tend to analyze the influencing factors of financing constraints and their action mechanism on inefficient investment from the internal perspective of enterprises, ignoring the influencing factors from the external perspective of enterprises, especially the uncertain fluctuation of the external environment of enterprises [13]. Some scholars have recognized the impact of external environment fluctuations on financing constraints and capital investment efficiency. After integrating their research paths, Liu Kangbing [3] expounded the relationship between environmental uncertainty and financing constraints from the perspective of theoretical models, and proposed that the rise of environmental uncertainty may aggravate the deterioration of financing constraints. At the same time, the marginal risk premium of capital will further deepen the financing constraints faced by enterprises, resulting in severe macroeconomic fluctuations. Again, the fluctuation of environmental uncertainty increases [3]. Fan Yanping [14] et al. Expounded the relevant effects of the two from the perspective of accounting prudence, and believed that financing constraints played an intermediary role between environmental uncertainty and accounting conservatism. Liu Xia [15] discussed the regulatory effect of environmental uncertainty on financing constraints from the perspective of financial flexibility. The current literature shows that there is an inevitable relationship between environmental uncertainty and financing constraints. Studying the mechanism of inefficient investment in enterprises in isolation can not fully reveal the mechanism of inefficient investment in enterprises. It is necessary to organically combine the two and comprehensively explore the relationship between environmental uncertainty and financing constraints.

In short, there is a clear correlation between environmental uncertainty and financing constraints. The fluctuation of uncertain environment may increase the unpredictability of enterprise financing cost, enlarge the level of information asymmetry, further affect the internal and external financing of enterprises, and aggravate the financing constraints of enterprises. Therefore, the following assumptions are made:

H1: the increase of environmental uncertainty magnifies the impact of corporate financing constraints.

## **2.2 restriction mechanism of financing constraints on inefficient investment of enterprises**

The main manifestation of inefficient investment is that the actual investment expenditure of enterprises deviates from the possible optimal investment expenditure, which can be divided into underinvestment and overinvestment. [2] Current studies believe that the main reasons for inefficient investment are agency contradiction and information asymmetry [1]. Myers and majuf first established the research framework of the relationship between financing constraints and enterprise investment, and expounded the causes of insufficient investment of enterprises from the perspective of financing constraints [11]. FHP found the impact of cash flow on investment efficiency. Using the dividend payment rate of enterprises as an independent variable, FHP weighed the relationship between financing constraints faced by enterprises and investment expenditure through investment cash flow sensitivity [9]. Liu Xing and others further explored the cross check relationship between

financing constraints and inefficient investment of enterprises under the agency conflict theory, and believed that the interaction between financing constraints and agency conflict magnified the inefficient investment behavior of enterprises [13]. Stiglitz, Weiss and Kou Jianhua demonstrated their negative impact on enterprise investment from the perspective of financing constraints [16,17]. In the research on the restrictive relationship of enterprise inefficient investment, the problem of capital has been widely concerned by scholars. Enterprise investment is inseparable from capital. Whether it is external financing cost or internal financing effect, it can directly affect enterprise inefficient investment. On the one hand, when enterprises are faced with financing constraints, the difference between internal and external financing costs may lead to the tension of enterprise capital chain, resulting in the management's cautious treatment of existing funds during investment, resulting in insufficient investment [1]. on the other hand, The management may also rebalance the capital of the enterprise out of "equalitarianism" and self-interest principle, reduce the capital of the superior departments to invest in the inferior departments, resulting in over investment in the inferior departments and insufficient investment in the superior departments, forming the inefficient investment of the enterprise [12,18] 。 Bernanke believes that the agency contradiction also exacerbates the financing constraints faced by enterprises to a certain extent. The management may ignore or even damage the interests of shareholders, interfere with the investment behavior of enterprises, and lead to inefficient investment [19]. It can be seen that financing constraints aggravate the inefficient investment behavior of enterprises to a great extent.

To sum up, the investment behavior of enterprises depends not only on the demand of investment itself, but also on the financing behavior. When the financing cost of the enterprise is high, it may trigger the inefficient investment behavior of the enterprise. Therefore, the following assumptions are made:

H2: financing constraints amplify the inefficient investment behavior of enterprises.

### **2.3 intermediary benefit analysis of financing constraints**

Environmental uncertainty has both direct and indirect effects on enterprises' inefficient investment. Environmental uncertainty can potentially affect the company's investment behavior and investment efficiency in terms of quantity and volatility. Firstly, high environmental uncertainty means that enterprises are in the process of environmental diversification and variability. When facing the diversified environment, the enterprise management may consider the needs of different investors and the needs of managers' own development, balance the investment needs of all interest classes of the enterprise, resulting in inefficient investment. Secondly, when the management faces the variability of the environment, the greater the volatility of the environment, the weaker the enterprise's control over the future, and the worse the management's grasp of resource allocation. [20] The fluctuation of the environment increases the investment risk of the enterprise, resulting in the management may be too cautious in investment and give up the projects with positive investment

income, resulting in insufficient investment. Third, environmental uncertainty may increase the difficulty of performance evaluation of enterprise management, give management the opportunity to cover up invalid investment and negative investment income, and lead to excessive investment and inefficient investment. [6,21] it can be seen that environmental uncertainty can directly affect the investment efficiency of enterprises.

In the perfect capital market, the investment and financing behavior of enterprises is not disturbed by information asymmetry, but in the actual investment process, enterprises often can only make investment and financing decisions based on limited information, resulting in enterprises unable to obtain sufficient funds and give up investing in profitable projects, resulting in insufficient investment. [17] Especially when the external environment is uncertain, the environmental uncertainty may aggravate and raise the external financing cost of enterprises, and then affect the investment behavior and investment efficiency of enterprises. This impact is more significant when enterprises face greater financing constraints. Liu Kangbing and others explored the possibility of environmental uncertainty affecting enterprise investment efficiency through financing constraints by using the data of listed manufacturing companies in China [3]. Shen Huihui's research shows that the effect of uncertainty on investment efficiency is unstable, and this instability is restricted by the level of financing constraints [6]. It can be seen that environmental uncertainty can indirectly affect the investment efficiency of enterprises through financing constraints, in which financing constraints play a media role.

To sum up, this paper believes that environmental uncertainty is closely related to enterprise inefficient investment. Environmental uncertainty can not only directly affect enterprise inefficient investment, but also affect enterprise inefficient investment through financing constraints. Therefore, the following assumptions are put forward:

H3: there are both direct and indirect impacts between environmental uncertainty and inefficient investment of enterprises. Financing constraints play an intermediary role in the indirect relationship between environmental uncertainty and inefficient investment.

#### **2.4 analysis on the adjustment effect of excess cash holdings**

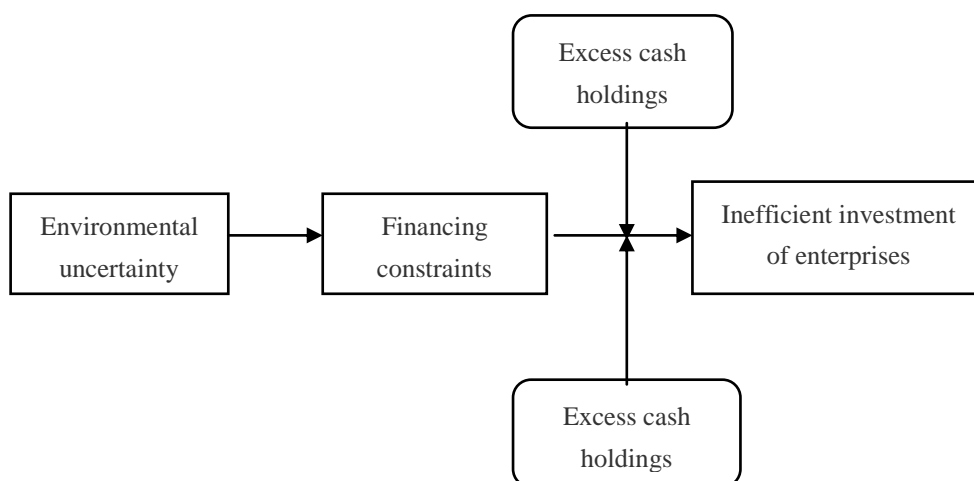
The restrictive effect of financing constraints on enterprise inefficient investment has been recognized by some scholars. Both agency theory and information asymmetry theory reveal the essence of inefficient investment behavior. In the research of enterprise inefficient investment, investment cash flow, which is closely related to financing constraints, has always been the focus of scholars. Enterprise investment needs the support of capital, and the cash flow analysis in the financing constraint theory directly affects the investment efficiency of enterprises. Information asymmetry theory holds that the motivation for enterprises to hold a large amount of cash is to alleviate the financing constraints faced by enterprises [22]. When the enterprise is faced with a high degree of financing constraints, the management prefers to use the internal funds of the enterprise, so the enterprise may hold a large amount of cash. Therefore, scholars believe that the cash holdings of

enterprises with greater financing constraints are more than those of enterprises with less financing constraints [23]. Agency theory holds that when an enterprise holds a large amount of cash, the management may invest in some ineffective projects for private purposes, so the motivation for the enterprise to hold a large amount of cash is to meet the personal desires of the management [13,22]. Both agency theory and information asymmetry only reflect the superficial motivation of enterprises to maintain a large amount of cash. The real purpose of enterprises having a large amount of cash is to maintain production. Only when enterprises hold excess cash can funds be used for investment and have a real impact on investment [24]. Zhang Xianzhi [22] and others believe that when enterprises face financing constraints, the management will hold a large amount of cash out of prudence. When the cash held by the enterprise exceeds the normal level, the excess will be used by the management to meet private purposes for "on-the-job consumption" or "empire construction" [22]. Therefore, when the enterprise holds a large amount of cash for prevention motivation, the enterprise management may misuse funds for private interests, resulting in excessive investment and inefficient investment [25]. Therefore, the greater the degree of financing constraints faced by enterprises, the more excess cash enterprises may store, and the more serious the inefficient investment behavior of enterprises may be.

To sum up, the excess cash held by enterprises increases the possibility of enterprise management abusing enterprise funds, that is, the excess cash holding plays a regulatory role in the relationship between financing constraints and enterprise inefficient investment. Therefore, the following assumptions are put forward:

H4: excess cash holdings increase the intermediary role between financing constraints and inefficient investment; When enterprises store more excess cash, the intermediary role of financing constraints is stronger; On the contrary, the weaker.

Based on the above analysis, this paper puts forward the theoretical research model of this paper, as shown in Figure 1.



**Fig. 1 Theoretical model**

### 3 research design

#### 3.1 selection of samples

China launched the new accounting standards in 2007. In order to avoid the impact of the changes of the old and new standards on the sample data, the starting period of the sample data selected in this paper is 2008. The data are mainly from Guotai'an and Wande. In order to ensure the researchability of the selected sample data, this paper takes the following steps to screen the data: firstly, considering the uniqueness of the financial industry, delete all the sample data; Secondly, the abnormal and missing samples were eliminated, and 15152 effective research samples were obtained through screening; Finally, in order to reduce the influence of extreme values on this model, the tail of continuous variables is reduced by 1% according to the general practice of other literature.

#### 3.2 variable setting

##### 1) Environmental uncertainty (EU)

As for the quantification of environmental uncertainty, according to the research methods of Ghosh [21] and Shen Huihui [6], this paper takes the variation coefficient of annual net sales revenue of sample enterprises in the past five years as the dimensional variable of environmental uncertainty, and uses the least square method to set the quantitative model of environmental uncertainty, such as model (1).

$$Sale = \theta_0 + \theta_1 Year + \varepsilon \quad (1)$$

Where: Sales represents the annual sales revenue of the enterprise, and year represents the annual variable. When the observed value is  $t = 0$  year, the value of year is 5; When the observed value is  $t = -1$  year, the value of year is 4, and so on.

##### 2) Financing constraints (WW)

As for the measurement of financing constraints, this paper refers to the research methods of whited and Wu [26], constructs the WW index model with the help of Euler equation, and establishes a mathematical model (2) to estimate the financing constraints faced by enterprises. This index method avoids the defect that Tobin Q value is difficult to measure accurately in other measurement indexes, and also reduces the probability of model estimation deviation due to the simultaneity of sample selection of dependent variables and independent variables in the construction of index model.

$$WW = \alpha_0 - \alpha_1 0.091Cf_{it} - \alpha_2 0.062Div_{it} + \alpha_3 0.021Lntd_{it} - \alpha_4 0.044Size_{it} + \alpha_5 0.102Is g_{it} - \alpha_6 0.035Sg_{it} \quad (2)$$

Where: Cf is the cash flow of the enterprise; Div is the variable of dividend payment; Lntd is the long-term liabilities of the enterprise; Size is the Size of the enterprise. Isg is the industry's sales growth rate; Sg is the sales growth rate of the sample enterprises.



### 3) Enterprise's inefficient investment (NEI)

Regarding the measurement of enterprises' inefficient investment, this paper constructed a mathematical model (3) referring to Richardson[2] to judge the degree and direction of enterprises' inefficient investment by regression residuals.

$$In_{it} = \beta_0 + \beta_1 Growth_{it-1} + \beta_2 Lev_{it-1} + \beta_3 Return_{it-1} + \beta_4 Cash_{it-1} + \beta_5 Size_{it-1} + \beta_6 Age_{it-1} + \beta_7 In_{it-1} + \beta_8 Roa_{it-1} + Year_i + Industry_t + \varepsilon_{it} \quad (3)$$

Where: In is the newly increased investment of the sample enterprise; Industry is the dummy variable of the sample Industry; Age is the listing years of sample enterprises; Cash is the Cash holding of sample enterprises, and other variables are set in Table 1.

### 4) Excess cash Holdings (EXCASH)

As for the calculation of excess cash holding, this paper refers to the research method of Yang Xingquan et al. [27] and establishes the ideal level model of cash holding (4) after considering all factors comprehensively, and judges whether the enterprise holds excess cash and the degree of holding according to the residual item.

$$Ln(cash)_{it} = \gamma_0 + \gamma_1 Size_{it} + \gamma_2 Cf_{it} + \gamma_3 Nwc_{it} + \gamma_4 Growth_{it} + \gamma_5 Cap_{it} + \gamma_6 Lev_{it} + \gamma_7 Div_{it} + Industry_t + Year_i + \varepsilon_{it} \quad (4)$$

Where: NWC is the net working capital of the sample enterprise; Cap is the capital expenditure of the sample enterprises, and the setting of other variables is shown in Table 1.

### 5. Control variables

In the actual operation and development process of enterprises, many factors will affect the inefficient investment of enterprises. Based on a large number of documents, this paper comprehensively selects the company's free cash flow (FCF), the shareholding ratio of the largest shareholder (top), the overall size of the enterprise (size), the return on total assets (ROA) and the asset liability ratio (Lev) as the control variables, and introduces the dividend payment (DIV) on this basis, Three dummy variables, such as industry and year, are used to construct the impact model of enterprise inefficient investment. See Table 1 for the specific definitions of the main variables of the model.

**Table 1 Setting of main variables**

Variable name	Variable definitions	Formula to calculate
NEI	Inefficient investment	According to the method in the paper
EU	Environmental uncertainty	According to the method in the paper
EXCASH	Excess cash holdings	According to the method in the paper

WW	Financing constraints	According to the method in the paper
Cash	Cash holdings	(Cash + marketable securities of sample enterprises)/ total assets of sample enterprises
Fcf	Free cash flow of the company	(Net operating profit after tax + Depreciation and amortization - Capital expenditure - increase in working capital)/ total assets of the sample firm
Cf	Cash flow	Cash flow generated by the business activities of the sample firm/total assets of the sample firm
Growth	Growth opportunities	Annual sales revenue growth rate of sample enterprises
Lev	Asset-liability ratio	Total corporate liabilities/total corporate assets
In	New investment	Value added of fixed assets/total assets of enterprises
Return	Annual return on stocks	The annual stock return ratio of the sample enterprise considering dividend reinvestment
Roa	Return on total assets	Annual net profit of the sample enterprise/total asset balance of the sample enterprise
Size	The enterprise scale	The natural logarithm of the sample firm's annual total assets
Nwc	Net working capital	(Working capital - cash and cash equivalents)/ total assets of sample firms
Top	Shareholding ratio of the largest shareholder	

### 3.3 Model Construction

In order to test the hypothesis H1-H3 in this paper, relevant models are set as follows:

$$WW_{it} = \beta_0 + \beta_1 EU_{it} + \beta_2 Fcf_{it} + \beta_3 Lev_{it} + \beta_4 Size_{it} + \beta_5 Top_{it} + \beta_6 Div_{it} + Industry_t + Year_i + \varepsilon_{it} \quad (5)$$

$$NEI_{it} = \beta_0 + \beta_1 WW_{it} + \beta_2 Fcf_{it} + \beta_3 Lev_{it} + \beta_4 Size_{it} + \beta_5 Top_{it} + \beta_6 Div_{it} + Industry_t + Year_i + \varepsilon_{it} \quad (6)$$

$$NEI_{it} = \beta_0 + \beta_1 WW_{it} + \beta_2 Fcf_{it} + \beta_3 Lev_{it} + \beta_4 Size_{it} + \beta_5 Top_{it} + \beta_6 Div_{it} + \beta_7 EU_{it} + Industry_t + Year_i + \varepsilon_{it} \quad (7)$$

In models (5)-(7), the direction of  $\beta_1$  coefficient is the focus of the model. According to the research hypothesis above, all the coefficients of  $\beta_1$  should be positive, indicating that environmental uncertainty can magnify enterprises' inefficient investment through financing constraints.

#### 4. Analysis of empirical results

##### 4.1 Correlation Analysis

Table 2 shows the mean values, standard deviations, 50% median values and correlation coefficients between variables. The upper part of Table 2 shows that the coefficient correlation of all variables is less than 0.5, indicating that the selection of variables meets the requirements. There is a certain correlation between environmental uncertainty and financing constraint, and between financing constraint and inefficient investment of enterprises at the level of 1%. Therefore, the hypothesis of H1 and H2 has been preliminarily verified. The lower half of Table 2 shows the mean, 50% median, and standard deviation of the variables. The median value of 50% of enterprise inefficient investment (NEI) is negative, indicating that most of the sample enterprises in China are in underinvestment, which also indicates that most of the sample enterprises in China have inefficient investment. [3] The mean value and 50% median value of financing constraints (WW) are both negative, indicating that most of the sample enterprises have severe financing constraints. The 50% median of environmental uncertainty (EU) is negative and less than the mean value, indicating that the overall environment fluctuation of sample enterprises is relatively stable, and the economic operation environment of enterprises is relatively stable. Among other control variables, the 50% median and mean value of the company's free cash flow (Fcf) are both negative, indicating that the operating cash flow of the sample enterprises basically cannot cover the investment of the enterprises, and also indicates from the side that most Chinese enterprises have the problem of over-investment. The mean value of the shareholding ratio of the largest shareholder (Top) and the median value of 50% are both higher than 0.3, indicating that most of the sample enterprises have relatively intensive ownership concentration. The average value of dummy variable of dividend payment (Div) is more than 0.5, and the median value of 50% is more than 1, indicating that the sample enterprises have a high rate of cash dividend payment.

**Table 2 Descriptive statistics and correlation analysis among variables**

	NEI	WW	EU	Fcf	Lev	Size	Top	Roa	Div
NEI	1.000								
WW	0.158** *	1.000							
EU	0.029** *	0.113** *	1.000						
Fcf	0.0080	-0.027* **	-0.0070	1.000					
Lev	0.054** *	0.067** *	-0.156* **	-0.056* **	1.000				
Size	0.147** *	-0.090* **	-0.539* **	0.0000	0.391** *	1.000			

Top	0.0090	-0.037* **	-0.191* **	0.0030	0.051** *	0.271** *	1.000		
Roa	0.154** *	-0.057* **	-0.111** *	0.210** *	-0.310* **	0.128** *	0.085** *		
Div	0.022**	-0.193* **	-0.262* **	0.168** *	-0.191* **	0.270** *	0.151** *	0.366** *	1.00 0
Mean	0.000	-1.014	0.744	-0.247	0.476	22.394	0.330	0.027	0.65 8
Standard deviation	0.105	0.108	1.334	0.207	0.214	1.326	0.016	0.071	0.47 4
Median	-0.016	-1.024	0.339	-0.215	0.477	22.266	0.311	0.028	1.00 0

\* represents significant at the 10% level, \*\* represents significant at the 5% level, and \*\*\* represents significant at the 1% level (two-tailed test).

#### 4.2 Direct benefit test

(1) Regression analysis of environmental uncertainty on financing constraints

**Table 3 Regression results of environmental uncertainty on financing constraints**

Variable	Financing constraints (WW)	
EU		0.120*** ( 5.39 )
Fcf	-0.048*** ( -4.87 )	-0.050*** ( -4.97 )
Lev	0.070*** ( 5.27 )	0.067*** ( 4.96 )
Size	-0.169*** ( -5.17 )	-0.053*** ( -3.49 )
Top	0.028** ( 2.49 )	0.043** ( 2.63 )
Div	-0.063*** ( -21.19 )	-0.063*** ( -21.09 )
Roa	0.054*** ( 3.8 )	0.053*** ( 3.66 )
Industry variable	control	control
Annual variable	control	control
N	15128	15128

Adj R2	0.820	0.822
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\* means significant at the 10% level, \*\* means significant at the 5% level, and \*\*\* means significant at the 1% level (T values are in parentheses).

The regression results of environmental uncertainty on financing constraints are shown in Table 3. On the left side of the model is the independent regression of control variables such as free cash flow; On the right side of the model is the overall regression of financing constraints after increasing the environmental uncertainty of independent variables. The results show that the coefficient of environmental uncertainty on financing constraint is 0.120 and significant at 1% level, indicating that the increase of environmental uncertainty leads to higher external financing costs for enterprises and increases the degree of corporate financing constraint [3]. Environmental uncertainty amplifies the impact of financing constraints, that is, H1 is verified.

(2) Regression analysis of financing constraints on inefficient investment of enterprises

**Table 4 Regression results of financing constraints on inefficient investment of enterprises**

Variable	Enterprise inefficient Investment (NEI)	
WW		0.443*** ( 10.64 )
Fcf	0.108*** ( 5.78 )	0.130*** ( 7.56 )
Lev	0.018 ( 1.4 )	-0.012 ( -0.90 )
Size	0.365*** ( 10.34 )	0.439*** ( 11.64 )
Top	0.059*** ( 4.19 )	0.046*** ( 3.53 )
Div	-0.004 ( -1.19 )	0.024*** ( 5.64 )
Roa	0.067*** ( 4.27 )	0.042*** ( 3.04 )
Industry variable	control	control
Annual variable	control	control
N	15122	15122
Adj R2	0.226	0.321

\* means significant at the 10% level, \*\* means significant at the 5% level, and \*\*\* means significant at the 1% level (T values are in parentheses).

The restriction results of financing constraints on inefficient investment of enterprises are shown in Table 4. On the left side of the model, free cash flow and other variables are taken as control variables for independent regression; On the right side of the model is the overall regression of

enterprise inefficient investment after adding financing constraints of independent variables. The results show that the coefficient of financing constraint on enterprises' inefficient investment is 0.443 and is significant at 1% level, indicating that credit rationing policy under financing constraint causes the difference in enterprises' financing cost [20] and increases enterprises' inefficient investment, that is, H2 has been verified.

#### 4.3 Analysis of the mediating effect of financing constraints

The analysis results of the mediation effect of financing constraints are shown in Table 5. Model 1 on the left is the regression result after controlling the sample enterprises' return on total assets, sample enterprises' size, sample enterprises' cash holding and the shareholding ratio of the largest shareholder, while model 2 in the middle is the regression result after considering the environmental uncertainty. The results of Model 2 show that environmental uncertainty increases enterprises' inefficient investment, and the correlation coefficient is 0.135 and significant at 1% level, indicating the amplification effect of environmental uncertainty on enterprises' inefficient investment. Model 3 shows that when environmental uncertainty and financing constraint are included in the same model, financing constraint has a significant amplification effect on inefficient investment of enterprises. The regression results also show that the impact of environmental uncertainty on enterprises' inefficient investment changes from 0.135 to 0.083 after the addition of financing constraint variables, indicating that the direct impact of environmental uncertainty on enterprises' inefficient investment decreases after the addition of financing constraint variables. On the premise that H1 is established, the above results are consistent with the mediating effect test results proposed by Baron et al. [28], indicating that the mediating effect of financing constraints on inefficient investment is established, that is, the hypothesis of H3 is verified.

**Table 5 Regression analysis results of mediation effect**

Variable	Enterprise inefficient Investment (NEI)		
	Model 1	Model 2	Model 3
EU		0.135*** ( 4.14 )	0.083*** ( 2.70 )
WW			0.439*** ( 10.74 )
Fcf	0.108*** ( 5.78 )	0.113*** ( 5.72 )	0.128*** ( 7.55 )
Lev	0.018 ( 1.40 )	0.014 ( 1.15 )	-0.014 ( -1.08 )
Size	0.365*** ( 10.34 )	0.424*** ( 8.97 )	0.474*** ( 10.68 )
Top	0.058*** ( 4.19 )	0.060*** ( 4.34 )	0.047*** ( 3.63 )

Div	-0.004 ( -1.19 )	-0.004 ( -1.13 )	0.024*** ( 5.68 )
Roa	0.067*** ( 4.27 )	0.065*** ( 4.25 )	0.041*** ( 3.03 )
Industry variable	control	control	control
Annual variable	control	control	control
N	15122	15122	15122
Adj R2	0.227	0.230	0.322
* means significant at the 10% level, ** means significant at the 5% level, and *** means significant at the 1% level. (T value in parentheses)			

However, some scholars have raised doubts about this method, believing that the sequential test method has a series of problems, such as the fact that the coefficient product is significant, but the test result is not significant, which may easily lead to the difference of regression results [29]. In order to verify the above conclusions, Bootstrap method was used to test the significance of coefficient product again on the basis of the above test methods to further verify the validity of the conclusions in this paper. Therefore, a 95% error correction confidence interval (CI) was constructed in this paper, and the bootstrap method was used for repeated extraction for 5000 times to test again. If the test results show that there is no zero between the upper and lower limits of the confidence interval constructed in this paper, it is proved that there is a significant mediating effect in the conclusion of this paper. Table 6 shows the results of Bootstrap analysis of mediating effects. The results show that the mediating effect of environmental uncertainty on inefficient investment through financing constraint is 0.012(CI=[0.007, 0.017]). Since the confidence interval does not include zero, the mediating effect of financing constraints is established. In addition the bootstrap test results show that financing constraints have not fully mediation effect, and combining with the results of regression model (2) in table 5 can be concluded that environmental uncertainty from two aspects of direct and indirect influence on the efficiency of investment, and in indirect intermediary effect, financing constraints play an important role, namely the H3 hypothesis verified again.

**Table 6 Mediation effect test results of Bootstrap method**

Mediation effect	Coefficient		Confidence interval	
	Effect	Standard error	Lower limit	Upper limit
Mediation effect	0.012	0.002	0.007	0.017

#### 4.4 Test of moderated mediating effects

In order to verify the moderating effect of excess cash holdings on environmental uncertainty and inefficient investment of enterprises, the Bootstrap test is used as a verification method of moderated

mediating effect model. The mediating effect of financing constraints on high excess cash holdings, low excess cash holdings and average excess cash holdings was described with the average value of excess cash holdings plus or minus one standard deviation as grouping conditions. As can be seen from Table 7, when the level of excess cash holdings is low, the indirect effect of financing constraints on inefficient investment of enterprises is 0.011(CI=[0.006, 0.016]). When the level of excess cash holdings is high, the indirect effect of financing constraints on inefficient investment is 0.013(CI=[0.008, 0.018]). The confidence intervals on the right of Table 7 do not include zero, indicating that the indirect mediating effect of financing constraints is significant no matter the excess cash holdings are at a low value or a high value, and the indirect effect coefficient is higher when the excess cash holdings are at a high value. So the hypothesis of H4 is supported.

**Table 7 Test results of moderated mediation effect under Bootstrap method**

Mediation effect	Adjust the variable	Coefficient		Confidence interval	
		Effect	Standard error	Lower limit	Upper limit
Mediation effect	-1SD	0.011	0.003	0.006	0.016
	Mean	0.012	0.003	0.007	0.017
	+1SD	0.013	0.003	0.008	0.018

#### 4.5 Robustness test

In order to verify the stability of this study, several robustness tests were carried out. Firstly, tobin's Q value is used to replace the growth rate of enterprise sales revenue to run the econometric model of financing constraint, and there is no substantial change in test results. Secondly, tobin's Q value is used to replace the growth rate of corporate sales revenue to run the measurement model of excess cash holdings, and the result has no substantial change. Thirdly, considering the possibility of multicollinearity in the data, VIF test was conducted in this paper, and the test results showed that the maximum value was 2.87 and the average value was 1.86, both within the upper limit of 5, indicating that the data in this paper basically did not have collinearity problem.

#### 5 Research Conclusions

Based on the theory of environmental uncertainty, this paper explores the restrictive relationship and mechanism of inefficient investment. The results show that environmental uncertainty increases the cost of external financing, leading to greater financing constraints. The increase of financing constraints leads to the decline of investment behavior and efficiency of enterprises, and causes the increase of inefficient investment from the side. In addition, financing constraint plays an incomplete intermediary role, and this mechanism is regulated by excess cash holdings, namely, the higher the amount of excess cash holdings, the greater the intermediary role of financing constraint in environmental uncertainty and inefficient investment, and vice versa. The research conclusion of this paper reveals that the investment efficiency of enterprises is affected by the fluctuation of external environment. Therefore, enterprises need to incorporate the environmental uncertainty into the



investment impact model when considering the investment behavior, and comprehensively consider the factors influencing the investment efficiency of enterprises.

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