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Research on the Impact of Environmental Regulation and Government Subsidy on Investment Efficiency of Listed Companies in Manufacturing Industry

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ABSTRACT. *This paper selects the listed companies in the manufacturing stage from the 10th to the 12th Five-Year Plan as the research object, and discusses the impact of government subsidies on the investment efficiency of enterprises based on the perspective of environmental regulation. Studies have shown that environmental regulation will reduce the efficiency of corporate investment, but when companies face more stringent environmental regulation goals, government subsidies will provide a strong support to avoid excessive investment or under-investment, and improve corporate investment efficiency. Throughout the "10th Five-Year Plan" period, government subsidies did not play an active role. Further research has found that government subsidies have a significant inhibitory effect on excessive investment compared to non-state-owned enterprises in the face of environmental regulations. However, regardless of the nature of the enterprise, government subsidies can help to reduce the degree of investment in enterprises. It shows that the mechanism of government subsidies affecting investment efficiency for enterprises with different property rights is not completely consistent.*

KEYWORDS: *environmental regulation, government subsidies, investment efficiency, manufacturing listed companies*

1. Introduction

At present, the research on the impact of government subsidies on corporate investment efficiency is mainly analyzed from the mechanism of resource allocation and subsidy allocation. This paper explores the impact of government subsidies on the investment efficiency of listed companies in the manufacturing industry from the perspective of environmental regulation, and extends this theoretical analysis.

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The mechanism and direction of the influence of government environmental regulation on investment efficiency is obviously different from the government's goal of increasing employment and driving economic growth. Whether it is to increase employment or to promote economic growth, its purpose is to cater to the needs of the government and carry out targeted investment strategies, which in turn has caused political subsidies to intensify blind investment by enterprises. In essence, environmental regulation is based on the maintenance of ecological benefits. It is committed to finding a balance between profitability and ecological benefits. Its main environmental regulation measures include collecting pollutant discharge taxes, controlling total pollutant emissions, green credit, green securities, green procurement, and The ecological compensation policy, etc., ordered the listed companies in the heavily polluting industries to provide annual environmental reports, including detailed information on pollutant categories, emission concentrations, scales, and routes, which undoubtedly increased the company's additional production costs. This paper takes the listed companies in the “10th Five-Year” to “Twelfth Five-Year” period as the research background, and discusses the influence mechanism of government subsidies on the investment efficiency of enterprises under the influence of environmental regulation, enriching relevant theoretical research.

On the other hand, the research on corporate investment efficiency basically focuses on foreign direct investment, most of which are discussed through the dimension of environmental regulation, and there is no literature on the impact of environmental regulation on corporate investment efficiency from the perspective of government subsidies, so it is also enriched. Regulatory economics theory.

2. Theoretical analysis and research hypothesis

2.1 The impact of environmental regulation on corporate investment

2.1.1. Environmental regulation and excessive investment by enterprises

Although Stefan V (2013) and Marklund (2017) validate the correctness of the Porter hypothesis by assessing the impact of static and dynamic environmental policies on productivity, it is believed that strict environmental regulations will enable companies to make pre-emptive investments, thereby contributing to company performance. The resulting dynamic impact creates profits and offsets production costs [1-2]. However, the existing research literature is not consistent with this conclusion. On the contrary, in order to comply with the national environmental protection management standards, enterprises need to take effective measures to control the environmental pollution caused by the construction process and production process, and then invest a large number of innovative technologies and equipment and equipment to increase the production cost of the enterprise, which makes a single The scale of the economy of the enterprise has been improved. For example, Naso et al. C (2017) used the Chinese ammonia, paper, cement and other industries as samples to test the relationship between environmental regulation and industrial productivity and competitiveness, and found that the “strong porter

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hypothesis" does not exist significantly [3]; Leiteram , Parolinia, Winnerh (2012) argue that when the negative effects of sunk costs are lower than the positive effects of mass production under oligopoly, companies will support environmental regulation policies [4]; Zhao Xin and Sun Bowen (2016) consider research and development capabilities The positive response of strong companies to environmental regulation will eventually lead them back to the ranks of sustainable companies. Especially for listed companies in the manufacturing industry, innovative compensation mechanisms will enable enterprises to actively respond to environmental policies. New technologies or new products will reduce the cost of inputs, thereby reducing the environmental governance costs per unit of output [5]. In addition, there are currently three types of environmental regulation in China, namely command-controlled, market-oriented, and voluntary protection. Countries generally prefer to adopt a micro-intervention strategy, that is, command-and-control, which not only includes the formulation of relevant laws and regulations, and other government interventions that restrict corporate investment decisions, but also limits waste discharge and regulates production processes. For example, to reduce pollution and reduce energy consumption as task-oriented, set up capacity adjustment programs, assess backward production capacity and define clear scope and requirements, and strictly control environmental protection thresholds for all sectors of heavy pollution industry. Therefore, the company must take into account the environmental regulation constraints, in response to environmental pollution caused by the minimum effective size and equipment selection and other guidance information, provide more financial support for fixed assets, resulting in excessive investment from the normal investment scale.

2.1.2. Environmental regulation and insufficient investment by enterprises

Environmental regulation may not only lead to excessive investment by enterprises, but may also lead to insufficient investment by enterprises. Existing research shows that when environmental regulation triggers policy volatility and produces a certain benefit loss result, the option value of its investment opportunity may increase, resulting in investment reduction or lag. On the other hand, investment projects of heavily polluting enterprises need to be approved by the government departments such as the Environmental Protection and Planning Bureau and subject to the control of the total amount of major pollutants. With the continuous strengthening of environmental management and control, considering the ecological load ceiling, it is difficult for local governments to expand potential investment space, and some companies will show signs of abnormally reduced investment scale. In addition, China's implementation of environmental credit policies such as green credit and green securities have restricted the external financing of listed companies in the heavily polluting industries, especially those with low environmental governance, which often result in insufficient investment.

Referring to the above-mentioned environmental regulation research on excessive investment and under-investment of enterprises, this paper believes that environmental regulation promotes the investment efficiency of different listed companies. Therefore, this paper proposes research hypothesis 1:

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Hypothesis 1: The stronger the binding of corporate environmental regulations, the lower the investment efficiency, that is, the higher the probability of over-investment or under-investment.

2.2 Impact of environmental regulation and government subsidies on corporate investment

2.2.1. Environmental regulation, government subsidies and excessive investment in enterprises

Jia Junxue and Guo Qingwang (2010) pointed out that fiscal decentralization encourages governments at all levels to intervene in the development of enterprises. The government encourages corporate investment and grants government subsidies in order to improve GDP and political achievements. The overall goal of environmental regulation policy serving economic and social development has become an important means of transforming the mode of economic development [6]. Wei Zhihua, Zhao Yueru, Wu Yuhui (2015) found that government subsidies can make up for the financial gap of enterprises to a certain extent, and provide guarantee for the external financing of enterprises, thus softening the financing constraints of enterprises. At the same time, government subsidies will also encourage enterprises to over-invest, which shows that when the problem of soft financing of enterprises is more serious, government subsidies are likely to increase the excessive investment of enterprises [7]. Since the "Eleventh Five-Year Plan", the major pollutant emission reduction targets have become binding targets for the first time. Under this background, the government's demand for pollution industry enterprises to pursue GDP and employment growth will decline, and the demand for pollution control levels will rise. . Therefore, when the company is faced with stricter environmental regulation and restraint, government subsidies will limit its excessive investment behavior in the polluting industry to avoid the political and social problems caused by environmental governance and industrial adjustment.

2.2.2. Environmental regulation, government subsidies and insufficient corporate investment

Zhang Zhonghua and Du Dan (2014) believe that the role of government subsidies for enterprises in corporate investment mainly manifests in two aspects. First, government subsidies can directly alleviate the financial distress of enterprises and promote enterprise investment. Second, administrative subsidies include A certain information orientation, its guiding information enables investors in the macro market to make effective investments and exerts the potential value of government subsidies [8]. Tu Hongxing and Xiao Xu (2014) introduced 36 local industrial industries during their research period, and used 2001 as the starting year of sample data, and 2010 as the year of sample data termination, exploring the benefit ratio information and industrial sewage discharge, through The directional distance function starts with the year and industry dimension to assess the efficiency loss and cost increase of the domestic industrial industry affected by environmental regulation [9]. Huang Nengli (2014) turned his attention to the Shanghai and Shenzhen markets, and analyzed and analyzed non-financial listed companies.

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Through empirical analysis, he explored the specific path and performance of government subsidy related companies' investment efficiency. The results show that government subsidies will promote excessive investment, but have a certain mitigation effect on insufficient investment. This relationship will be differentiated by the competition conditions of the product market and the level of marketization process [10]. Therefore, under the same conditions, enterprises receiving government subsidies can alleviate the risks and uncertainties of the government's high-intensity environmental supervision, and help to reduce the investment shortage caused by external uncertainty and risks.

Government-subsidized resource access mechanisms also help regulated companies reduce underinvestment. Studies have shown that government subsidies will provide companies with more productive factors because government subsidies shorten the distance between the company and the executive branch. For enterprises facing environmental regulation, their investment activities need to obtain the following favorable conditions from the government: (1) Project approval. The more heavily polluting projects of listed companies that receive government subsidies, the more likely they are to pass the review, and the resistance of the project is relatively small; (2) external financing. Government subsidies through government intervention, reduce information asymmetry between investors and enterprises, reduce government financing constraints, promote financing and thus increase asset-liability ratio. Therefore, government subsidies can promote listed companies within the scope of environmental regulation to obtain exogenous funds. To prevent underinvestment caused by shortcomings in financing.

In summary, the political goal of government subsidies is to curb excessive investment by enterprises; the concentration of resources and the risk regulation of environmental regulation have reduced the investment of enterprises. The above-mentioned mechanism of action restricts the formation of non-efficiency investments (over-investment and under-investment) of enterprises regulated by the environment, thereby improving the investment efficiency of enterprises. Therefore, the research hypothesis 2 of this paper is proposed:

Hypothesis 2: The more stringent environmental regulations a company faces, the more significant the positive impact of its government subsidies on corporate investment efficiency. That is, government subsidies can help curb excessive investment or reduce underinvestment.

3. Research design

3.1 The main variable settings

3.1.1. Calculation of investment efficiency

This paper introduces the Richardson (2006) investment model to estimate the normal level of investment.

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$$Inv = \alpha_0 + \alpha_1 Growth_{i,t-1} + \alpha_2 Lev_{i,t-1} + \alpha_3 Cf_{i,t} + \alpha_4 Ret_{i,t-1} + \alpha_5 Roa_{i,t-1} + \alpha_6 Age_{i,t} + \alpha_7 Size_{i,t} + \alpha_8 Inv_{i,t-1} + \sum Ind + \sum Year + \varepsilon_{i,t} \quad (1)$$

Among them, $Inv_{i,t}$ is the new capital investment of the company i in the t-th year. Different scholars have different measurement methods. This paper uses the cash flow statement (purchase of fixed assets intangible assets and other long-term assets). The ratio of the fixed assets intangible assets and other long-term assets recovered by cash) to the total assets at the beginning of the period; $Growth_{i,t-1}$ is the investment opportunity of the company that lags the first period, expressed by Tobin Q value, which is the total market value of the company's stock and total liabilities. The ratio of the total amount to the total assets at the end of the year; $Lev_{i,t-1}$ is the asset-liability ratio of the first-phase lag; $Cf_{i,t}$ is the ratio of the net cash flow generated by operating activities to the total assets; $Ret_{i,t-1}$ is the lag one Annual stock return rate; $Age_{i,t}$ is the company's listing period; $Size_{i,t}$ is the natural logarithm of the company's total assets; Year and Ind are annual and industry dummy variables.

After regression of the model (1), the absolute value of each company's annual residual value is calculated, and the residual value is the degree of excessive investment of the company i in the t-year, that is, the residual value is greater than 0 or the residual value is less than 0. The higher the Abseinv value, the more serious the company's non-efficiency investment; the higher the Overinv value, the more serious the investment; the Underinvi, the higher the value of t, the more serious the underinvestment.

3.1.2. Variable setting of environmental regulation intensity

How to determine the environmental regulation intensity parameters is always the bottleneck of current research. The main methods currently used include: (1) Lu Hao (2009) uses the “per capita income level” (GNI) as a proxy variable for environmental regulation. This means that endogenous profitability will be closely linked to environmental regulation. The higher the income level, the higher the concern about the environment and the stricter the environmental regulatory policy. On the contrary, the lower the income level, the weaker the administrative control of environmental regulation [11]; (2) Fu Jingyan and Li Lisha (2010) summarized the number of units discharged into the corresponding activities of manufacturing activities, and designed the corresponding standards [12]; 3) Xu Songtao and Xiao Xu (2011) also use the unit sewage discharge as an entry point to design a quantitative control threshold [13]; (4) Li Gang (2010) uses the law enforcement intensity of environmental regulation to represent the strictness of environmental regulation [14]. Since the environmental regulation intensity index of each company cannot be obtained, this paper adopts the practice of most scholars and replaces the environmental regulation intensity index with the industry's environmental governance expenditure. The reason is that the stronger the government's environmental regulations, the more prevention and control measures the company will take in order not to violate the government's goals, and the pollution control expenditures accompanying the industry will increase. Therefore, this paper adds up the operating costs of wastewater and waste gas treatment facilities, and reduces the

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industrial output value of the industry as a proxy variable for the intensity of environmental regulation.

Based on the disclosed annual operating costs of wastewater and waste gas from 29 industries in the manufacturing industry, this paper divides manufacturing listed companies into 29 industries and calculates them annually. In addition, the total industrial output value and environmental treatment facility operating cost data for 2018 are not disclosed in the China Statistical Yearbook 2019. Based on the industrial added value of various manufacturing industries and the PPI index of various industries published by the National Bureau of Statistics, this paper calculates 2016. The total industrial output value of various industries in the manufacturing industry from 2018 to 2018.

3.2 Model setting

In order to study the mechanism of government subsidies on the efficiency of corporate investment in the context of the study of environmental regulation effectiveness, this paper constructs a model (2):

$$Abseinv_{i,t} \text{ or } Overinv_{i,t} \text{ or } Underinv_{i,t} = \beta_0 + \beta_1 Sub_{i,t} + \beta_2 Ers_{i,t} + \beta_3 Sub_{i,t} * Ers_{i,t} + \beta_4 Ret_{i,t-1} + \beta_5 TQ_{i,t-1} + \beta_6 Cf_{i,t} + \beta_7 Roa_{i,t-1} + \beta_8 Lev_{i,t-1} + \beta_9 Age_{i,t} + \beta_{10} Size_{i,t} + \sum \mu Year_{i,t} + \sum \tau Industry_{i,t} + \varepsilon_{i,t} \quad (2)$$

The variables of model (2) are described in Table 1.

Table 1 Definition of main variables

Variable Symbol	Variable Name	Variable Type	Definition
$Abseinv_{i,t}$	Investment efficiency	Explained variable	Absolute value of residual value calculated according to Richardson's (2006) model
$Overinv_{i,t}$	Excessive investment	Explained variable	Calculate residual values greater than 0 according to the Richardson (2006) model
$Underinv_{i,t}$	Insufficient investment	Explained variable	Calculate the absolute value of the residual value less than 0 according to the Richardson (2006) model
$Sub_{i,t}$	Government subsidies	Explanatory variables	Government subsidy income / operating income, referred to as $Sub_{i,t}$
Er-intensity$_{i,t}$	Environmental regulation intensity	Explanatory variables	Industry wastewater and waste gas treatment facilities operating costs / industry industrial output value, referred to as $Ers_{i,t}$
$Ret_{i,t-1}$	Annual stock return	Control variable	Annual stock return
$TQ_{i,t-1}$	Tobin Q	Control variable	(Company stock market value + net debt value) / book total assets
$Cf_{i,t}$	cash flow	Control variable	Net cash flow from operating activities / total assets
$Roa_{i,t-1}$	Return on total assets	Control variable	Net profit / total assets
$Lev_{i,t-1}$	Assets and liabilities	Control variable	Total liabilities / total assets
$Age_{i,t}$	Company listing age	Control variable	Years the company has been listed
$Size_{i,t}$	Company Size	Control variable	Natural logarithm of total assets

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This paper mainly investigates whether the interaction coefficient of the government subsidy variable ($Sub_{i,t}$) and the environmental regulation intensity variable ($Ers_{i,t}$) is significantly less than zero. If the full sample investment efficiency ($Abseinv_{i,t}$) is the explanatory variable, the coefficient of the interaction term is significantly less than 0, indicating that the more strict the environmental regulation is, the more the government subsidy will help to improve its investment efficiency; The degree of overinvestment ($Overinv_{i,t}$) is the explanatory variable, and the coefficient of interaction coefficient less than 0 indicates that government subsidies help to curb excessive investment; for example, the underinvestment of underinvestment samples ($Underinv_{i,t}$) is the explanatory variable, interaction A negative factor indicates that government subsidies help to alleviate the underinvestment of companies.

3.3 Sample selection and data source

Considering that the data on environmental regulation of sub-sectors in 2019 has not been announced and the effect of the first phase of the study is delayed, this paper takes the year 2000 of the "10th Five-Year Plan" as the starting point of the research time, and as of 2018, it is the sample industry. During the selection period, it is considered that industrial enterprises are the main industries affected by the maximum environmental regulation, and the industrial environmental governance information is not involved in the fields of agriculture and service industries. Therefore, the choice of samples is limited to listed companies in the manufacturing industry. This article removes financial companies and companies with missing data, and ultimately consists of sample data from 17,912 manufacturing listed companies from 2000 to 2018.

In addition to the above description of the intensity of environmental regulation and the source of government subsidy data, the financial data and government subsidy data of this paper are from the Guotaian database, and the sample data is subjected to the Hausmann F test. The test results are in 1 the null hypothesis was rejected at the significance level of percent; the regression of this paper used the fixed effect regression model.

Table 2 shows descriptive statistics for the main variables. The average investment expenditure is 0.055, and the maximum and minimum values are 0.603 and - 1.782, respectively, indicating that the selected sample data differs from the investment expenditures of different companies. The TQ mean is 0.507, and the maximum and minimum values are 15.622 and 0.007, respectively, indicating that the investment opportunities of each company vary widely. All the parameters in Table 2 have significant range of extreme value fluctuations, indicating that the homogeneity of each company is not significant.

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4. Empirical test results and analysis

4.1 Descriptive statistics

Table 2 Descriptive statistics of the main variables

Variable	N	mean	standard	minimum	maximum
$Abseinv_{i,t}$	17912	.055	.13	-1.782	.603
$Overinv_{i,t}$	5528	.047	.045	0	.42
$Underinv_{i,t}$	5951	-.043	.038	-.781	0
$Er\text{-}intensity_{i,t}$	16723	.02	.038	0	.443
$Sub_{i,t}$	13200	.006	.016	0	1.169
$Lev_{i,t-1}$	17912	.513	1.306	.007	0.641
$TQ_{i,t-1}$	17620	.507	1.715	.007	15.622
$Cf_{i,t}$	17912	.047	.08	-1.686	.914
$Roa_{i,t-1}$	17912	.033	.484	-0.483	0.221
$Ret_{i,t-1}$	16153	.244	.816	-.909	16.119
$Age_{i,t}$	17913	16.029	6.944	1	29
$Size_{i,t}$	17912	21.662	1.192	16.181	27.307

4.2 The regression test results

4.2.1. Full sample regression analysis

Table 3 Full-sample regression results of environmental regulation and government subsidies for investment efficiency

Explained Variables	Full sample			
	(1)	(2)	(3)	(4)
Subi,t	-0.200***		-0.210***	-0.270***
	(0.0274)		(0.0280)	(0.0389)
Er-intensityi,t		0.00689**	0.0357**	0.0455***
		(0.0278)	(0.0150)	(0.0156)
Ersi,t*Subi,t				-2.410**
				(1.077)
TQi,t-1	-0.00258	-0.0114***	-0.00777	-0.00776
	(0.00664)	(0.00104)	(0.00781)	(0.00781)
Cfi,t	-0.00681	0.0438***	-0.00580*	-0.00577*
	(0.00673)	(0.0130)	(0.00687)	(0.00687)
Levi,t-1	0.00945	-0.000617	0.0146**	0.0146**
	(0.00637)	(0.00137)	(0.00732)	(0.00732)
Reti,t-1	-0.000841	-0.000675	-0.00105*	-0.00105*
	(0.000559)	(0.00111)	(0.000571)	(0.000570)
Roai,t-1	0.0121***	0.0468***	0.0121***	0.0121***

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	(0.00375)	(0.00231)	(0.00385)	(0.00385)
Agei,t	0.00511	0.00391	0.00514	0.00516
	(0.00630)	(0.0151)	(0.00631)	(0.00631)
Sizei,t	-0.0113***	-0.0130***	-0.0116***	-0.0116***
	(0.000886)	(0.00138)	(0.000901)	(0.000901)
Constant	0.206**	0.268	0.213**	0.213**
	(0.0975)	(0.248)	(0.0975)	(0.0975)
Observations	11,691	14,565	11,479	11,479
R-squared	0.49	0.44	0.530	0.538
Number of id	1,631	1,598	1,591	1,591

Note: *** p<0.01, ** p<0.05, * p<0.1, T value in parentheses, the same below.

The debt ratio ($Lev_{i,t-1}$) coefficient is significantly positive, reflecting that the long-term creditors have not played a positive role in the investment efficiency of listed companies in the manufacturing industry; the net cash flow ($Cf_{i,t}$) of operating activities is negative, indicating that the company Governance is more rigorous, inhibiting over-investment, or companies are more inclined to finance. The return on total assets ($Roa_{i,t-1}$) is positive, indicating that to a certain extent, the more cash flow, external equity financing and total return on assets, the more supportive the investment behavior of the company. Table 3 shows the full sample regression test for all listed companies in the manufacturing industry. According to Table 3, the paper finds that the coefficient of environmental regulation intensity ($Er\text{-}intensity_{i,t}$) is always significantly greater than 0, which can be used as the basis of hypothesis 1: the more stringent the environmental regulation, the lower the investment efficiency. This paper also finds that when the regression equation does not introduce the government subsidy and environmental regulation intensity variable interaction term ($Er\text{-}intensity_{i,t}*Sub_{i,t}$), the government subsidies ($Sub_{i,t}$) are significantly less than 0, indicating that government subsidies can increase the investment of enterprises. Effectiveness. However, when the interaction between government subsidies and environmental regulation intensity is related, the government subsidy coefficient is no longer significant, the coefficient of interaction is significantly negative and the original hypothesis is rejected at 5%. Therefore, it can be considered that the more the enterprises are bound by environmental regulation, the more government subsidies will help to improve the investment efficiency of enterprises. Verification of Hypothesis 2: Government subsidies are more likely to increase corporate investment efficiency when companies face stronger environmental regulatory pressures. In terms of control variables, the investment opportunity ($TQ_{i,t-1}$) coefficient is significantly negative, indicating that there is a strong correlation between investment expenditure and investment opportunities, that is, when the enterprise has investment opportunities, it will make investment expenditure; The coefficient of ($Lev_{i,t-1}$) is significantly positive, which means that the company's level of operating activities based on the creditor's investment amount is insufficient to increase its investment efficiency; the net cash flow ($Cf_{i,t}$) coefficient generated during the operation period is negative. It shows that enterprises adopting strict measures to manage investment activities can appropriately reduce blind investment and reduce excessive investment. The coefficient of return on total assets ($Roa_{i,t-1}$) is

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positive, indicating that the more total return on assets, the more it can promote the investment behavior of enterprises.

According to the results of Table 3, the R-squared is greater than 0.4, and with the continuous addition of the main variables, the goodness of fit is gradually getting better, so the overall regression results are more reliable.

4.2.2. Regression analysis of over-investment and under-investment samples

Table 4 Sample regression results of over-investment and under-investment

	$Overinv_{i,t}$		$Underinv_{i,t}$	
	(1)	(2)	(3)	(4)
$Er\text{-}intensity_{i,t}$		0.0112**		0.00822**
		(0.0204)		(0.0153)
$Sub_{i,t}$	-0.0118	0.0645	-0.109***	-0.126*
	(0.0369)	(0.0690)	(0.0296)	(0.0346)
$Ers_{i,t}*Sub_{i,t}$		-2.676**		-0.799**
		(2.042)		(0.848)
$TQ_{i,t-1}$	0.0270*	0.0269*	-0.00337	-0.00341
	(0.0140)	(0.0140)	(0.00658)	(0.00658)
$Cf_{i,t}$	0.00137	0.000427	0.00511	0.00488
	(0.0109)	(0.0109)	(0.00595)	(0.00596)
$Lev_{i,t-1}$	-0.00794	-0.00797	6.76e-05	6.72e-05
	(0.0120)	(0.0120)	(0.00617)	(0.00617)
$Ret_{i,t-1}$	-0.00148*	-0.00146*	0.000595	0.000602
	(0.000861)	(0.000861)	(0.000508)	(0.000508)
$Roa_{i,t-1}$	0.0328***	0.0325***	-0.00719*	-0.00725*
	(0.00584)	(0.00584)	(0.00382)	(0.00382)
$Age_{i,t}$	0.00395	0.00393	-0.00356	-0.00357
	(0.00670)	(0.00670)	(0.00877)	(0.00877)
$Size_{i,t}$	-0.0166***	-0.0166***	0.00994***	0.00994***
	(0.00139)	(0.00140)	(0.000831)	(0.000831)
Constant	0.358***	0.357***	-0.190	-0.190
	(0.0799)	(0.0800)	(0.167)	(0.167)
Observations	5,528	5,528	5,951	5,951
R-squared	0.53	0.53	0.48	0.48
Number of id	1,400	1,400	1,010	1,010

Table 4 shows the subsample regression results of over-investment and under-investment. This paper finds that the coefficient of environmental regulation intensity variable is significantly positive. It can be considered that environmental regulation will not only strengthen the investment tendency of listed companies, but also lead to excessive investment, which will also cause insufficient investment of some companies. The hypothesis 1 of this paper is also verified; the government subsidy variables of model (1) and model (2) have not passed the test level of 10%.

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However, when adding environmental regulation variables and interaction items, the interaction between environmental regulation and government subsidies Significantly negative at the 5% level of significance, indicating that the more stringent environmental regulations, the more government subsidies help to curb excessive investment; in model (3) and model (4), government subsidies and their interactions It has obvious inhibitory effect on the lack of investment in enterprises, and verified the research hypothesis of this paper.

4.2.3. Sample regression analysis of time segments

Table 5 Sample regression analysis of time segments

Abseinv	2001-2005		2006-2010		2011-2015	
	(1)	(2)	(3)	(4)	(5)	(6)
$Er\text{-}intensity_{i,t}$		0.146		0.236**		0.181**
		(0.387)		(0.145)		(0.0782)
$Sub_{i,t}$	-0.398	-0.119	-0.0261	0.149	-0.490*	-0.624*
	(4.505)	(7.681)	(0.0927)	(0.153)	(0.0597)	(0.0767)
$Ers_{i,t}*Sub_{i,t}$		0.34		-0.921**		-0.715*
		(3.56)		(6.191)		(3.718)
$TQ_{i,t-1}$	0.422	0.174	-0.0358**	-0.0333**	0.000166	-0.0364
	(7.588)	(1.754)	(0.0145)	(0.0149)	(0.0131)	(0.0455)
$Cf_{i,t}$	0.114	-0.194	0.0208	0.0224	0.0177	0.0188
	(0.415)	(0.504)	(0.0146)	(0.0150)	(0.0123)	(0.0125)
$Lev_{i,t-1}$	-0.427	-0.175	0.0285***	0.0279***	-0.0224	0.0141
	(7.574)	(1.753)	(0.00917)	(0.00930)	(0.0151)	(0.0459)
$Ret_{i,t-1}$	-0.0206	-0.0568	0.00352***	0.00289***	-0.0158***	-0.0155***
	(0.0832)	(0.134)	(0.000930)	(0.000972)	(0.00158)	(0.00159)
$Roa_{i,t-1}$	0.346	0.331	-0.0136	-0.0125	-0.0263***	-0.0264***
	(0.675)	(0.827)	(0.0148)	(0.0150)	(0.00948)	(0.00955)
$Size_{i,t}$	0.0654	0.134	0.0204***	0.0186***	-0.0137***	-0.0123***
	(0.164)	(0.238)	(0.00369)	(0.00389)	(0.00280)	(0.00282)
$Age_{i,t}$					0.00432	0.00426
					(0.00966)	(0.00967)
Constant	-1.133	-2.825	-0.385***	-0.350***	0.314**	0.283*
	(3.548)	(5.066)	(0.0805)	(0.0845)	(0.157)	(0.157)
Observations	69	64	2,694	2,619	4,669	4,593
R-squared	0.250	0.392	0.39	0.36	0.68	0.63
Number of id	49	46	801	776	1,276	1,252

Table 5 shows the sample regression analysis for the time period. It can be seen from Table 5 that due to the weak overall environmental regulation intensity during the Tenth Five-Year Plan (2001-2005), there is no significant impact on investment efficiency. Therefore, government subsidies, environmental regulation intensity and their interaction items are not significant; In the “Eleventh Five-Year Plan” and “Twelfth Five-Year Plan” period, the coefficient of interaction between government

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subsidies and environmental regulation intensity is significantly negative. Therefore, it can be speculated that the more stringent the environmental regulation intensity, the contribution of government subsidies to promote investment efficiency growth. The stronger, this further validates the research hypothesis 2 of this paper.

Throughout the development trend, China's "Eleventh Five-Year" period is a turning point in the change of environmental regulation intensity. The effective period of the "10th Five-Year Plan" was 2001-2005. At that time, the use of domestic environmental regulations was not obvious enough, and the environmental protection program stayed on paper, and the implementation progress was slow. For the first time, the "Eleventh Five-Year Plan" has added the threshold of the sewage index in the field of economic construction as a condition for restricting blind investment. The original intention of this initiative is to set eco-efficiency targets for the “Eleventh Five-Year Plan”, set up investment priorities and allocate policy documents, clearly define the rights and responsibilities of the government and environmental protection units, and commit to leading the listed companies and the public. Achieve multi-party linkages and jointly create an environmentally friendly platform. The upper limit of the scale of the major pollutants listed in the outline deserves our attention. Anti-pollution is regarded as a key task, which promotes the purpose of structural optimization and enhances the ability to control pollution. In order to achieve the pre-set goal of reducing SO2 and chemical oxygen demand by 10% in 2010 (refer to the 2005 data). In addition, major river basin management projects such as Songhua River, Taihu Lake and Chaohu Lake must be paid attention to, and more energy should be invested to assist the city's daily waste water treatment capacity upgrade to provide more quality drinking water for the masses. During the "Twelfth Five-Year Plan" period, China's environmental regulation continued to maintain a high-pressure policy, aiming to accelerate the construction of a resource-saving and environment-friendly society. This effect was less pronounced during the Tenth Five-Year Plan period. Therefore, we can assume that the “Eleventh Five-Year” and “Twelfth Five-Year” phases have been strengthened by the environmental regulations, and the role of government subsidies is stronger. During the “Tenth Five-Year Plan” period, this effect may not be significant.

4.2.4. Sample regression analysis of the nature of property rights

Existing research shows that the government has strong incentives for state-owned enterprises to intervene. The research by Kong Dongmin, Liu Shasha, and Wang Yanan (2013) shows us that the government is keener to provide financial support to companies with obvious market appeal. Among the companies receiving subsidies, the loss-making enterprises received a greater degree of subsidies. State-owned enterprises have thus won more financial support, while non-state-owned enterprises face fewer subsidy opportunities and the degree of benefit is weak [15]. The government achieves its goal of promoting local economic development, GDP, and employment through state-owned property bonds. However, the government’s intervention in non-state-owned enterprises is weak, and non-state-owned enterprises are less responsible for the multiple objectives of the government, and the government the two channels of government subsidies affect the investment behavior of enterprises to achieve their political goals. Moreover, the impact of

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government subsidies on state-owned enterprises is stronger than that on non-state-owned enterprises. The reason is that non-state-owned enterprises regard profitability as the ultimate goal. The main purpose of establishing government subsidies is to obtain credit resources and government assistance. Therefore, it can be expected that when state-owned enterprises face the limitation of environmental regulation, government subsidies can reduce their financing restrictions, and companies are less prone to under-investment problems, but the situation of excessive investment may be more serious. This is due to the environmental regulations. The concentrated characteristics of the market will be highlighted, especially the mandatory management regulation strategy, which is likely to accelerate the pace of capacity update, raise investment and entry threshold to new heights, and backward production capacity can only be withdrawn from the market, so enterprises are likely to increase investment. Initiative. Non-state-owned enterprises basically do not consider the political objectives of the government. Therefore, the government subsidies of non-state-owned enterprises that are bound by environmental regulations are difficult to have an inhibitory effect on excessive investment behavior. For state-owned enterprises, the importance of realizing the political goals of the government is prominent, which often constitutes the political task of state-owned enterprises. The intrinsic motivation of government environmental regulation is to promote energy conservation and eco-environmental protection, and promote industrial positioning adjustment. Therefore, when state-owned enterprises are faced with the impact of environmental regulation, it is easier to combine the initial objectives of government subsidies to restrict enterprises from over-investing in heavily polluting industries, and bring about reductions in social and political fields. With reference to the positive impact of government subsidies and the advantages of centralized production factors of state-owned property rights to prevent investment shortages, this paper argues that the deeper the degree of environmental regulation constraints on state-owned enterprises, the government subsidies will inhibit their excessive investment and reduce the under-investment of enterprises. . In order to investigate the inconsistency of enterprise property rights categories, the differences between environmental regulation and government subsidies on the results of corporate investment efficiency are also part of the research content of this paper. Here, it is only classified into state-owned enterprises and non-state-owned enterprises, and is separately processed for regression.

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Table 6 Sample regression results of state-owned enterprises

	$Abseinv_{i,t}$		$Overinv_{i,t}$		$Underinv_{i,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Er\text{-}intensity_{i,t}$		0.0686***		0.0304**		0.00439**
		(0.0231)		(0.0294)		(0.0200)
$Sub_{i,t}$	-0.136***	-0.0155	-0.0314	0.0696	0.0405	-0.142***
	(0.0331)	(0.0520)	(0.0328)	(0.103)	(0.0472)	(0.0520)
$Ers_{i,t}*Sub_{i,t}$		-4.611***		-3.392**		-5.463***
		(1.517)		(3.289)		(1.172)
$Lev_{i,t-1}$	0.0304***	0.0300***	0.00626	0.00686	0.0122	0.0123
	(0.0108)	(0.0108)	(0.0162)	(0.0162)	(0.00893)	(0.00889)
$TQ_{i,t-1}$	-0.0289**	-0.0283**	0.0195	0.0180	-0.0157	-0.0144
	(0.0117)	(0.0117)	(0.0173)	(0.0173)	(0.00984)	(0.00980)
$Cf_{i,t}$	0.00845	0.00736	0.0187	0.0162	0.0321***	0.0322***
	(0.0111)	(0.0112)	(0.0183)	(0.0184)	(0.00936)	(0.00933)
$Roa_{i,t-1}$	0.0374***	0.0372***	0.0266***	0.0258***	-0.0277***	-0.0251**
	(0.00592)	(0.00591)	(0.00649)	(0.00652)	(0.0103)	(0.0102)
$Ret_{i,t-1}$	0.00217**	0.00221**	-0.00139	-0.00141	0.00165**	0.00159**
	(0.000891)	(0.000899)	(0.00133)	(0.00133)	(0.000745)	(0.000742)
$Age_{i,t}$	-0.00199	-0.00200	0.00265	0.00265	-0.00323	-0.00319
	(0.00949)	(0.00945)	(0.0125)	(0.0125)	(0.00882)	(0.00878)
$Size_{i,t}$	-0.0110***	-0.0110***	-0.0154***	-0.0156***	0.0103***	0.0102***
	(0.00157)	(0.00158)	(0.00233)	(0.00234)	(0.00132)	(0.00131)
Constant	0.326*	0.328*	0.337*	0.340*	-0.205	-0.205
	(0.182)	(0.181)	(0.194)	(0.194)	(0.183)	(0.183)
Observations	4,505	4,455	1,434	1,434	3,021	3,021
R-squared	0.61	0.66	0.82	0.84	0.37	0.46
Number of id	484	479	372	372	397	397

It can be seen from Table 6 that no matter how the sample interval is defined, the coefficient of interaction between the government subsidies of state-owned enterprises and the intensity of environmental regulation is significantly negative. Therefore, it can be judged that when state-owned enterprises face stricter environmental regulations, the more government subsidies Help it to improve investment efficiency. This result further shows that the government has reached the goal of environmental regulation through property rights channels and government subsidy routes, which can inhibit excessive investment in heavy pollution projects and promote industrial structure upgrading. In addition, government subsidies can avoid the lack of investment by enterprises. During the period of operation of state-owned heavy polluting units, government subsidies can still provide resource acquisition advantages and risk regulation of environmental regulation.

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Table 7 Sample regression results of non-state-owned enterprises

	$Abseinv_{i,t}$		$Overinv_{i,t}$		$Underinv_{i,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Er\text{-}intensity_{i,t}$		0.0715***		0.00836*		0.00910
		(0.0227)		(0.0270)		(0.0238)
$Sub_{i,t}$	-0.313***	-0.512***	0.200	0.209	-0.189***	-0.384***
	(0.0532)	(0.0670)	(0.145)	(0.150)	(0.0380)	(0.0463)
$Ers_{i,t}*Sub_{i,t}$		7.442***		-1.007		8.855***
		(1.661)		(2.701)		(1.218)
$TQ_{i,t-1}$	-0.0156*	-0.0221*	0.0456**	0.0456**	0.00916	0.00948
	(0.00897)	(0.0118)	(0.0205)	(0.0205)	(0.00894)	(0.00884)
$Cf_{i,t}$	-0.0190**	-0.0171*	-0.0340**	-0.0344**	-0.0100	-0.0135*
	(0.00934)	(0.00952)	(0.0140)	(0.0140)	(0.00780)	(0.00774)
$Lev_{i,t-1}$	0.0123	0.0189*	-0.0130	-0.0133	-0.0113	-0.0117
	(0.00873)	(0.0109)	(0.0172)	(0.0172)	(0.00851)	(0.00842)
$Ret_{i,t-1}$	-0.00240***	-0.00246***	-0.00216**	-0.00217**	-0.000273	-0.000199
	(0.000791)	(0.000798)	(0.00110)	(0.00110)	(0.000692)	(0.000684)
$Roa_{i,t-1}$	-0.00138	-0.00124	0.143***	0.143***	-0.00547	-0.00555
	(0.00590)	(0.00618)	(0.0193)	(0.0194)	(0.00463)	(0.00458)
$Age_{i,t}$	0.0100	0.0101	0.00400	0.00402		
	(0.00909)	(0.00911)	(0.00784)	(0.00784)		
$Size_{i,t}$	-0.0143***	-0.0145***	-0.0173***	-0.0172***	0.00995***	0.0102***
	(0.00118)	(0.00120)	(0.00172)	(0.00172)	(0.00107)	(0.00106)
Constant	0.240**	0.245**	0.366***	0.364***	-0.252***	-0.257***
	(0.120)	(0.120)	(0.0843)	(0.0844)	(0.0233)	(0.0231)
Observations	7,111	7,025	4,094	4,094	2,930	2,930
R-squared	0.38	0.42	0.59	0.59	0.76	0.97
Number of id	1,128	1,112	1,028	1,028	613	613

It can be seen from Table 7 that in the sample of non-state-owned enterprises and the sample of under-investment, the coefficient of interaction between government subsidies and environmental regulation intensity is significantly positive, but government subsidies are significantly negative, indicating that government subsidies have the advantage of resource advantages and risk control. Non-state-owned enterprises play a lower role; in the sample of non-state-owned enterprises, the interaction coefficient does not show significant characteristics, which means that the government-oriented role has not really taken effect, this is related to non-state-owned enterprise subsidies. The main goal is to achieve profit maximization rather than political goals. Considering that environmental regulation will promote the deepening of industry concentration, companies with more resource advantages can expand market space. Therefore, non-state-owned polluting enterprises will reduce their suppression under the mechanism of resource subsidy and risk control of government subsidies. Over-investment.

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5. Research conclusions

This paper defines the sample scope as the full sample information in the “10th” to “12th Five-Year” period of the manufacturing industry. Taking environmental regulation as the entry point, it discusses the specific performance of the listed company's investment efficiency by government subsidies. In the theoretical analysis framework, this paper first discusses the mechanism of environmental regulation on the phenomenon of over-investment and under-investment, and introduces the political objectives, risk regulation and resource concentration of government subsidies, and other factors that affect the excessive investment and under-investment of enterprises. The direction was demonstrated. This paper argues that in order to achieve eco-efficiency, industrial upgrading and other goals, the political goal of government subsidies can avoid excessive investment problems; while the risk control function can reduce corporate environmental policies and regulatory risks, and resource concentration can help enterprises to participate in financing, investment, etc. Activities have avoided problems such as insufficient investment in enterprises.

In addition, overall environmental regulation restricts the investment efficiency of enterprises, but government subsidies help to improve the investment efficiency of enterprises with strict environmental regulations, curb excessive investment and reduce underinvestment. Based on the above theoretical content as the background of the empirical link, this paper introduces the Richardson (2006) model to infer the investment efficiency of different sample objects in different years. On this basis, three types of sample intervals are divided to explore the new changes in corporate investment efficiency, investment over-investment and under-investment under the interaction of environmental regulation and government subsidy elements. The study found that although environmental regulation reduces the efficiency of corporate investment from a macro level, government subsidies help to improve the investment efficiency of companies with strict environmental regulations, curb excessive investment and reduce investment.

This paper also explores the investment efficiency impacts of various stages of business, environmental regulation, and government subsidy interactions. The results show that in the "Eleventh Five-Year Plan" and "Twelfth Five-Year Plan" period, the interaction between the two has a significant positive impact on investment efficiency, and the "10th Five-Year" stage has no significant promotion effect. This is because the “Eleventh Five-Year Plan” has given more practical value to environmental regulation, and the green securities policy has been continuously improved. The government has placed eco-efficiency in a strategic position in the field of economic construction, and has adopted government subsidies to prevent over-investment; this trend has also extended to the “Twelfth Five-Year Plan” stage, making the importance of government subsidies for environmental regulation risk control and resource acquisition advantages. Prominent, so that the lack of investment in enterprises is effectively suppressed.

The study found that, unlike the maximization of the wealth of non-state-owned government subsidies, government subsidies for state-owned enterprises are

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constrained by the political objectives of environmental regulation, making government subsidies restrict excessive investment to state-owned enterprises that are strictly regulated by the environment, while non-state-owned The Company has no significant impact. But whether it is a state-owned enterprise or a non-state-owned enterprise, government subsidies can help reduce the degree of investment in enterprises. At the end of this paper, the changes in investment efficiency faced by various types of ownership enterprises under the influence of environmental regulation and government subsidy interaction are explained. The study found that compared with non-state-owned enterprises, profitability is the primary goal, and state-owned enterprises are more politically oriented, thus avoiding excessive investment. But whether it is a state-owned enterprise or a non-state-owned enterprise, both can use government subsidies to reduce the degree of underinvestment.

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