An Empirical Research on the Impacts of Haze Governance on Over-investment of Heavy Air Pollution Enterprises of China

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This study examines the impacts of haze governance on heavy air pollution enterprises' over-investment based on the data of Chinese listed companies. We find that heavy air pollution enterprises inhibit over-investment more significantly compared with other enterprises after haze governance since 2012 and the results are more remarkable in the non-state owned heavy air pollution enterprises. The research conclusions of this paper verify the effectiveness of haze governance from the perspective of investment efficiency, but the effect of governance has some difference in different property rights heavy air pollution enterprises.

1. Introduction

Haze that mainly consists of sulfur dioxide, nitrogen oxides and particulate matter (PM) is a state of atmospheric pollution and PM 2.5 is considered to be the leading cause of haze. At the end of 2011, the emergence of a large range of haze and the boom of PM 2.5 in china brought serious harm to the people's life and social production, causing widespread concern in the whole society. Worsening haze and public discontent have promoted the government to implement a series of haze governance measures since 2012. China National Environmental Protection Ministry issued a document to implement the new environmental air quality standards and PM 2.5 was incorporated into the standard system as a general evaluation project in February 2012. China's State Council issued the "air pollution prevention action plan" and pointed out that China should adhere to the air pollution prevention and control mechanism of regional cooperation In September 2013.

Chemical, thermal power and other heavy air pollution enterprises have an important responsibility for haze pollution. In April 2015, the national environment monitoring conference released the result of investigation that industrial production, coal, motor vehicles are the main sources of PM in China, accounting for about 85%-90%.

Over-investment refers to that the Investment project is still carried out in the condition that the net present value of it is less than 0, which is a non-efficiency investment behavior, such as expanding the production scale blindly and so on. Over-investment of heavy air pollution enterprises not only does not benefit their own value, but also lead to further serious haze pollution just because the increase in pollutant emissions. Therefore, the haze governance that began in early 2012 will inevitably have an impact on the Over-investment of heavy air pollution enterprises.

Chinese scholars' studies on haze pollution are mainly focus on the haze pollution prevention and control and the studies concern economic consequences of gaze pollution are rare. Shi Changkuan (2014) analyzed the impacts of haze pollution on foreign direct investment. Cao Caihong and Han Liyan (2015) assessed the social health costs caused by haze. Liu Yunguo and Liu Mengning (2015) examined the impacts of political costs on heavy pollution enterprises' earnings management. Based on the data of the listed companies of China, this paper makes an empirical study on the impacts of haze governance on over-investment, which will expand the research of gaze pollution's economic consequences.

2. Theoretical analysis and research hypothesis

Haze governance will undoubtedly become an external constraint on over-investment of heavy air pollution enterprises. On the one hand, haze governance has raised public's unprecedented attention on the pollution of heavy air pollution enterprises. Facing the deterioration of the quality of living environment, people severely denounced heavy air pollution enterprises' act of omission. Such negative public concern brings huge pressure of public opinion, investment risk and even litigation risk to the heavy air pollution enterprises. On the other hand, the government is strengthening the supervision of environmental pollution and such as real-time monitoring and huge amount of punishment and so on will become the normal, which makes heavy air pollution enterprises be more cautious in the investment decision-making and the occurrence of over-investment will face greater risks and higher costs.

Thus, we propose the hypothesis of H1: After haze governance since 2012, heavy air pollution enterprises will more significantly inhibited over-investment compared with other enterprises.

The political environment of the state-owned enterprises and the non state-owned enterprises in China has great differences. Because the government is the real owner of the state-owned enterprises, state-owned enterprises have a closer political relationship with government compared with non state-owned enterprises. In the face of the haze governance, the pressure and the cost of environmental pollution of state-owned enterprises is less than the non state-owned enterprises.

Based on this, we propose the hypothesis of H2: After haze governance since 2012, compared with the state-owned heavy air pollution enterprises, non state-owned heavy air pollution enterprises will have more incentive to inhibit over-investment.

3. Research design

3.1 Sample selection

This paper chooses A-share listed companies from 2009 to 2013 as research samples and the following screen is carried out: (1) Financial companies are removed; (3) The ST or *ST and other companies operating abnormal are removed. (3) Companies that financial data missed are removed; (4) The measure of over-investment is related to the previous one year's data, in order to ensure the continuity of data, this paper has removed the companies that listed after December 31, 2008. Finally, we obtain 4980 observation values of 996 listed companies for five consecutive years. We take "Announcement on the implementation of special emission limits for air pollutants "released by the Ministry of Environmental Protection in 2013 as the standard. If the listed company belongs to the six major industries (thermal power, iron and steel, petrochemical, cement, non-ferrous metals, chemical) that the announcement stipulated, then it is defined as heavy air pollution enterprises. The Data of listed companies comes from WIND and CSMAR database. SPSS18.0 software is used to process Data.

3.2 Measurement of over-investment

In this paper, we use Richardson (2006) model to analyze the sample data in model (1). The negative residuals that the model calculates reflect the under-investment, and the positive residuals reflect over-investment.

$$Inv_{i,t}=a_0+a_1Growth_{i,t-1}+a_2Inv_{i,t-1}+a_3Lev_{i,t-1}+a_4Return_{i,t-1}+a_5Cash_{i,t-1}+a_6Size_{i,t-1}$$

$$+a_7Age_{i,t-1}+\sum Year+\sum Ind+\varepsilon_{i,t} \tag{1}$$

Inv_t, Inv_{t-1} equal to net change of fixed assets, long-term investment and intangible assets divided by the average total assets in (t) year and (t-1) year; $Growth_{t-1}$ represents (t-1) year's growth opportunities, equal to Tobin Q value of (T-1) year; Lev_{t-1} is the company's debt to assets ratio at the end of (T-1) year; $Return_{i,t-1}$ is the return on assets ratio of (T-1) year; $Cash_{t-1}$ represents the company's cash holdings, equal to cash and cash equivalents at the end of the (T-1) year divided by the total assets at the end of the (T-1) year; $Size_{t-1}$ represents the size of the company, equal to the natural log of the total assets at the end of the (T-1) year; Age_{t-1} is the company's listed years by the end of (T-1) year; Year is year dummy variable and Ind is industry dummy variable.

3.3 The model of the relationship between haze governance and over-investment

In order to examine the impacts of the haze governance on over-investment, this paper refers to the relevant research results in recent years and builds the model (2) to test the hypothesis proposed:

$$Over\_Inv_{i,t}=\beta_0+\beta_1HAPE_{i,t}+\beta_2After_{i,t}+\beta_3HAPE_{i,t}\times After_{i,t}+\beta_4Size_{i,t}+\beta_5Age_{i,t-1}+\beta_6LEV_{i,t}+\beta_7ROA$$

$$+\beta_8Tangibility+\beta_9OC+\beta_{10}Fees+\beta_{11}CFO+\varepsilon_{it} \tag{2}$$

The variables of Model (2) are defined in table 1. HAPE x After is the key variable that tests our conclusions. The heavy air pollution enterprises will be more significant to restrain over-investment after the haze governance and the symbol of HAPE x after should be negative.

Table 1: The variables of model (2)

Over_Inv	The regression residuals that are great than 0
HAPE	Heavy air pollution enterprises are defined as 1; other enterprises is defined as 0
After	2012-2013 is defined as 1; 2009-2011 is defined as zero
Size	The natural log of total assets at the end of the term
Age	The natural log of the company's listed years
LEV	Total liabilities/total assets
ROA	Earnings before interest and tax/ average total assets
Tangibility	Fixed assets/ total assets
OC	Top ten shareholders' holding proportion
Fees	Management fees/ sales revenue
CFO	Net cash flow from operating activities/ sales revenue

4. Empirical results

4.1 Industry distribution of heavy air pollution enterprises

To 996 sample firms, the heavy air pollution enterprises in a total is 229, accounting for 22.99% of the total samples. Table 2 lists the specific industry distribution of them. The letter codes represent the industry category that the China Securities Regulatory Commission revised in 2012.

Table 2: Industry distribution of heavy air pollution enterprises

Industry	B07	B08	B09	C25	C26	C28	C29	C30	C31	C32	D44	D45	Total
frequency	4	4	8	11	54	12	10	29	23	22	50	2	229
Proportion	1.747	1.747	3.493	4.803	23.581	5.240	4.367	12.664	10.044	9.607	21.834	0.873	100

*B07 (oil and natural gas mining industry), BO8 (ferrous metal mining industry), B09 (non ferrous metal mining industry), C25 (petroleum processing, coking and nuclear fuel processing), C26 (chemical raw materials and chemical products manufacturing, C28 (chemical fiber manufacturing industry), C29 (rubber and plastic products industry), C30 (non metallic mineral products industry), C31 (ferrous metal smelting and rolling processing industry), C32 (non-ferrous metal smelting and rolling processing industry), D44 (electricity, heat production and supply industry), a total of 12 industries.

4.2 Descriptive statistics

The number of the regression residuals of model (1) that are greater than 0 is 1814, accounting for 36.43% of total observation values. There are 409 residuals that are greater than 0 belonging to heavy air pollution enterprises and state-owned heavy air pollution enterprises account for 292.

Table 3 shows the results of descriptive statistics of over-investment before and after the haze governance. We compare the mean and the median of Over_Inv before and after the haze governance. There is significantly positive difference in heavy air pollution enterprises and the difference of other enterprises is not obvious. To a certain extent, it shows heavy air pollution enterprises' achievements in inhibiting over-investment.

Table 3: Descriptive statistics of Over_Inv before and after the haze governance

	Heavy air pollution enterprises				Other enterprises			
	N	mean	median	Std.de	N	mean	median	Std.de
Over_Inv (before governance)	246	1.2605	0.7151	1.6065	571	0.7061	0.3631	1.0351
Over_Inv(after governance)	163	0.9689	0.5149	1.4561	834	0.6364	0.3152	1.0311

4.3 Multiple regression analysis of model (1)

Table 4 shows the results of the multiple regression analysis of the model (1). As can be seen from the table, the fitting effect of this model is good and the overall explanatory power is strong.

Table 4: The results of the multiple regression analysis of the model (1)

Variable	Intercept	$Growth_{t-1}$	Inv_{t-1}	LEV_{t-1}	$Return_{t-1}$	$Cash_{t-1}$	$Size_{t-1}$	Age_{t-1}
Coefficient	-0.123***	0.009***	0.027**	0.045***	0.067**	-0.006	0.005***	-0.003
T	-2.833	6.149	2.009	4.329	2.512	-0.388	3.274	-0.567

$AdjR^2=0.056$; F=10.757

***, **, and * denote statistical significance at 1%, 5%, and 10% levels.

4.4 Multiple regression analysis of model (2)

The variables of model (2) are tested by Pearson correlation and the results are shown in Table 5. P values are in the brackets.

Table 5: Correlation coefficient analysis

	Over_Inv	AHPE	After	Size	Age	LEV	ROA	Tangibility	OC	Fees	CFO
Over_Inv	1										
HAPE	0.164 (0.000)	1									
After	-0.051 (0.031)	-0.007 (0.775)	1								
Size	0.064 (0.006)	0.193 (0.000)	0.076 (0.001)	1							
Age	-0.005 (0.839)	-0.056 (0.017)	0.322 (0.000)	-0.088 (0.000)	1						
LEV	0.057 (0.016)	0.173 (0.000)	-0.025 (0.296)	0.326 (0.000)	-0.002 (0.947)	1					
ROA	0.136 (0.000)	-0.057 (0.015)	-0.138 (0.000)	0.073 (0.002)	-0.063 (0.008)	-0.202 (0.000)	1				
Tangibility	0.31 (0.000)	0.341 (0.000)	-0.026 (0.262)	0.178 (0.000)	-0.167 (0.000)	-0.106 (0.000)	0.065 (0.006)	1			
OC	0.178 (0.000)	0.08 (0.001)	-0.025 (0.28)	0.363 (0.000)	-0.241 (0.000)	0.153 (0.000)	0.174 (0.000)	0.123 (0.000)	1		
Fees	0.027 (0.249)	-0.096 (0.000)	0.063 (0.007)	-0.327 (0.000)	0.089 (0.000)	0.272 (0.000)	-0.15 (0.000)	-0.127 (0.000)	-0.162 (0.000)	1	
CFO	0.109 (0.000)	0.05 (0.032)	-0.02 (0.385)	0.028 (0.234)	-0.053 (0.024)	-0.28 (0.24)	0.119 (0.000)	0.181 (0.000)	0.059 (0.012)	-0.245 (0.000)	1

From table 5, we can see that the correlation coefficient between the variables are all less than 0.4. Comprehensive analysis can be carried out.

Table 6 shows the results of the multiple regression analysis of model (2) distinguishing the whole sample, the sample of the state-owned listed companies and the sample of the non-state-owned listed companies.

Table 6: The results of the multiple regression analysis of model (2)

	whole sample		state-owned companies		non state-owned companies	
	Coefficient	T	Coefficient	T	Coefficient	T
Intercept	-0.093	-1.444	-0.042	-0.466	-0.162*	-1.748
AHPE	0.021**	2.227	0.006	0.458	0.05***	3.605
After	-0.006	-0.949	-0.007	-0.723	-0.007	-0.759
HAPE×After	-0.024*	-1.808	-0.007	-0.416	-0.063***	-3.065
Size	-0.006**	-1.977	-0.008**	-2.105	-0.003	-0.776
Age	0.039***	4.095	0.031**	2.442	0.059***	4.161
LEV	0.064***	3.305	0.092***	3.400	0.026	0.989
ROA	0.391***	6.881	0.436***	5.135	0.335***	4.689
Tangibility	0.198***	11.894	0.211***	9.149	0.18***	7.406
OC	0.124***	6.463	0.138***	4.870	0.116***	4.608
Fees	0.212***	5.453	0.18**	2.249	0.187***	4.588
CFO	1.855***	2.592	1.92	1.563	1.562**	1.995
AdjR^2	0.169		0.166		0.193	
F	30.71***		18.281***		14.022***	

***, **, and * denote statistical significance at 1%, 5%, and 10% levels.

As can be seen from table 6: In the whole samples, the regression coefficient of AHPE×After is -0.024, which is significant at 10% level. After haze governance, heavy air pollution enterprises have more significantly inhibited over-investment compared with other enterprises and the hypothesis 1 is proved.

Before and after the haze governance, Inhibition on over-investment in state-owned and non state-owned heavy air pollution enterprises ARE different. The regression coefficient of AHPE×After in the non state-owned heavy air pollution listed companies is negative and it is significant at the 1% level. However, although the coefficient of AHPE×After in the state-owned heavy air pollution listed companies is negative, it is not significant. This means that non state-owned heavy air pollution enterprises have more incentive to inhibit over-investment and the effectiveness is more obvious and the hypothesis 2 is proved.

5. Conclusions and recommendations

In this paper, A-share listed companies from 2009 to 2013 taken as the research object, we study whether haze governance effect heavy air pollution enterprises' over-investment after 2012. The results show that: After haze governance since 2012, heavy air pollution enterprises have more significantly inhibited over-investment compared with other enterprises. Compared with the state-owned heavy air pollution enterprises, non state-owned enterprises have more incentive to inhibit over-investment.

Although China's haze pollution is still serious, the research conclusions of this paper has confirmed that haze governance since 2012 has played a role on over- investment of heavy air pollution enterprises, and the reduction of over-investment will relieve the air pollution to a certain extent. Government should continue to reinforce the supervision of air heavy pollution enterprises and more effective measures must be taken to guide and urge heavy air pollution enterprises to reduce the discharge of pollutants.

The conclusions of this study also confirmed that non-state-owned heavy air pollution enterprises have a more positive response in the face of haze governance. Their ability to resist risks is much lower than that of the state-owned heavy air pollution enterprises due to the more miscellaneous administrative regulation, policy

discrimination, and financial discrimination. However, the state-owned heavy air pollution enterprises that have stronger economic strength should make a greater contribution to environmental protection. Perhaps more drastic policies should be implemented to the state-owned heavy air pollution enterprises.

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