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Air Pollution and Employee Protection: The Moderating Effect of Public Attention and Environmental Regulations

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Abstract: Air pollution is imposing substantial health and economic burdens on billions of people around the world. Although the impacts of air pollution on human health and economic growth have long been recognized, empirical evidence on whether and how air pollution affects firms' employee protection remains unclear. Using a sample of publicly listed Chinese firms from 2010 to 2019, we show that air pollution can significantly increase firms' employee protection. The results indicate that employee protection is an effective substitute for poor air quality in firm headquarters. Further analyses suggest that public pressure enhances the influence of air pollution on firms' labor protection, while environmental regulation lessens the positive relationship between air pollution and employee treatment. Overall, we emphasize that air pollution is a significant non-economic determinant affecting firms' human capital stock and employee treatment strategy. This study would be of particular interest to economists, managers, and regulators who are concerned about designing optimal environmental and welfare policies.

Keywords: air pollution; employee protection; public attention; environmental regulations

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1. Introduction

Air pollution is imposing substantial health and economic burden on billions of people around the world, especially for those in developing counties. According to the recent green paper published by the Chinese Academy of Social Sciences, China is experiencing its greatest level of air pollution since 1961 due to the increase in haze and fog. The annual average number of hazy days has increased from six to eighteen over 13 years [1]. Since 2000, more than 92 percent of Chinese citizens have been exposed to particle concentrations greater than 10 g/m^3 [2].

With the increasing concern about the externality of air pollution, the recent literature has extended this line of research and linked air pollution to the capital market and the behavior bias of individuals. For instance, air pollution significantly impacts investors' dispositions by affecting their mental health and cognition [3]. Poor air quality also affects analysts' forecasting bias. Higher air pollution induces a pessimistic mood and then leads to forecasts of lower earnings [4]. Air pollution can change individual investors' trading behaviors and performances as well. Huang et al. [5] have found that air pollution makes investors more susceptible to the disposition effect and to attention-driven buying behaviors. Further, air pollution lowers firms' productivities by influencing the labor supply [6,7].

However, less attention has been given to the effect of air pollution on firm strategy in terms of employee protection. Firms treating employees well can receive positive long-run stock returns [8] and reduce the probability of bankruptcy by operating with lower debt ratios [9]; additionally, employee-friendly policies also benefit corporate innovation, which in turn enhances the firm's value [10,11]. Given the fact that employees are the most important intangible assets [12] and human capital is the key factor for a firm's market power, we believe that studying the association between air pollution and employee protection can enrich our understanding of the economic consequences of air pollution and provide evidence for the determinants of employee protection.

We believe that air pollution increases employee protection. Rational employees in firms located in regions with severe air pollution make tradeoffs between their health and the payoffs. With the increasing concern about environmental risks, employees are more likely to migrate to areas with clean air. Moreover, it will be difficult for firms to attract replacement employees with comparable qualifications at comparable compensation rates compared with firms in regions with clean air. Facing the loss of human capital and rising recruitment costs, we expect that firms will increase employee protection as a compensation for reduced environmental quality.

To measure firms' levels of employee treatment, we used employee relation scores from the Hexun corporate social responsibility scores to proxy employment protection. Hexun provides CSR ranking scores of all the listed firms in China. Employee responsibility is one part of their evaluation system based on the information from firms' CSR reports [13]. The air quality index (AQI) is generated by measuring the concentration of six major air pollutants in accordance with the requirements of the Chinese Ministry of Environmental Protection air quality standard. We obtained the annual data of the AQI for all cities in China from the Chinese Research Data Service (CNRDS) database.

Based on the sample of Chinese publicly listed firms from 2010 to 2019, the baseline results show a positive and significant association between air pollution and the firms' employee protection. The results indicate that employee protection is an effective substitute for poor air quality in firm headquarters. The positive association is robust to a series of robustness checks, including an instrumental variable regression, placebo tests, and alternative measures of air pollution. Further analyses suggest that public pressure enhances the influence of air pollution on firms' labor protection, while environmental regulation lessens the positive relationship between air pollution and employee treatment.

This study contributes to the growing literature in several ways. First, our study contributes to the burgeoning literature examining the economic consequences of air pollution [14]. By documenting the relationship between air pollution and firms' employment policies in China, we add evidence of the impacts of environmental risks on individual decision-making processes and firm strategies. Severe air pollution creates an external environmental uncertainty that limits business development and raises potential risks. Our results suggest that severe air pollution can significantly increase employee protection to avoid the loss of human capital.

Second, our study emphasizes the effect of environmental policy on quality economic development. Specifically, we find that environmental regulations can reduce the influence of air pollution on firms' employee protection. The moderating effect of environmental regulation indicates that environmental policies can effectively lessen the impacts of air pollution at the firm level. The results shed light on the influence of environmental factors on the promotion of the long-term development of regional economies. Our findings also provide empirical support for the cost–benefit assessment of environmental regulation policies.

Third, this paper develops the determinant factors of employee protection. Employee protection is an important part of corporate social responsibility. Current research mainly focuses on the influence of employee protection and its economic consequences, but the determinant factors of employee treatment remain unexplored. In this study, we use Chinese data to investigate whether environmental factors could affect firms' decision making, for example, in regards to the favorable treatment of employees, which complements the existing literature from the perspective of environmental risk.

The remainder of this paper is organized as follows: Section 2 discusses the related literature and develops the hypotheses; Section 3 presents the data and research design; Our main empirical results and a series of robustness checks are presented in Section 4; Section 5 provides further analysis; and Section 6 concludes this paper.

2. Literature Review and Hypothesis Development

2.1. Influence of Air Pollution on Employee Protection

The high health risks of air pollution have long been recognized. Medical studies provide evidence that air pollution can cause strokes, heart disease, and even lung cancer [15–18]. Recent studies have linked air pollution to the capital market and economic activities. Chang et al. [19] confirmed that higher levels of air pollution decrease worker productivity. Isen et al. [20] found that air pollution is associated with lower labor force participation and lower earnings. Dong et al. [4] documented a negative relationship between air pollution during corporate site visits by investment analysts in China and earnings forecasts. Severe air pollution results in low stock returns by inducing pessimistic moods [21–23]. However, whether and how air pollution influences the decision making of firms regarding employee protection remains unclear.

We expect air pollution to promote employee protection for two reasons. First, on the labor supply side, people are increasingly concerned about environmental quality and are willing to pay higher costs for clean air [24]. Meanwhile, environmental quality is being considered as having increasingly important non-monetary benefits to employees [25]. Therefore, rational employees are facing a hard tradeoff between air pollution and economic benefits. They have to weigh the benefits and drawbacks of working in areas with severe environmental pollution. If companies are located in polluted or otherwise unlivable regions, employees may require a higher premium in pay for their quality of life compared with companies in locations with better air quality. For instance, in pollution-related industries, such as gold mining, companies need to increase employee health insurance costs to prevent a reduction in the labor supply caused by severe pollution [26]. This pay premium can be higher for highly skilled employees with stronger bargaining power in the labor market because they have the ability to choose a good working environment. Therefore, improved employee protection is an effective substitute for reduced welfare.

Second, on the labor demand side, firms located in more polluted areas have experienced a loss of human capital, brain drain, and poor performance [2,27–31]. Long-term exposure to severe air pollution causes a negative impact on human health, and also reduces employees' working hours because they may spend more time caring for ill family members [32], which might lead to reduced labor productivity. Moreover, the migration of highly educated human capital could also be a threat to firms. When the marginal utilities from the increase in wages are lower than the marginal utilities from the improvement in air quality, high-quality labor forces might have a stronger incentive to leave air-polluted regions [33,34]. As a result, firms located in polluted regions are less likely to attract and retain more skilled employees, leading to reduced firm output, technological innovation, and firm values [35]. The migration of high-quality human capital can also increase recruitment and training costs. In response to this pollution-induced labor migration, firms are expected to increase employment protection to attract potential job candidates and reduce labor turnover rate, which in turn can improve labor productivity and promote human capital stock.

Based upon this discussion, we hypothesize that firms located in more polluted regions are more likely to improve labor protection:

H1. *Firms located in more polluted regions are associated with a higher level of employee protection.*

2.2. Moderating Role of Public Attention

According to the legitimacy theory, as a social organization, firms need to meet social expectations through a series of behaviors in order to avoid illegitimacy penalties and obtain more resources, which are called legitimacy benefits [36,37]. However, legitimacy comes at a price, requiring businesses to spend scarce resources and even make internal changes. As a result, managers must balance costs and benefits [38]. Empirical research on various organizations backs up this legitimacy trade-off, pointing out that public concern, regulatory pressure, and a variety of institutional factors will influence such strategic decisions [39–41]. Air pollution not only increases the external uncertainty that businesses face, but it also raises public concern about environmental issues. We believe that firms under greater public attention will be more likely to take steps to demonstrate their efforts to handle this problem. By improving employee protection, the company can improve its reputation, gain legitimacy benefits, and reduce human capital loss or address the decline in labor productivity caused by air pollution. Rational managers will put more effort on employee protection because the benefits far outweigh the costs. Therefore, we expect that:

H2. *For firms under stronger public pressure, employees will obtain more protection from air pollution.*

2.3. Moderating Role of Environmental Regulations

In response to the adverse impacts of air pollution on public health and economic development, the Chinese government set up a series of environmental regulations. The stringent enforcements and regulations have caused effects on air quality and related economic outcomes. In general, Zhou and Li [42] found that environmental regulation in China improves environmental quality. Wang et al. [43] further verified that the environmental policies in China have different effects on various categories of air pollutants. Moreover, monitoring and pollution control efforts can significantly affect the influence of environmental policies on air quality. Liu et al. [32] suggested that environmental enforcements result in heterogeneous effects on different levels of the workforce. Low-skilled employees are more likely to lose their jobs under the environmental regulations. Sun et al. [44] found a positive influence of environmental regulation on the progress of green technology. Empirical findings have shown that the establishment of air monitoring stations for central environmental regulation can significantly reduce pollution emissions [45] and promote firms' green innovation [46].

Given that environmental regulations can significantly improve air quality, employees in firms located in areas with intensive environmental policies can enjoy clean air and an improved quality of life. Hence, they have lower bargaining power for additional welfare and will reduce the demand for employee treatment. Meanwhile, firms located in areas with severe air pollution may be more likely to afford high employment protection due to the loss of human capital and increased recruitment costs. Thus, if the aforementioned compensation explanation is true, we may find that the influence of air pollution on employee protection will be constrained if firms are located in areas under more environmental regulations. Then we have the third prediction:

H3. *For firms located in areas with more environmental regulations, employees will obtain less protection from air pollution.*

Figure 1 presents our theoretical model of air pollution and employee protection, and the moderating effects of public attention and environmental regulations.

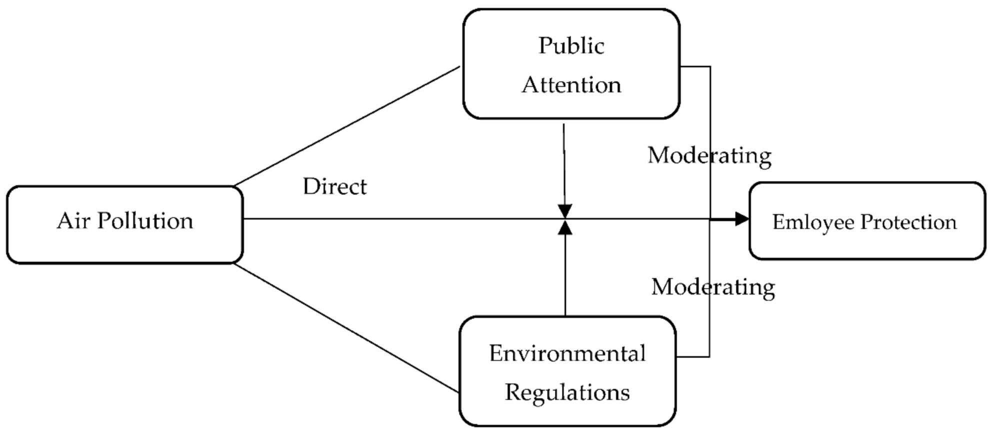

Figure 1. Conceptual diagram.

3. Data and Research Methods

3.1. Sample

In order to investigate the relation between air pollution and employee protection, we construct our sample and obtain data from various sources. First, firm-level employee protection data are obtained from Hexun.com, which is a well-known third-party rating agency in China. The Chinese Research Data Service (CNRDS) provides us with the air quality index (AQI) of all cities, which collects daily air quality data for all cities in China. Final, financial and corporate governance data are obtained from the China Stock Market and Accounting Research (CSMAR) database.

After combining the data, the initial sample consists of all public Chinese firms from the period of 2010–2019. According to the existing literature, observations of financial institutions are omitted because those firms are subject to significantly different regulations. Next, observations with missing values are excluded for the variables used in the analyses. This process yields our final sample of 24,875 yearly observations with 3504 unique firms.

3.2. Variable Construction

3.2.1. Employee Protection

Following the prior literature [47–49], we use Hexun's employee scores to measure employee protection. Hexun evaluates and scores the corporate social responsibility of listed companies using comprehensive evaluation methods. Their rating scores are based on information from social responsibility reports and financial reports. Thirteen secondary indicators and 37 tertiary indicators are established from the five aspects of shareholder responsibility, employee responsibility, supplier and customer rights, environmental responsibility, and public responsibility, respectively, which objectively reflect the performance of a firm's corporate social responsibility.

The employee score is one of the components of the overall score; it ranges from 0 to 15 and has three components: employee safety training, employee care, and work safety. A higher value of the score indicates better employee protection.

3.2.2. Air Pollution

The air quality index (AQI) is used to assess the air pollution in the city where each firm is located [2,50]. Specially, the annual mean value is calculated and processed by a logarithm using AQI data from 286 cities at the prefecture level. The AQI index is generated by measuring the concentration of six major pollutants in the air in accordance with the requirements of the Chinese Ministry of Environmental Protection's ambient air quality standard. Fine particles, inhalable particles, sulfur dioxide, nitrogen dioxide, ozone, and carbon monoxide are among the pollutants measured. The index has a scale of 0 to 500. The higher the index, the more severe the air pollution.

3.2.3. The Moderating Variables

The moderating variable, public attention, represents the public's concern about the environmental problems of a firm. According to the work of Fang et al. [51] and Chen et al. [52], we use the log value of the total number of environmental problems of a firm reported by the media in a given year as a proxy for a firm's public attention (MC). The second moderating variable is environmental regulation, which plays an important role in explaining corporate behavior. We manually collected environmental policy documents from the local government and then calculated the log value of the number of environmental regulation policies (ER) in a given area for each year as a proxy for environmental regulation in the firm's area.

3.3. Model

To test hypothesis 1, we constructed the following baseline ordinary least squares (OLS) model:

$$\mathrm{EP}_{i,t+1} = \beta_0 + \beta_1 \mathrm{AQI}_{i,t} + \gamma \mathrm{Controls}_{i,t} + \mathrm{IndustryFE} + \mathrm{Province} \times \mathrm{YearFE} + \mathrm{FirmFE} + \varepsilon_{i,t+1} \quad (1)$$

where EP is the dependent variable, which is a firm-level employee protection measure that is discussed above. Our main variable of interest, AQI, is the natural logarithm of the average daily AQI in a given year and city. Except for EP, our variables all adopted lagged values because of the causal relationship in time. H1 predicts a positive coefficient on AQI. This paper also includes the firm's and industry's fixed effects to control the unobservable time invariant characteristics, and the province*year fixed effect to control the time-variable regional characteristics. In addition, all firms in a given city are exposed to the same level of air pollution at any given time, so standard errors in all regressions are clustered at the city level.

Furthermore, to control for various factors that are likely to confound the relationship between employee protection and air pollution, a vector of firm- and city-level control variables is included, particularly with those correlated with corporate social responsibility [13,53]. At the firm level, we control for firm size (SIZE), firm profitability (ROA), financial leverage (LEV), cash flows from operating (CFO), the number of years after listing (AGE), the nature of ownership (SOE), shareholding ratio of the largest shareholder (TOP1), CEO and chairman duality (DUAL), independent director ratio (BRDIND), shareholding ratio of institutional investors (INST), and analyst following (ANALYST). At the city level, this study controls for annual GDP (GDP) and population density (POP), because the weather conditions at the city level have a significant impact on local air pollution. This paper further controls for average sunshine hours (sunshine), average temperature (TEMP), average wind speed (WIND), and average humidity (humid). Detailed variable definitions for all control variables are shown in Table 1.

Table 1. Variable definitions.

Variables	Definition
	Dependent variables
EP	Employee protection score, provided by Hexun.com.
	Independent variable
AQI	The natural logarithm of the daily average AQI in a given year and city.
Firm level controls	
SIZE	The natural logarithm of a firm's total assets at the end of year.
ROA	Net income divided by total assets at the end of year.
LEV	Total debt divided by total assets at the end of year.
CFO	Cash flows from operating divided by total assets at the end of year.
AGE	The number of years after listing.
SOE	Dummy variable that takes the value of 1 if the firm is state-owned enterprises and 0 otherwise.
TOP1	Shareholding ratio of the largest shareholder.
DUAL	Dummy variable that takes the value of 1 if the firm's CEO and chairman are the same person and 0 otherwise.
BRDIND	Number of independent directors divided by the total number of directors.
INST	Shareholding ratio of institutional investors.
ANALYST	The natural logarithm of analyst following.
	Macroeconomiccontrols
GDP	The natural logarithm of annual GDP in a given year and city.
POP	The natural logarithm of population in a given year and city.
Climate controls	
SUNSHINE	The natural logarithm of average sunshine hours in a given year and city.
TEMP	The natural logarithm of average temperature in a given year and city.
WIND	The natural logarithm of average wind speed in a given year and city.
HUMID	The natural logarithm of average humidity in a given year and city.

4. Empirical Results

4.1. Descriptive Statistics and Analysis

Table 2 presents descriptive statistics for the main variables used in our empirical analyses in terms of mean, median, standard deviation, 25th percentile, and 75th percentile. To mitigate the influence of outliers, all of the continuous variables are winsorized at the 1st and 99th percentiles. As shown in Table 2, the mean value of employee protection score (EP) is 3.630, with a standard deviation of 4.233, which indicates that the employee protection in Chinese companies is weak, and there are great variation between companies in our sample. The average air pollution index (AQI) is 4.302, which is similar to the values reported in the previous literature [6,7,19]. In our sample, about 36% are state-owned firms and the average institutional shareholding ratio is 5.9%. In general, the descriptive statistics of variables seem to be reasonable.

Table 2. Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	P25	Median	P75
EP	24,875	3.630	4.233	0.990	1.930	4.000
AQI	24,875	4.302	0.301	4.083	4.289	4.478
SIZE	24,875	22.080	1.321	21.130	21.910	22.850
ROA	24,875	0.038	0.063	0.015	0.038	0.067
LEV	24,875	0.427	0.216	0.252	0.415	0.586
CFO	24,875	0.042	0.072	0.004	0.043	0.084
AGE	24,875	2.036	0.923	1.386	2.197	2.833
SOE	24,875	0.360	0.480	0.000	0.000	1.000
TOP1	24,875	0.347	0.149	0.231	0.328	0.449
DUAL	24,875	0.275	0.447	0.000	0.000	1.000
BRDIND	24,875	0.375	0.053	0.333	0.333	0.429
INST	24,875	0.059	0.067	0.008	0.035	0.087
ANALYST	24,875	1.486	1.164	0.000	1.386	2.485
GDP	24,875	11.400	0.510	11.090	11.480	11.770
POP	24,875	6.429	0.665	6.040	6.487	6.868
SUNSHINE	24,875	7.540	0.222	7.421	7.519	7.722
TEMP	24,875	2.901	0.248	2.775	2.940	3.016
WIND	24,875	2.258	0.410	1.994	2.208	2.524
HUMID	24,875	4.248	0.138	4.164	4.305	4.348
MC	24,875	3.144	1.460	2.197	3.045	3.892
ER	24,875	1.595	1.091	0.693	1.386	2.079

Table 3 shows the Pearson correlation matrix of dependent variables, independent variables, and control variables. On average, the local air pollution level is positively correlated with a firm's next period of employee protection (corr. = 0.251), which provides preliminary evidence for our hypothesis. The firms' financial statuses and corporate governance are positively correlated with their employee protection, indicating that firms with better performance and greater governance generally have higher levels of employee protection. In addition, the correlation coefficient values of all variables in Table 3 are lower than 0.5, which means that there is no serious multicollinearity concern in our model.

4.2. Main Empirical Results

Table 4 reports the results of the effect of air pollution on employee protection. In the first column, we only include the fixed effects, and find the coefficient on AQI is positive and statistically significant at 1% (coefficient = 2.662, T-stat = 4.030), suggesting that firms headquartered in cities with higher levels of air pollution tend to increase employee protection. Next, firm-level control variables and macroeconomic variables sequentially are included in the model and are reported with the regression results in column (2) and column (3), respectively. Our main findings have not changed. Finally, we control for climate variables in the cities where the firms are located and present the results in column (4). The coefficient of the lagged air pollution index is found to be positive and significant (coefficient = 2.585, T-stat = 3.738). In conclusion, these findings support H1 that firms facing serious environmental risks will improve employee protection in order to attract human capital and mitigate potential negative effects.

Furthermore, in terms of control variables, the firm size and firm age are significantly positively associated with employee protection. Analyst following is significantly positive, suggesting that an external governance mechanism helps to promote employee protection.

4.3. Robustness Checks

Although our OLS regression results show that air pollution has a positive impact on employee protection, our findings may be biased by some potential endogenous issues. In this section, a series of tests are conducted to ensure the robustness of our findings.

Table 3. Pearson's correlation.

Variable	EP	AQI	SIZE	ROA	LEV	CFO	AGE
EP	1						
AQI	0.252 ***	1					
SIZE	0.124 ***	0.050 ***	1				
ROA	0.011 *	−0.013 **	−0.008	1			
LEV	0.084 ***	0.043 ***	0.468 ***	−0.383***	1		
CFO	−0.008	−0.026 ***	0.076 ***	0.343 ***	−0.166 ***	1	
AGE	0.067 ***	0.055 ***	0.375 ***	−0.242 ***	0.410 ***	−0.017 ***	1
SOE	0.161 ***	0.117 ***	0.367 ***	−0.091 ***	0.292 ***	0.011 *	0.430 ***
TOP1	0.059 ***	0.034 ***	0.223 ***	0.130 ***	0.037 ***	0.101 ***	−0.093 ***
DUAL	−0.082 ***	−0.080 ***	−0.189 ***	0.050 ***	−0.148 ***	−0.009	−0.243 ***
BRDIND	−0.020 ***	−0.047 ***	0.007	−0.025 ***	−0.00400	−0.017 ***	−0.025 ***
INST	0.073 ***	0.035 ***	0.221 ***	0.166 ***	0.042 ***	0.085 ***	0.110 ***
ANALYST	0.108 ***	0.028 ***	0.359 ***	0.365 ***	−0.065 ***	0.181 ***	−0.152 ***
GDP	−0.139 ***	−0.117 ***	0.038 ***	0.038 ***	−0.047 ***	0.014 **	−0.067 ***
POP	0.069 ***	0.295 ***	0.066 ***	0.032 ***	−0.004	−0.017 ***	−0.004
SUNSHINE	0.113 ***	0.268 ***	0.091 ***	−0.027 ***	0.032 ***	−0.036 ***	0.037 ***
TEMP	−0.191 ***	−0.490 ***	−0.093 ***	0.037 ***	−0.084 ***	0.024 ***	−0.104 ***
WIND	−0.036 ***	−0.102 ***	−0.013 **	0.011 *	−0.022 ***	0.004	0.007
HUMID	−0.209 ***	−0.458 ***	−0.117 ***	0.026 ***	−0.064 ***	0.043 ***	−0.064 ***

Variable	SOE	TOP1	DUAL	BRDIND	INST	ANALYST	GDP
SOE	1						
TOP1	0.223 ***	1					
DUAL	−0.298 ***	−0.043 ***	1				
BRDIND	−0.064 ***	0.044 ***	0.107 ***	1			
INST	0.020 ***	−0.098 ***	−0.020 ***	0.00300	1		
ANALYST	−0.021 ***	0.104 ***	0.012 *	−0.00500	0.480 ***	1	
GDP	−0.108 ***	0.00400	0.097 ***	0.056 ***	−0.012 *	0.020 ***	1
POP	0.097 ***	0.061 ***	−0.034 ***	−0.00600	0.0100	0.053 ***	0.103 ***
SUNSHINE	0.086 ***	0.043 ***	−0.020 ***	0.00800	−0.00100	0.019 ***	0.070 ***
TEMP	−0.179 ***	−0.053 ***	0.098 ***	0.033 ***	−0.012 *	0	0.257 ***
WIND	−0.00400	0.011 *	−0.00100	−0.00500	−0.028 ***	−0.022 ***	0.101 ***
HUMID	−0.158 ***	−0.062 ***	0.077 ***	0.0100	−0.022 ***	−0.051 ***	0.087 ***

Variable	POP	SUNSHINE	TEMP	WIND	HUMID
POP	1				
SUNSHINE	−0.115 ***	1			
TEMP	−0.178 ***	−0.544 ***	1		
WIND	−0.101 ***	0.357 ***	−0.080 ***	1	
HUMID	−0.102 ***	−0.773 ***	0.743 ***	−0.024 ***	1

Notes: *, **, *** represent the two-tailed significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Main evidence of air pollution on employee protection.

Variables	**(1) EP**	**(2) EP**	**(3) EP**	**(4) EP**
AQI	2.662 ***	2.630 ***	2.720 ***	2.585 ***
	(4.030)	(3.919)	(4.066)	(3.738)
SIZE		0.329 ***	0.327 ***	0.328 ***
		(4.377)	(4.357)	(4.380)
ROA		0.535	0.530	0.509
		(1.037)	(1.033)	(0.988)
LEV		0.032	0.028	0.015
		(0.109)	(0.095)	(0.051)
CFO		−0.430	−0.428	−0.435
		(−1.285)	(−1.279)	(−1.306)
AGE		0.688 ***	0.688 ***	0.691 ***
		(5.366)	(5.365)	(5.372)
SOE		−0.026	−0.020	−0.031
		(−0.101)	(−0.077)	(−0.119)
TOP1		0.706	0.671	0.663
		(1.667)	(1.582)	(1.567)
DUAL		0.052	0.051	0.052
		(0.643)	(0.637)	(0.645)
BRDIND		1.278	1.309	1.303
		(1.566)	(1.605)	(1.595)
INST		−0.363	−0.356	−0.381
		(−0.656)	(−0.641)	(−0.683)
ANALYST		0.086 *	0.084 *	0.085 *
		(2.098)	(2.066)	(2.077)
GDP			0.218	0.231
			(0.974)	(1.024)
POP			1.234	1.293
			(1.454)	(1.458)
SUNSHINE				−0.430
				(−0.342)
TEMP				4.962
				(1.224)
WIND				0.308
				(0.810)
HUMID				2.257
				(0.621)
Constant	−7.818 **	−17.206 ***	−27.954 ***	−49.344
	(−2.751)	(−5.600)	(−3.758)	(−1.847)
Observations	24,802	24,802	24,802	24,802
Cluster	City	City	City	City
Province × Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Adj.R^2	0.394	0.397	0.397	0.397

Notes: Reported in parentheses are t values, based on robust standard errors clustered by city. *, **, *** represent the two-tailed significance at the 10%, 5%, and 1% levels, respectively.

4.3.1. Endogeneity

Although we believe that air pollution is a highly exogenous variable, our results may still be subject to the threat of endogeneity. One potential concern about our previous results is that air pollution may be influenced by the firms' employee treatment, i.e., reverse causality. Another concern is the omittance of variables.

This paper uses a two-stage least square method with an instrumental variable to exclude some potential endogenous concerns. Valid instrumental variables can effectively alleviate endogenous problems, confirming a causal relation [54,55]. We employ the inversion days of a city (thermal days) in a given year as an instrumental variable of air pollution [56,57]. We believe that the number of inversion days is an effective instrumental variable. There is no empirical evidence or theory to suggest that inversion days at the city level are related to employee protection. Inversion is a meteorological phenomenon that has a significant impact on air pollution [57]. Therefore, the days of inversion are positively related to the degree of air pollution, which satisfies the correlation condition. In other words, days of inversion can only affect employee protection through air pollution, thereby satisfying the exclusive constraints.

First, we downloaded NASA's global inversion data and collected it at four observation points every day because they are measured every 6 h. Then we matched the grid data with the city area, and the average temperatures of the first and second layers were compared to determine whether there is a thermal inversion phenomenon. If the average air temperature in the second layer is higher than the average air temperature in the first layer, a thermal inversion phenomenon has occurred. A day is considered a thermal inversion day if there is at least one thermal inversion phenomenon at each of the four observation time points in the day. Finally, we accumulated the thermal inversion days for the year to construct our IV variable.

The regression results of the instrumental variables analysis are presented in Table 5. The first column reports the results of the first stage in which the dependent variable is the air pollution index and the independent variable is the number of days of inversion. This paper finds that the coefficient on thermal days is positive and significant at the 1% level, which is in line with our expectation. It is worth noting that the value of F-statistics in the first stage is 16.86, indicating that there is not any concern about weak instrumental variables [58]. Next, we use the predicted AQI to replace AQI and re-estimate our model. Column (2) of Table 5 shows the second stage's results; we find that the coefficient on the instrumented AOI is still positive and significant, indicating that the potential endogenous problems will not affect our main findings. In addition, the IV coefficient is 3.174 (p = 2.279), while the OLS coefficient is 2.585 (p = 3.738). As expected, the IV coefficient is larger than the OLS coefficient, which is caused by the local average treatment effect.

4.3.2. Alternative AQI Measure

Next, we further confirm our results by using an alternative measure of air pollution. In our baseline model, we employ the mean value of the annual air pollution index as a proxy for air pollution, which may underestimate the impact of extreme air pollution days [59]. To alleviate this concern, we calculate the annual air quality index rate (AQI_RATE), which is the mean value of daily air pollution level (from 0 to 5, indicating good air quality to severe pollution). Then we replace AQI with AQI_RATE and re-run our tests similar to Table 4. Table 6 shows that the coefficients on AQI RATE are positive and significant in all columns, suggesting that an alternative measure of air pollution does not change our main findings.

4.3.3. Placebo Test

Finally, we conducted a placebo test to provide evidence of the causal relationship between air pollution and employee protection. Specifically, we randomly assigned an AQI index to each city in the sample, created a pseudo AQI index, and used it to re-run the benchmark model. We repeated this process 500 times, obtaining the t-statistics of each regression and drawing the distribution diagram shown in Figure 2. We found that most of the t-values of the pseudo AQI index are near zero and they have a normal distribution, with only a few estimated results being close to or exceeding the real t-value (red line), indicating that some unobserved or time-variable factors will not affect our results.

Table 5. Instrumental Variables Analysis.

Variables	**(1)** **First-Stage** **AQI**	**(2)** **Second-Stage** **EP**
Thermal Days	0.001 ***	
	(6.383)	
Predicted AQI		3.174 **
		(2.279)
SIZE	0.001	0.354 ***
	(1.037)	(7.182)
ROA	−0.010	0.779 *
	(−0.572)	(1.770)
LEV	−0.005	−0.063
	(−0.718)	(−0.296)
CFO	0.014	0.202
	(1.239)	(0.529)
AGE	−0.000	0.096 **
	(−0.037)	(2.193)
SOE	0.004	0.487 ***
	(1.249)	(3.625)
TOP1	−0.018 **	−0.175
	(−2.223)	(−0.579)
DUAL	0.002	−0.069
	(0.878)	(−1.049)
BRDIND	−0.005	0.350
	(−0.302)	(0.496)
INST	−0.010	0.245
	(−0.779)	(0.484)
ANALYST	−0.001	0.084 **
	(−0.410)	(2.285)
GDP	0.002	0.095
	(0.109)	(0.519)
POP	0.042 ***	0.070
	(3.000)	(0.459)
SUNSHINE	−0.232 ***	0.473
	(−2.937)	(0.535)
TEMP	−0.195 **	0.129
	(−2.101)	(0.147)
WIND	−0.030	−0.479 *
	(−1.141)	(−1.922)
HUMID	−0.613 ***	−2.467
	(−4.462)	(−1.218)
Constant	8.764 ***	−15.330
	(8.573)	(−0.820)
Observations	24802	24802
Cluster	City	City
Province × Year FE	Yes	Yes
Industry FE	Yes	Yes
Firm FE	Yes	Yes
Adj.R^2	0.920	0.265
First stage F-statistics	16.86 ***	

Notes: Reported in parentheses are t values, based on robust standard errors clustered by city. *, **, *** represent the two-tailed significance at the 10%, 5%, and 1% levels, respectively.

Table 6. Alternative AQI measure.

	(1) EP	(2) EP	(3) EP	(4) EP
AQI_RATE	1.560 ***	1.543 ***	1.573 ***	1.514 ***
	(4.279)	(4.156)	(4.249)	(3.944)
SIZE		0.329 ***	0.327 ***	0.328 ***
		(4.377)	(4.359)	(4.384)
ROA		0.525	0.519	0.497
		(1.019)	(1.013)	(0.966)
LEV		0.032	0.029	0.015
		(0.110)	(0.097)	(0.051)
CFO		−0.420	−0.418	−0.426
		(−1.256)	(−1.249)	(−1.281)
AGE		0.689 ***	0.689 ***	0.693 ***
		(5.383)	(5.384)	(5.392)
SOE		−0.025	−0.020	−0.031
		(−0.098)	(−0.078)	(−0.121)
TOP1		0.699	0.667	0.659
		(1.644)	(1.568)	(1.553)
DUAL		0.050	0.050	0.050
		(0.623)	(0.618)	(0.626)
BRDIND		1.288	1.318	1.311
		(1.578)	(1.616)	(1.606)
INST		−0.359	−0.354	−0.380
		(−0.646)	(−0.634)	(−0.679)
ANALYST		0.085 *	0.084 *	0.085 *
		(2.078)	(2.049)	(2.063)
GDP			0.255	0.267
			(1.109)	(1.153)
POP			1.105	1.184
			(1.297)	(1.333)
SUNSHINE				−0.464
				(−0.377)
TEMP				4.958
				(1.230)
WIND				0.342
				(0.908)
HUMID				2.427
				(0.660)
Constant	2.047 ***	−7.452 ***	−17.448 **	−40.008
	(5.518)	(−4.361)	(−2.680)	(−1.548)
Observations	24,802	24,802	24,802	24,802
Cluster	City	City	City	City
Province × Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Adj.R^2	0.394	0.397	0.398	0.398

Notes: Reported in parentheses are t values, based on robust standard errors clustered by city. *, **, *** represent the two-tailed significance at the 10%, 5%, and 1% levels, respectively.

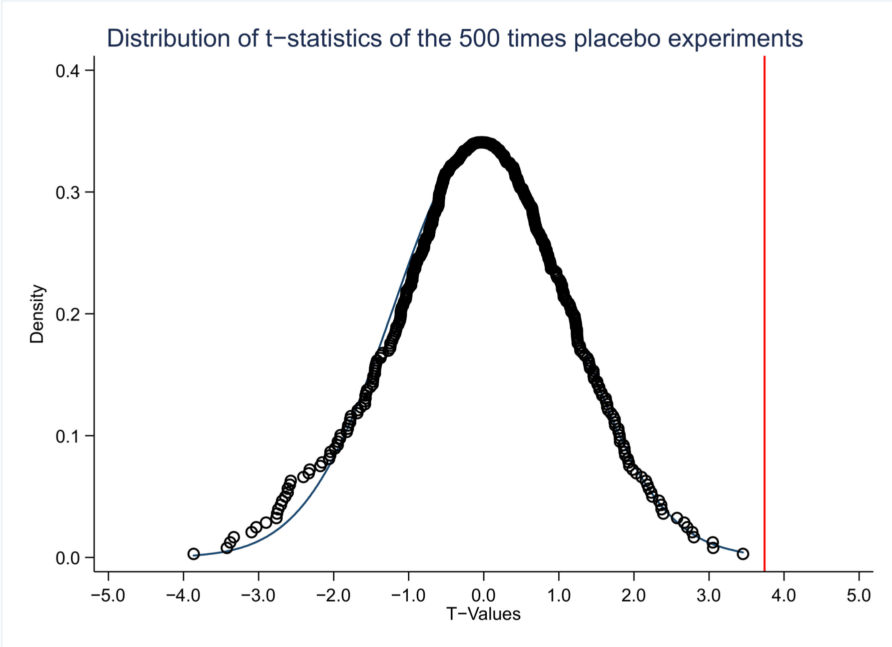

Figure 2. Placebo test: random assignments of AQI to each city, repeated 500 times.

5. The Moderating Effect of Public Attention and Environmental Regulations

This section examines the moderating effect of public attention and environmental regulations on the relation between air pollution on employee protection. To that end, we must demonstrate that the marginal effect of air pollution on employee protection is greater for firms that (1) receive more public attention and (2) face less government environmental regulations.

Our measure of a firm's public attention is media coverage (MC), which is defined as the total number of environmental problems reported by the media about that firm [51,52]. Because the media has played a positive supervisory role, it is believed that more media reports demonstrate increased social attention and public pressure [60,61]. Second, we manually collected the local government's environmental policy documents, and then calculated the number of environmental regulation policies (ER) as a proxy for environmental regulation in the area where the firm is located. Then we interacted MC (or ER) with AQI and tested our hypothesis.

Table 7 shows the results of the OLS and IV regression, in which the moderating variables are public attention in columns (1) and (3) and environmental regulation in columns (2) and (4). Consistent with our expectation, we find the interaction term AQI*MC is significantly positive in columns (1) and (3), which means that firms under great public attention are more likely to increase employee protection to compensate the employees in the air-polluted regions. In Columns (2) and (4), the coefficients of AQI*ER are negative and significant, which indicates that firms with more environmental regulations have a lower level of employee protection than firms with less environmental regulations. It suggests that firms located in areas with severe air pollution may be more likely to afford high employment protection due to the loss of human capital and increased recruitment costs. Hence, the increase in employee protection is more pronounced for firms subject to less environmental regulations. Taken together, these findings support our prediction that external public and regulatory pressure encourages firms to adopt more employee protection policies to alleviate concerns about the risk of human capital loss, which is consistent with the view that firms use employee protection as a compensation for poor air quality.

Table 7. The moderating effect of public attention and environmental regulations.

Variables	(1)	(2)	(3)	(4)
	OLS		IV	
	Public Attention	Environmental Regulation	Public Attention	Environmental Regulation
AQI*MC	1.430 ***		1.624 ***	
	(8.444)		(8.980)	
AQI*ER		−1.650 ***		−0.777 *
		(−4.555)		(−1.799)
AQI	3.773 ***	2.557 ***	3.071 **	3.206 **
	(4.581)	(3.675)	(2.060)	(2.296)
MC	4.763 ***		6.092 ***	
	(6.358)		(7.900)	
ER		6.808 ***		3.218 *
		(4.235)		(1.736)
SIZE	0.192 **	0.318 ***	0.044	0.346 ***
	(2.660)	(4.227)	(0.568)	(7.033)
ROA	−0.092	0.575	0.435	0.772 *
	(−0.183)	(1.082)	(1.057)	(1.775)
LEV	−0.266	0.022	−0.222	−0.084
	(−0.968)	(0.076)	(−1.078)	(−0.394)
CFO	−0.657 *	−0.502	−0.632	0.143
	(−2.017)	(−1.486)	(−1.605)	(0.383)
AGE	0.818 ***	0.673 ***	0.089 **	0.096 **
	(7.551)	(5.099)	(1.962)	(2.216)
SOE	−0.047	−0.027	0.441 ***	0.474 ***
	(−0.213)	(−0.109)	(3.312)	(3.548)
TOP1	0.909*	0.583	−0.218	−0.158
	(2.161)	(1.362)	(−0.803)	(−0.513)
DUAL	0.002	0.049	−0.100 *	−0.062
	(0.034)	(0.574)	(−1.699)	(−0.940)
BRDIND	1.990 **	1.752 *	−0.157	0.288
	(2.648)	(2.082)	(−0.213)	(0.412)
INST	0.217	−0.079	0.292	0.239
	(0.453)	(−0.141)	(0.593)	(0.472)
ANALYST	−0.071	0.073	−0.029	0.085 **
	(−1.698)	(1.828)	(−0.787)	(2.273)
GDP	0.304	0.259	0.251 *	0.117
	(1.675)	(1.155)	(1.694)	(0.651)
POP	0.974	1.405	0.090	0.057
	(1.319)	(1.632)	(0.674)	(0.372)
SUNSHINE	0.807	0.464	0.457	0.708
	(0.775)	(0.360)	(0.590)	(0.835)
TEMP	1.971	2.877	−0.226	0.247
	(0.704)	(0.712)	(−0.283)	(0.285)
WIND	0.365	0.377	−0.391 **	−0.451 *
	(1.118)	(0.981)	(−2.020)	(−1.895)
HUMID	0.569	1.404	−1.128	−2.313
	(0.182)	(0.398)	(−0.668)	(−1.222)
Constant	−16.175	−47.358	10.945	−18.201
	(−0.733)	(−1.781)	(0.641)	(−1.017)
Observations	24,875	24,875	24,875	24,875
Cluster	City	City	City	City
Province*Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Adj.R^2	0.506	0.387	0.364	0.257

Notes: Reported in parentheses are t values, based on robust standard errors clustered by city. *, **, *** represent the two-tailed significance at the 10%, 5%, and 1% levels, respectively.

6. Conclusions, Implications, Limitations and Future Prospects

6.1. Conclusions

Severe air pollution creates an external environmental uncertainty that limits business development and raises potential risks. The negative effects of air pollution on firms' productivity have received considerable attention in the prior literature. In line with this branch of study, we investigated firms' strategies when under severe air pollution in terms of employee protection. Using a sample of Chinese publicly listed firms from 2010 to 2019, our results show that air pollution where firms are headquartered can significantly increase employee protection. Further analysis indicates that public pressure increases the impact of air pollution on labor protection in firms, whereas environmental regulation reduces the positive relationship between air pollution and employee treatment. Overall, our study finds that improving employee protection can benefit companies by mitigating the negative effects of air pollution, which has significant implications for managers. When facing the threat of serious air pollution, managers can retain or attract talent by developing effective employee protection policies to reduce the loss of human capital and decrease operating costs, which is beneficial to enterprises' long-term sustainable development.

6.2. Managerial and Policy Implications

The results reported in this paper may have critical implications in several ways. First, the results highlight the detrimental effect of air pollution on employment protection, which provides policy implications for regulators on the economic outcomes of local environmental regulation. Given the fact that the environment has a significant influence on firms' employee treatment strategies, the government should further strengthen its awareness of environmental protection and recognize more comprehensively the impact of air pollution on quality economic development. The moderating effect of environmental regulation indicates that environmental policies can effectively alleviate the impacts of air pollution at the firm level. Thus, the findings suggest that government regulators should strengthen supervision for air pollution to promote the long-term development of regional economies.

Second, this paper also has significant implications for firms' managers. Facing the reduced human capital and rising recruitment costs induced by severe air pollution, managers and other related stakeholders should adjust their employee treatment strategies to counteract employees' concerns about their reduced welfare, such as the increase in mortality and pollution-related diseases. To attract high-level and well-educated talents, firms need to provide improved treatment to motivate employees in exchange for their efforts, increased loyalty, and productivity as well as to reduce turnover costs. Therefore, managers should make cost–benefit assessments under environmental regulation policies and public pressure.

6.3. Limitations and Future Prospects

Although our research provides some useful evidence, it also has some limitations. First, an OSL estimation was used to explore the relationship between air pollution and employee protection, which has been widely applied in the prior literature. We also used an instrumental variable approach to solve potential endogenous problems. However, our study might still be influenced by some unobservable potential factors. Some other recognition strategies can be considered in future research, such as exogenous shock and natural experiments. Second, due to the data limitation, we relied on third-party rating agencies to measure employee protection. Future research could lead to the development of more direct proxies. Third, we only investigated firms' strategic decisions regarding employee protection when there was severe environmental uncertainty. Future research could investigate other aspects of firms' decision-making.

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