Will Cleaner Air Reduce Corporate Labor Cost?

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Abstract: *With China's listed companies from 2005 to 2015 as samples, this paper investigates how air quality influences labor cost based on city-level air quality data. Our study finds a significant negative correlation between air quality and corporate employee compensation - such a negative correlation is particularly strong in regions where employees are more rights-conscious and for companies that are non-labor-intensive. By adjusting employee compensation according to air quality, firms will increase their future corporate value. In addition, air quality has significantly differentiated effects on employee compensation for firms of different ownership nature and different level of cash on hand. Further research reveals that the effects mainly stem from poor air quality. In general, extreme air quality changes will lead to a difference of 14,210 yuan in the annual average compensation to employees from sample companies, or a labor cost difference of around 23 trillion yuan for all companies nationwide during the sample period. Our research conclusions have broadened the scope of research on how air quality influences firm behavior, and provide empirical reference for employee motivation and cost management, as well as empirical evidences for China's policy principle that "lucid waters and lush mountains are invaluable assets".*

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1. Introduction

For employees, good air quality is an important non-monetary benefit (Jensen and Murphy, 1990), as well as a key aspect of interpreting a company's compensation policy (Mathios, 1989). Existing studies have extensively discussed corporate executives' non-monetary benefits (Chen, 2005). However, academics have yet to pay due attention to the non-monetary benefits of employees as another group of stakeholders who contribute to firm value alongside executives (Schultz, 1961; Becker, 1962). The role of employees in companies has received growing attention in the academia, as evidenced in a growing body of studies on employee compensation. Yet most studies are concerned with employees' monetary incentives (Maureen et al., 2009; Chen *et al.*, 2015; Fang *et al.*, 2011) and the determinants of such incentives (Lu, 2012; Li and Hu, 2012), and seldom pay much attention to employees' non-monetary benefits. Previous studies have extensively examined the determinants of employee compensation from such perspectives as macroeconomics, policy-making, financial management, and corporate governance,

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yet without paying due attention to the environment. Whether and how air quality as part of the natural environment vital to human survival influences employee compensation are not explained in the literature. Previous studies on the determinants of employee compensation provide this paper with an important theoretical basis and further research opportunities.

Recent years have seen growing public attention to air pollution in China. In many cities, average fine particulate matter (PM2.5) concentrations have exceeded limits. In January 2017, Beijing, Tianjin, Guangzhou, Xi'an and Chengdu saw their average PM 2.5 concentrations rise by 20%. In the same month, Urumqi's monthly average PM2.5 concentration reached as high as 234.81 $\mu g/m^3$. Among 114 Chinese cities on the air quality index (AQI) ranking list, only eight cities met air quality standards.[1] Air quality is vital to human health and regional economic development (Myers, 1987; Schmenner, 1982; Boustan *et al*., 2012; Chen *et al*., 2013; Ebenstein *et al*., 2015). Long-term exposure to an unhealthy environment will make people more vulnerable to diseases (Dominici *et al*., 2006). Based on their comparative studies on the environment and mortality rate in various countries, Chay *et al*. (2003) and Cropper (2010) have reached the same conclusion: Air pollution affects people's longevity, and increases regional mortality rate. With China's Huai River as boundary between northern and southern China, Chen *et al*. (2013) believes that uneven air pollution between northern and southern China will affect people's life expectancy by different degrees. Ebenstein *et al*. (2015) arrives at similar conclusions based on Chinese data.

With employees' non-monetary benefits as the entry point, this paper identifies air quality as a proxy variable for "lucid waters and lush mountains," and examines the relationship between air quality and average employees' compensation to find out whether air quality serves as a non-monetary benefit for employees that may mutually substitute for their monetary benefits.[2] Then, this paper further investigates how firm value is influenced by adjusting employee compensation according to air quality. As Karl Marx mentioned in his works about workers' wage, "labor consumes certain muscle, neurons and brain power, and such consumption must be compensated for. The more one spends, the more he shall be paid for (Marx, 1867)." Polluted air not only harms employees' health (Dominici *et al*., 2006) and cuts their life short (Chen *et al*., 2013), but creates anxiety and inefficiency (Fehr *et al*., 2017; Lu *et al*., 2018), forcing firms to raise employee compensation to offset such adverse effects. Academics have also paid sufficient attention to the correlation between air quality and firm behavior. Roback (1982) finds that people prefer to live in places with a high quality of life, and firms in regions known for poor quality of life have to pay higher wages to retain employees. Myers (1987) finds that in regions with an attractive quality of life, a firm will pay less to recruit and retain the same level of workforce. Based on US data, Deng and Gao (2013) finds that executive pay is higher in regions with poor quality of life. Based on China's insurance sector's data, Chang *et al*. (2018) finds that severe air pollution will prompt people to buy health insurance. Based on data from Chinese manufacturers, Li and Li (2017) identifies a causal relationship between air pollution and falling firm productivity, i.e. less visibility resulting from air pollution makes transportation less efficient and firm inventory rise.

This paper is concerned with average company employees instead of executives due to the following considerations: (i) Average employees are less privileged than executives, but contribute an important share to firm value, and deserve to be protected. (ii) Employees earn less incomes than executives do,

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[1] Published on February 2, 2017 at Air Matters app by Wang Jun. Air Matters is a smartphone app for real-time air quality, pollen and weather data launched in 2011.

[2] From an economic perspective, air's non-exclusivity and non-competition determine that for air as a public good independent from private goods and commodities, its production and consumption cannot take place in a market-based manner. Given air's non-exclusivity, all employees benefit from good air quality. Working in a place with fresh air makes people feel happy and healthy (Fehr *et al.,* 2017; Lu *et al.,* 2018). Such benefits as proven in the literature are employees' non-monetary benefits. Based on US data, Deng and Gao (2013) finds that a good living environment including clean air is a non-monetary benefit for executives. Hence, air quality can be a non-monetary benefit for both executives and average employees. In this sense, air quality may serve as a non-monetary benefit for employees (Jensen and Murphy, 1990).

and are less likely to afford a costly migration to places with cleaner air. Hence, employees are more motivated to ask for monetary compensation from their employers for air pollution. (iii) Employee compensation is dwarfed by executive pay. According to the marginal diminishing utility theory, employees derive a much higher marginal value from monetary compensation than executives do. Change in employee compensation is more likely to influence employee behavior. (iv) Although employees earn less than executives do on average, total employee compensation and labor cost still account for around 10% of corporate revenues during the sample period. Change in this hefty amount will sway business performance in significant ways, and warrants our attention.

This paper's potential theoretical implications are threefold: (i) It broadens the theoretical literature on employees' non-monetary benefits by demonstrating that air quality is a non-monetary benefit for employees. (ii) It contributes to the literature on the determinants of employee wage incentives and air quality's impact on firm behavior. Previous studies uncover the determinants of employee compensation from such perspectives as firm performance (Chen *et al*., 2015), ownership nature (Lu *et al*., 2012), executive power (Wang *et al*., 2012), implicit contract (Chen *et al*., 2011), and employees' rights awareness (Shen *et al*., 2017). Very few studies deal with air quality's impact on employee compensation from the perspective of employees' non-monetary benefits. (iii) It broadens theoretical literature on air quality and employee compensation. Previous studies are focused on employees' pay incentives (Maureen et al., 2009; Chen *et al*., 2010, 2015; Fang *et al*., 2011), and very few studies are concerned with the economic effects of firms adjusting employee compensation according to changes in the natural environment.

This study finds that firms may incentivize their workforce to work hard and contribute to firm value by adjusting employee compensation according to air quality. As a contribution to management practice, this paper may provide empirical references to employee motivation and wage cost management for firms of different types.

The Report to the 19th CPC National Congress states that ecological civilization is vital to the sustainable development of the Chinese nation. The primary contradiction facing the Chinese society has changed into one between people's growing needs for a better life and imbalanced and insufficient development. In this context, research on the relationship between air quality and employee compensation is of great practical relevance. The findings of our empirical study provide labor cost evidence to the policy principle that "lucid waters and lush mountains are invaluable assets" put forward at the 19th CPC National Congress. Research indicates that clean air may spare firms tremendous labor cost. According to our rough estimate, extreme air quality changes will lead to a labor cost variation of 20~23 trillion yuan for all firms in China.

2. Theoretical Analysis and Hypotheses

This paper contends that air quality is an important non-monetary benefit for employees and will affect their wage incentive contract. Specifically, the role of air quality can be discussed at the levels of employees and firms.

According to Maslow's hierarchy of needs theory (Maslow, 1943), with basic physical needs satisfied, employees will pursue security needs. For employees exposed to dirty air, they tend to ask for compensation from their employers to compensate for the health effects and disease risks (Dominici *et al*., 2006; Cropper, 2010; Chen *et al*., 2013).[3] Such compensation is of the same nature[4] with Panasonic's

[3] During China's annual legislative sessions in 2014, one of the most interesting proposals suggested "enacting smog allowance as soon as possible." This topic triggered extensive debates among news agencies (People.com.cn, March 11, 2014 http://lianghui.people.com.cn/2014npc/n/2014/0311/c376088-24605104.html).

[4] Are you willing to put up with smog in China if given a 15% pay raise? http://blog.sina.com.cn/s/blog_4b8bd1450102vy5y.html.

"pollution allowance,"[5] Coca-Cola's "smog hazard allowance"[6] and Huawei's "hardship allowance."[7] With other conditions being equal, an improvement in air quality will address employees' security needs and diminish their motivation to ask for a raise, thus lowering firms' burden of employee compensation.

According to the "economic man" hypothesis, employees will weigh the pros and cons of clean air as a non-monetary benefit versus monetary compensation. Combinations of the two at various ratios may constitute a utility no-difference curve with a trade-off relationship. With other external conditions being equal, health cost resulting from air pollution exceeds gains from working in such an environment. In this case, employees will ask for a raise to maintain the cost-benefit equilibrium. In the cost-benefit calculus, the marginal cost of air quality is increasing, i.e. as air quality deteriorates and the health impacts become more severe, employees will ask for more compensation. On the contrary, clean air as a non-monetary incentive will offset employees' motivation to ask for a raise (Myers, 1987). Existing studies suggest that poor air quality will cause people to migrate (Boustan *et al*., 2012; Wang, 2016). Given Chinese people's emotional attachment to ancestral hometowns as part of Chinese culture (Fei, 2015), the State-imposed household registration (*hukou*) system, as well as employees' low incomes, employees tend to ask for a higher pay and work in the same city without migrating elsewhere.[8]

Firms are motivated to internalize the external cost of air pollution to incentivize their workforce and promote firm value. Firms adjust employee compensation for air pollution under the following considerations: (i) Studies suggest that air pollution will cause changes in employees' psychological state. Employees believe that air pollution will make them more vulnerable to diseases (Dominici *et al*., 2006; Cropper, 2010; Chen *et al*., 2013), and raise their cost of work. Psychological changes, if left unaddressed, will exhaust their self-control capacity, hamper their behaviors as organized citizens, and give rise to inefficiency (Fehr *et al*., 2017). At this moment, firms must pay an additional compensation premium and offer necessary incentives to maintain employees' psychological cost-benefit equilibrium. (ii) With other conditions being equal, firms will find it harder to attract talents. Firms may have to pay an additional compensation premium to recruit professionals to work in a heavily polluted city. (iii) Air pollution makes it more likely for employees, especially well-educated and highly skilled employees who are able to migrate elsewhere - to quit their jobs, thus raising the costs of a brain drain, recruitment and training. Air pollution may even lead to a loss of customers and worsening business performance. Poor air quality will force firms to raise employee compensation.

Based on the above analysis, we put forward Hypothesis 1:

Hypothesis 1: With other conditions being equal, the poorer local air quality is, the higher employee compensation a listed company has to pay.

With steadily rising incomes, Chinese employees are increasingly keen on defending their rights and interests. Studies find that such an awareness is significantly positively correlated with social security contributions (Shen, *et al*. 2017). Other studies suggest that employees at Chinese enterprises defend their rights and interests through trade unions (Yao and Zhong, 2013; Wei *et al*., 2013; Wei *et al*., 2015). Poor air quality will harm employees' health, exposing them to disease risks (Chay *et al*., 2003; Dominici *et al*., 2006; Cropper, 2010). Normally, employees will ask for a pay rise to compensate for the health damages they endure (Roback, 1982). The more rights-conscious employees are, the less tolerant they are about lousy air quality. Having sensed any infringement on their personal interests,

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[5] According to *China Daily* (chinadaily.com.cn/hqcj), on March 12, 2014, Panasonic announced that it would give allowances to expatriates in China to compensate for hazardous air pollution - the first multinational firm in China to do so.

[6] According to a website (http://zhenhua.163.com), Coca-Cola was offering hefty "smog allowances" to its expatriates in China in a bid to attract and retain professionals.

[7] According to NetEase technology (http://tech.163.com), Huawei has been issuing allowances to employees dispatched to hardship regions.

[8] Chang *et al.* (2018) finds that severe air pollution will prompt people to buy health insurance, which verifies that employees tend to stay in one city rather than migrate.

rights-conscious employees will negotiate with their employers, and may protest or put on a strike to demand their employers to pay higher compensation for their damages (Dittmer, 1987; Shen *et al.*, 2017). According to Karl Marx's class struggle theory, actual wage is determined by capitalists as the exploiting class and the bargaining power of workers. As long as workers are not united, wage tends to be suppressed (Marx, 1867). In this sense, if employees fight for their rights, they will receive more pay to the extent acceptable to their employers.

Within an acceptable extent, executives tend to give in to rights-conscious employees. On one hand, they do so for social stability considerations. When their legitimate rights are being infringed upon, employees will protest in various forms, which increases social instability. Firms are also concerned with poor labor relations that raise the costs of transaction between executives and employees and harm firm value. Executives are also motivated to take advantage of shareholder resources to create private relations with their employees for their own convenience (Pagano, 2005; Chen *et al.*, 2011).

Based on the above analysis, we put forward Hypothesis 2:

Hypothesis 2: Other conditions to be constant, employees' awareness to defend their rights will enhance the negative correlation between a listed company's local air quality and employee compensation.

This paper believes that employees from non-labor-intensive companies may ask for more compensation due to poor air quality. (i) Compared with employees from labor-intensive companies, employees from non-labor-intensive companies are more able to migrate due to poor air quality. Such employees are usually better educated and skilled with higher asset specificity. Their wage income is apparently higher than their peers at labor-intensive companies (Slaughter, 2007). Asset specificity and wage are the key determinants of employment mobility. Compared with employees from labor-intensive companies, employees from non-labor-intensive companies are therefore much more mobile (Zhou *et al.*, 2012). Lousy air quality is more likely to nudge employees from non-labor-intensive companies, who are costly to recruit and train, to migrate, forcing employers to raise their pay to maintain a cost-benefit equilibrium. (ii) Educated and skilled employees from non-labor-intensive companies have more bargaining power against their employers and are more rights-conscious. Mindful of air pollution's harmfulness, they will use their influence to negotiate with their employers, fight for their personal rights and interests, and achieve a cost-benefit equilibrium. (iii) According to Maslow's hierarchy of needs (Maslow, 1943), employees from non-labor-intensive companies are well-paid, and as their basic needs are satisfied, will pursue higher needs. Lousy air quality becomes a key threat to their health (Dominici *et al.*, 2006; Cropper, 2010; Chen *et al.*, 2013). Therefore, they will ask for more "environmental injury compensation."

Based on the above theoretical analysis, we put forward Hypothesis 3:

Hypothesis 3: Other conditions to be constant, the non-labor-intensive attribute of firms will reinforce the negative correlation between a listed company's local air quality and employee compensation.

Poor air quality harms employees' mental and physical health (Fehr *et al.*, 2017; Lu *et al.*, 2018), and increases their cost of work. At constant income, a rise in employees' cost of work will induce change in their psychological state, prompting them to slack off (Fehr *et al.*, 2017). To incentivize their workforce to exert themselves, firms are motivated to internalize the external cost of air pollution by adjusting employees' compensation according to change in air quality. Incentivizing the workforce according to change in air quality will promote firm value for the following reasons: (i) By adjusting employee compensation according to change in air quality, firms send a signal of goodwill to employees that their non-monetary losses would be compensated for, which helps improve labor relations and firm value (Dittmer, 1987; Shen *et al.*, 2016; 2017). (ii) According to the gift exchange model under the efficiency wage theory, firms are willing to give their employees a pay rise in exchange of the latter's loyalty and hard work, which contribute to firm value. So long as the marginal revenue of raising employee compensation exceeds the marginal cost, firms will raise compensation as air quality worsens until Pareto optimality is reached. (iii) By compensating for employees' non-monetary losses arising from worsening air quality, firms send a positive signal that helps attract talents, reduce staff turnover rate, and promotes firm value through less costs of recruitment, training and customer loss. Based on the above discussions, this paper puts forward Hypothesis 4:

Hypothesis 4: Other conditions to be constant, adjusting employee compensation according to change in local air quality increases firm value.

3. Research Design

3.1 Sample Selection and Data Source

This paper's research samples are China's A-share listed companies from 2005 to 2015. The key explanatory variable is the air quality index (AQI) in cities where the listed companies are registered with data from *Yearbook of China City Competitiveness*[9]. Firms' financial data are mainly from CSMAR and Wind databases. Other macro variables are from *China Statistical Yearbook* and *China Population and Employment Statistical Yearbook*. Samples are screened by excluding: (i) financial sector data; (ii) samples with missing variables; (iii) ST samples, i.e. listed companies subject to special treatment by regulators. Finally, we have obtained 17,815 samples. This paper winsorizes continuous variables other than AQI at 1% to exclude the interference of outliers.

3.2 Model Design and Variable Definition

3.2.1 Empirical model

To test Hypothesis 1, we specify the following empirical model (1):

$$\begin{aligned} Lgwage_t = {} & \alpha_0 + \beta_1 Air_{t-1} + \beta_2 Soe_t + \beta_3 Nlabor_t + \beta_4 Cash_t + \beta_5 Roe_t + \beta_6 Shr_t + \beta_7 Lev_t + \beta_8 Size_t \\ & + \beta_9 Lgcom_t + \beta_{10} Ghouse_t + \beta_{11} Oldratio_t + \beta_{12} Indratio_t + \beta_{13} Gdp_t + \beta_{14} Cpi_t \\ & + Ind + Year + \varepsilon \end{aligned}$$

To test Hypothesis 2, we include the dummy variable of employees' rights awareness into Model (1) to investigate rights awareness's effects on the relationship between air quality and employee compensation, as detailed in Model (2):

$$\begin{aligned} Lgwage_t = {} & \alpha_0 + \beta_1 Air_{t-1} + \beta_2 Slrc_t + \beta_3 Air\_Slrc_t + \beta_4 Soe_t + \beta_5 Nlabor_t + \beta_6 Cash_t + \beta_7 Roe_t \\ & + \beta_8 Shr_t + \beta_9 Lev_t + \beta_{10} Size_t + \beta_{11} Lgcom_t + \beta_{12} Ghouse_t + \beta_{13} Oldratio_t \\ & + \beta_{14} Indratio_t + \beta_{15} Gdp_t + \beta_{16} Cpi_t + Ind + Year + \varepsilon \end{aligned}$$

To test Hypothesis 3, we specify the dummy variable of non-labor-intensive firms in the model on the basis of Model (1), and include the interaction term between the non-labor-intensive dummy variable and AQI, as detailed in Model (3):

$$\begin{aligned} Lgwage_t = {} & \alpha_0 + \beta_1 Air_{t-1} + \beta_2 Nlabor_t + \beta_3 Air\_Nlabor_t + \beta_4 Soe_t + \beta_5 Cash_t + \beta_6 Roe_t + \beta_7 Shr_t \\ & + \beta_8 Lev_t + \beta_9 Size_t + \beta_{10} Lgcom_t + \beta_{11} Ghouse_t + \beta_{12} Oldratio_t + \beta_{13} Indratio_t \\ & + \beta_{14} Gdp_t + \beta_{15} Cpi_t + Ind + Year + \varepsilon \end{aligned}$$

To test Hypothesis 4, this paper specifies Tobin's Q ratio as a dependent variable, and specifies

[9] It should be noted that data for 2011 and 2014 are not published, and that given the limited change in AQI in various regions in the preceding and following years, data for these two years are obtained by taking the average values of two adjacent phases.

Model (4) as follows with whether change in air quality is matched with change in employee compensation as a key observed variable:

$$TobinQ_t = \alpha_0 + \beta_1 Match_{t-1} + \beta_2 Soe_t + \beta_3 Cash_t + \beta_4 Roe_t + \beta_5 Shr_t + \beta_6 Lev_t + \beta_7 Size_t + Ind + Year + \varepsilon$$

Considering the robustness of research conclusions, this paper conducts a company clustered regression model.

3.2.2 Variable definitions

Table 1 shows the detailed definitions of relevant variables.

Employee compensation (*Lgwage*) is defined as follows: Referencing Chen's *et al*. (2011; 2015)

Table 1: Definitions of Key Variables

Symbol	Name	Definition
Lgwage	Employee compensation	Average employee compensation = (cash paid to and on behalf of employees - compensation paid to board members, supervisors and executives) / (total employees - total number of board members, supervisors and executives); then, take the natural logarithm of employee average compensation in the current period.
Air	Air quality index (AQI)	AQI (tertiary indicator) with one-phase lag.
Soe	Ownership nature	If the company is a state-owned enterprise (SOE), this variable is 1; otherwise, it is 0.
Nlabor	Non-labor-intensive	If the company's per capita business revenue is higher than the median value of samples in a year, this company is non-labor-intensive, and this variable is 1; otherwise, the company is labor-intensive, and this variable is 0.
Slrc	Employee rights awareness	Accepted labor dispute cases = Number of labor dispute cases accepted in the current period / Regional year-end total population (10,000 people); if the number of labor dispute cases accepted exceeds the median value of labor cases accepted in the year, the implication is that local employees are rights-conscious, and this variable is 1; otherwise, it is 0.
Match	Dummy variable of match between air quality and employee compensation	If the air quality deteriorates and employee compensation increases or air quality improves while employee compensation decreases, this dummy variable is 1; otherwise, it is 0.
TobinQ	Firm value	(Firm equity value + nominal debt value) / total assets
Cash	Cash on hand	Cash on hand at the beginning of period = Monetary capital at the beginning of period / total assets.
Roe	Return on equity	Return on equity = Profit/total assets.
Shr	Equity concentration	Shareholding ratio of the first majority shareholder
Lev	Asset-liability ratio	Debt-to-assets ratio = Total liabilities/total assets.
Size	Company size	Natural logarithm of the company's total assets.
Lgcom	Executive pay	Natural logarithm of the company's executive pay.
Ghouse	Housing price growth rate	Housing price growth rate. Data from *China Statistical Yearbook*.
Oldratio	Percentage of elderly population	Percentage of elderly population = population aged at 65 and above/total regional population in the current period with data from *China Demographic and Employment Statistical Yearbook*.
Indratio	Ratio of industrialization	Ratio of industrialization = Urban industrial GDP / urban GDP.
Gdp	GDP growth rate	Regional GDP growth. Data from *China Statistical Yearbook*.
Cpi	Consumer price index	Consumer price index. Data from *China Statistical Yearbook*.

employee compensation calculation method, we extract total executive pay from “Cash paid to and behalf of employees” in the cash flow statement, divide the result by the total number of employees, and take natural logarithm as the proxy variable of ordinary employees’ compensation (*Lgwage*). Such compensation is in the broad sense, i.e. a company’s total per capita labor cost. This variable includes two components: The first component is compensation directly paid by a company to its employees and reflected in the employees’ pay slip, including salary, bonuses, allowances, monetary benefits, and non-monetary benefits. Non-monetary benefits include anti-pollution masks, air quality testing devices, among other benefits. The other component is collective benefits paid by a company for its employees, such as air purifiers, anti-dust window screens, and physical examination costs, which will not appear in employee compensation. Air-quality index (*Lgwage*) is from the tertiary indicators of environmental quality index in the *China City Competitiveness Yearbook*[10] (China Institute of City Competitiveness, 2015). The value of this index is between 0 and 1. Higher value means better air quality in a region. Given air quality’s lag effect on employee compensation, we adopt a one-phase lag of air quality index (AQI).

Referencing the definition of employee rights awareness in Shen *et al*.’s (2017), this paper employs the number of accepted regional labor dispute cases from *China Labor Statistical Yearbook* to calculate the number of labor dispute cases per 10,000 population in the region where a company is located. Samples for which this variable is higher than the median value of the year are defined as regions with a strong employee rights awareness (*Slrc*), and the value is 1; otherwise, it is 0. Referencing Shen *et al*.’s (2017) definition of the dummy variable of labor-intensive companies, we define sample companies whose median per capita business revenue is above the median value of sample year as non-labor-intensive companies (*Nlabor*), and the value is 1; other companies below the median per capita business revenue as labor-intensive companies, and the value is 0.

We have specified a dummy variable for the degree of match between change in air quality and change in employee compensation to measure the economic effects of adjusting employee compensation according to change in air quality. If air quality worsens and employee compensation increases or if air quality improves and employee compensation falls, a company is believed to have adjusted employee compensation according to air quality, and changes in the two are matched. In this case, the dummy variable is 1; otherwise, it is 0.

4. Analysis of Empirical Results

4.1 Hypothesis 1 Test: Air Quality and Employee Compensation

To test Hypothesis 1, we have conducted a company-clustered multivariable regression test for the relationship between employee compensation and air quality according to Model (1) as detailed in Table 2.

As shown in the regression results of Table 2, the regression coefficient -0.143 of air quality index (AQI) is significant at the level 0.05. That is to say, with other conditions held constant, as a listed company’s local air quality worsens, the company will pay more employee compensation. This result supports Hypothesis 1, and to some extent, verifies Jensen and Murphy’s (1990) non-monetary gain

[10] The *China Institute of City Competitiveness* divides city competitiveness indicators into objective indicators, subjective indicators and subjective-objective indicators. Data of objective indicators is from the *China City Competitiveness Statistical Yearbook, China City Yearbook, China Statistical Yearbook,* as well as relevant statistical yearbooks of Hong Kong, Macao and Taiwan from 2001 to 2014. In addition, we have also referenced other professional yearbooks, city statistic yearbooks, and information from city government websites, such as statistical communiques. Given the inaccuracies or deviations in the comparable data of cities in some respects, it is also necessary to conduct expert appraisal of such information based on existing data. Indicators formed with such expert-appraised data are referred to as subjective-objective indicators. Raw data of subjective indicators is obtained from questionnaire survey with the fuzzy judgement method. Hence, there is certain subjectivity in soft indicators, which may not fully reflect a city's real level on such indicators.

Table 2: Multivariable Regression Analysis of the Relationship between Air Quality and Employee Compensation

Variable	Symbol	Company-clustered regression result
Air quality index (AQI)	Air_{t-1}	-0.143** (-1.981)
SOE	Soe_t	0.151*** (6.239)
Non-labor-intensive	$Nlabor_t$	0.421*** (18.188)
Cash on hand	$Cash_t$	0.350*** (5.184)
Return on equity	Roe_t	0.255* (1.718)
Equity concentration	Shr_t	0.002*** (2.736)
Debt-to-asset ratio	Lev_t	0.000 (0.002)
Company size	$Size_t$	-0.019 (-1.447)
Executive pay	$Lgcom_t$	0.157*** (9.230)
Housing price growth rate	$Ghouse_t$	0.006 (0.112)
Percentage of elderly population	$Oldratio_t$	3.611*** (5.894)
Ratio of industrialization	$Indratio_t$	-0.337** (-2.366)
Economic growth rate	Gdp_t	-0.017*** (-3.031)
Consumer price index	Cpi_t	-0.022** (-2.006)
Constant term	Cons	8.781*** (29.690)
Year	Year	Yes
Industry	Ind	Yes
Observed value	N	17815
Goodness of fit	adj. R-sq	0.379

Note: Regression dependent variable is the logarithm Lgwage of employee compensation. Numbers in parentheses are T values. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

hypothesis. The regression coefficient -0.143 of air quality index (AQI) has the following economic implications: Other conditions to be constant, change in air quality by each unit will result in a 14.3% increase in employee compensation. In other words, with other conditions held constant, there is a 14.3% difference in the average employee compensation between a city with extremely poor air quality (index is zero) and one with extremely good air quality (index is 1). Mean employee compensation is 99,380 yuan. Extreme difference in air quality will lead to a 14,210 yuan difference in annual employee salary or an around 1,200 yuan difference in monthly employee salary.

4.2 Hypothesis 2 Test: Rights Awareness's Effect on the Relationship between Air Quality and Employee Compensation

Table 3: Employee Rights Awareness's Effect on the Relationship between Air Quality and Employee Compensation

Variable	Symbol	Company-clustered regression result
Air quality index (AQI)	Air_{t-1}	0.042 (0.533)
Employee rights awareness	$Slrc_t$	0.390*** (7.513)
Interaction term	$Slrc\_Air_t$	-0.353*** (-4.990)
SOE	Soe_t	0.166*** (6.892)
Non-labor-intensive	$Nlabor_t$	0.400*** (17.691)
Cash on hand	$Cash_t$	0.311*** (4.631)
Return on equity	Roe_t	0.284* (1.924)
Equity concentration	Shr_t	0.001** (2.042)
Debt-to-asset ratio	Lev_t	0.014 (0.240)
Company size	$Size_t$	-0.012 (-0.956)
Executive pay	$Lgcom_t$	0.129*** (7.533)
Housing price growth rate	$Ghouse_t$	0.129** (2.326)
Percentage of elderly population	$Oldratio_t$	2.852*** (4.743)
Ratio of industrialization	$Indratio_t$	-0.108 (-0.749)
Economic growth rate	Gdp_t	0.001 (0.207)
Consumer price index	Cpi_t	0.009 (0.939)
Constant term	Cons	8.433*** (28.599)
Year	Year	Yes
Industry	Ind	Yes
Observed value	N	17815
Goodness of fit	adj. R-sq	0.392
Combined test	Jointtest	-3.800***

Note: Dependent variable of regression is employee compensation Lgwage. Numbers in parentheses are T values. The last line is the combined test between air quality index (AQI) and the sum of interaction term coefficients. *** p<0.01, ** p<0.05, * p<0.1

Table 3 shows the regression results of employee rights awareness's effect on the relationship between air quality and employee compensation.

Regression results in Table 3 suggest that the AQI's (Air) regression coefficient 0.042 does not pass significance test, i.e. in regions where employees are less rights-conscious, employee compensation did not increase as a result of poor air quality. In those regions, there is a need to enhance employee protection. The regression coefficient -0.353 of interaction term Slrc_Air is significant at 0.01. This result shows that compared with companies in regions where employees are less rights-conscious, companies in regions with a strong employee rights awareness have to pay more employee compensation to reach a cost-benefit equilibrium due to poor air quality. This finding is consistent with the views of Dittmer (1987) and Shen *et al*. (2017).

The economic implication is that in regions with a strong employee rights awareness, with other conditions being equal, there is an average difference of 30,910 yuan in employee compensation between regions with extremely good air quality (AQI is 1) and extremely poor air quality (AQI is 0[11]). Obviously, employee rights awareness plays a significant role in safeguarding employee rights. Citywide, extreme air quality differences may cause an annual labor cost difference of 1,202.6 million yuan.

4.3 Hypothesis 3 Test: Industry Attribute's Regulatory Effect on the Relationship between Air Quality and Employee Compensation

Table 4 shows the test results of how industry attribute influences the relationship between air quality and employee compensation.

As shown in Table 4's regression results, the air quality's regression coefficient 0.026 does not pass significance test, which means that labor-intensive companies did not pay more compensation to their workforce as a result of poor air quality. The regression coefficient of interaction term -0.325 is significant at 0.01, which indicates that the non-labor-intensive attribute of companies will enhance the correlation between air quality and employee compensation. The regression coefficient of non-labor-intensive companies is -0.299. After the combined test, this coefficient is significant at 0.01. The economic implication is that with other conditions being equal, a non-labor-intensive company will pay an additional 29,710 yuan to an employee annually for poor air quality. Citywide, listed companies have to pay an additional 1,156.2 million yuan in labor cost due to extreme air quality. In general, Table 5's regression results may support Hypothesis 3.

4.4 Hypothesis 4 Test: Firm Value Effects of the Degree of Match between Change in the Air Quality and Change in Employee Compensation

Table 5 shows how firms' adjustment of employee compensation according to air quality influences the test result of firm value:

As shown in the regression of total samples in Table 5, the regression coefficient 0.078 of future firm value on the degree of match between change in air quality and change in employee compensation is significant at 0.05. That is to say, adjusting employee compensation according to change in air quality increases firm value. Further, we divide change in air quality into two different conditions of worsening and improving air quality to uncover whether the effect is attributable to worsening or improving air quality. As shown in Regression (2), the regression coefficient 0.09 of the observed variable is significant at 0.01 for the worsening air quality group, which means a rise in employee compensation when air quality worsens leads to an increase in firm value. Yet for the improving air quality group, the regression coefficient is positive but insignificant. A possible reason is that firms find it hard to reduce employee

[11] Extremely poor air quality, i.e. AQI is 0, only has theoretical significance. In this paper's samples, there are no cities where AQI is 0.

Table 4: Industry Attribute's Effect on the Relationship between Air Quality and Employee Compensation

Variable	Symbol	Company-clustered regression result
Air quality index (AQI)	Air_{t-1}	0.026 (0.364)
Non-labor-intensive	$Nlabor_t$	0.603*** (11.695)
Interaction term	Air_Nlabor_t	-0.325*** (-4.228)
SOE	Soe_t	0.154*** (6.369)
Cash on hand	$Cash_t$	0.356*** (5.294)
Return on equity	Roe_t	0.249* (1.684)
Equity concentration	Shr_t	0.002*** (2.689)
Debt-to-asset ratio	Lev_t	0.005 (0.079)
Company size	$Size_t$	-0.020 (-1.517)
Executive pay	$Lgcom_t$	0.157*** (9.206)
Housing price growth rate	$Ghouse_t$	0.022 (0.422)
Percentage of elderly population	$Oldratio_t$	3.519*** (5.781)
Ratio of industrialization	$Indratio_t$	-0.300** (-2.040)
Economic growth rate	Gdp_t	-0.016*** (-2.924)
Consumer price index	Cpi_t	-0.019* (-1.715)
Constant term	Cons	8.645*** (28.603)
Year	Year	Yes
Industry	Ind	Yes
Observed value	N	17815
Goodness of fit	adj. R-sq	0.382
Combined test	Joint test	-3.250***

Note: Dependent variable of regression is employee compensation Lgwage. Numbers in parentheses are T values. The last line is the combined test of air quality index and the sum of interaction term coefficients. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Firm Value Effects of the Degree of Match between Change in Air Quality and Employee Compensation Adjustment

		(1)	(2)	(3)
Variable	Symbol	Total samples	Quality worsens	Quality improves
Dummy variable of the degree of match between air quality and compensation	$Match_{t-1}$	0.078** (2.523)	0.090*** (2.588)	0.029 (0.535)
Company type	Soe_t	-0.241*** (-4.769)	-0.189*** (-3.647)	-0.336*** (-5.128)
Cash on hand	$Cash_t$	0.693*** (3.531)	0.670*** (3.239)	1.149*** (3.879)
Return on equity	Roe_t	6.569*** (11.396)	6.294*** (9.413)	6.755*** (8.133)
Equity concentration	Shr_t	0.003** (1.986)	0.003* (1.809)	0.003 (1.418)
Asset-liability ratio	Lev_t	-0.203 (-0.947)	-0.042 (-0.186)	-0.398 (-1.471)
Company size	$Size_t$	-0.762*** (-21.337)	-0.642*** (-17.544)	-0.975*** (-22.143)
Constant term	Cons	17.058*** (24.003)	18.350*** (18.378)	23.246*** (24.884)
Year	Year	Yes	Yes	Yes
Industry	Ind	Yes	Yes	Yes
Observed value	N	14607	9686	4921
Goodness of fit	adj. R-sq	0.461	0.421	0.503

Note: The dependent variable for regression is Tobin's Q for firm value. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

compensation as doing so would incur significantly negative effects.

Based on the regression results in Table 5, we may arrive at the following conclusion that adjusting employee compensation according to change in air quality increases firm value. This effect is particularly striking in regions with worsening air quality.

4.5 Further Test

4.5.1 Effects of ownership nature: implicit guarantee

Lu *et al*. (2012) argues that SOEs pay higher compensation to their workforce. Theoretically, differences in the implicit guarantee offered by firms of different ownership types to their workforces may also influence the relationship between air quality and employee compensation. This assumption is tested with the direct results in Table 6.

As shown in the regression results in Table 6, air quality may not have affected employee

Table 6: Relationship between Air Quality and Employee Compensation: Differences between SOEs and Private Enterprises

		(1)	(2)
Variable	Symbol	SOE	Private firms
Air quality index (AQI)	Air_{t-1}	-0.029 (-0.302)	-0.288*** (-2.813)
Non-labor-intensive	$Nlabor_t$	0.489*** (15.455)	0.345*** (10.854)
Cash on hand	$Cash_t$	0.288** (2.451)	0.441*** (5.331)
Return on equity	Roe_t	0.360* (1.783)	0.141 (0.701)
Equity concentration	Shr_t	0.005*** (4.669)	-0.002** (-2.089)
Debt-to-asset ratio	Lev_t	-0.157** (-2.070)	0.149* (1.788)
Company size	$Size_t$	-0.003 (-0.169)	-0.049** (-2.159)
Executive pay	$Lgcom_t$	0.125*** (5.491)	0.198*** (7.795)
Housing price growth rate	$Ghouse_t$	-0.079 (-1.212)	0.123 (1.399)
Percentage of elderly population	$Oldratio_t$	4.757*** (5.307)	2.403*** (3.073)
Ratio of industrialization	$Indratio_t$	-0.372* (-1.778)	-0.270 (-1.497)
Economic growth rate	Gdp_t	-0.014* (-1.895)	-0.021*** (-2.870)
Consumer price index	Cpi_t	-0.023* (-1.761)	-0.020 (-0.976)
Constant term	Cons	7.892*** (21.599)	9.131*** (18.378)
Year	Year	Yes	Yes
Industry	Ind	Yes	Yes
Chi2 test	Chi2	3.390*	
Observed value	N	9343	8472
Goodness of fit	adj. R-sq	0.421	0.345

Note: Dependent variable for regression is employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

compensation at SOEs, but has significantly influenced employee compensation at private enterprises. Test Chi2 values of two groups of coefficients are also significant at 0.1.

4.5.2 Impact of cash on hand: ability to pay

Any increase in employee compensation as a major cash expenditure for companies requires sufficient cash reserves. When air quality worsens, whether a company is able to give its employees a pay rise is subject to the amount of its cash on hand. With more cash on hand, a company is more likely to raise employee compensation. Hence, we have tested how a company's cash on hand regulates the

Table 7: Relationship between Air Quality and Employee Compensation: Grouped by the Level of Cash on Hand

		(1)	(2)
Variable	Symbol	Low cash on hand	High cash on hand
Air quality index (AQI)	Air_{t-1}	-0.105 (-1.216)	-0.181** (-2.271)
SOE	Soe_t	0.123*** (4.089)	0.162*** (5.951)
Non-labor-intensive	$Nlabor_t$	0.436*** (14.974)	0.400*** (16.047)
Return on equity	Roe_t	0.431** (2.345)	0.040 (0.198)
Equity concentration	Shr_t	0.003*** (3.459)	0.001 (1.583)
Debt-to-asset ratio	Lev_t	-0.113* (-1.652)	-0.012 (-0.188)
Company size	$Size_t$	-0.009 (-0.596)	-0.038*** (-2.612)
Executive pay	$Lgcom_t$	0.145*** (7.166)	0.165*** (7.928)
Housing price growth rate	$Ghouse_t$	0.386*** (3.848)	-0.311*** (-2.831)
Percentage of elderly population	$Oldratio_t$	3.658*** (5.088)	3.290*** (4.921)
Ratio of industrialization	$Indratio_t$	-0.270 (-1.561)	-0.197 (-1.263)
Economic growth rate	Gdp_t	0.008 (1.249)	-0.030*** (-4.465)
Consumer price index	Cpi_t	-0.030** (-2.213)	-0.000 (-0.013)
Constant term	Cons	8.617*** (17.213)	9.077*** (26.221)
Year	Year	Yes	Yes
Industry	Ind	Yes	Yes
Chi2 test	Chi2	0.940	
Observed value	N	7926	9889
Goodness of fit	adj. R-sq	0.402	0.342

Note: All dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

relationship between air quality and employee compensation. Specifically, if a company's cash on hand exceeds annual industry median value, it is deemed as a company with high cash on hand; otherwise, it is deemed as a company with low cash on hand. Table 7 shows specific regression results:

As shown in the above table, the regression coefficient -0.105 of air quality index is insignificant for samples with low cash on hand. However, the regression coefficient -0.181 is significant at 0.05 for samples with high cash on hand. The implication is that a company's ability to pay will influence the relationship between air quality and employee compensation.

Table 8: Test of Samples with Good and Bad Urban Air Quality

		(1)	(2)
Variable	Symbol	Bad air quality	Good air quality
Air quality index (AQI)	Air_{t-1}	-0.267*** (-2.780)	-0.128 (-0.824)
SOE	Soe_t	0.154*** (5.395)	0.145*** (5.245)
Non-labor-intensive	$Nlabor_t$	0.452*** (16.748)	0.360*** (13.252)
Cash on hand	$Cash_t$	0.286*** (3.767)	0.522*** (5.481)
Return on equity	Roe_t	0.153 (0.870)	0.438** (2.008)
Equity concentration	Shr_t	0.002*** (2.810)	0.001 (1.478)
Debt-to-asset ratio	Lev_t	-0.004 (-0.064)	0.029 (0.355)
Company size	$Size_t$	-0.017 (-1.108)	-0.020 (-1.417)
Executive pay	$Lgcom_t$	0.155*** (7.744)	0.155*** (7.972)
Housing price growth rate	$Ghouse_t$	-0.124** (-2.012)	0.394*** (3.422)
Percentage of elderly population	$Oldratio_t$	5.714*** (7.668)	0.663 (0.969)
Ratio of industrialization	$Indratio_t$	-0.077 (-0.416)	-0.268 (-1.391)
Economic growth rate	Gdp_t	-0.032*** (-4.691)	0.017** (2.546)
Consumer price index	Cpi_t	-0.029** (-2.160)	0.014 (0.838)
Constant term	Cons	8.927*** (24.657)	8.861*** (18.889)
Year	Year	Yes	Yes
Industry	Ind	Yes	Yes
Chi2 test	Chi2	0.600	
Observed value	N	10968	6847
Goodness of fit	adj. R-sq	0.357	0.439

Note: All dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

4.5.3 Non-linear relationship between air quality and employee compensation: is good or bad air quality at play?

According to literature, poor air will harm people's health and life expectancy (Dominici *et al*., 2006; Cropper, 2010; Chen *et al*., 2013). Hence, good and bad air quality may influence firm behavior in different ways. Following the median value of urban air quality index, we divide all cities into those with good air quality and those with bad air quality. If a city's median air quality exceeds the median air quality of total samples, the city is defined as one with good air quality; otherwise, it is defined as one with bad air quality. Table 8 shows specific regression results:

As shown in the above table, the regression coefficient -0.267 of air quality index is significant at 0.01 for samples with poor air quality, but the regression coefficient -0.128 of air quality index does not pass significance test for samples with good air quality. This result suggests that poor air quality exerts a greater impact on firm behavior, and requires firms to pay a compensation premium. Although good air quality may reduce firms' compensation payment, the effect is not significant.

4.6 Discussions on Endogeneity

This paper carries out the following analysis and test to mitigate endogeneity's impact on empirical results.

4.6.1 Mitigating endogeneity by means of the instrumental variable method

We use environmental workers per 10,000 population as an instrumental variable to further mitigate possible endogeneity arising from missing variables. This variable is also from the *City Competitiveness Yearbook* of various years. Theoretically, this variable is significantly correlated with air quality and not

Table 9: Analysis Based on the Instrumental Variable Method

Variable	Symbol	(1)
Air quality index (AQI)	Air_{t-1}	-1.531*** (-8.447)
SOE	Soe_t	0.117*** (10.022)
Non-labor-intensive	$Nlabor_t$	0.431*** (40.556)
Cash on hand	$Cash_t$	0.317*** (8.254)
Return on equity	Roe_t	0.261*** (2.953)
Equity concentration	Shr_t	0.001*** (4.016)
Debt-to-asset ratio	Lev_t	0.011 (0.415)
Company size	$Size_t$	-0.032*** (-5.569)
Executive pay	$Lgcom_t$	0.173*** (21.367)
Housing price growth rate	$Ghouse_t$	0.079 (1.172)
Percentage of elderly population	$Oldratio_t$	2.148*** (6.270)
Level of industrialization	$Indratio_t$	0.370*** (3.380)
Economic growth rate	Gdp_t	0.006 (1.454)
Consumer price index	Cpi_t	-0.011 (-1.238)

Constant term	Cons	9.327*** (20.088)
Year	Year	Yes
Industry	Ind	Yes
Observed value	N	17815
Goodness of fit	adj. R-sq	0.296

Note: All dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

correlated with employee compensation, which meets the criteria as an instrumental variable. Table 9 shows the regression results of the instrumental variable method:

As shown in the above table, the regression results remain generally constant when environmental workers per 10,000 urban population is used as an instrumental variable, and air quality is still significantly negatively correlated with employee compensation at the level 0.01. The implication is that endogeneity arising from missing variables does not significantly affect empirical conclusions.

4.6.2 Regression grouped by the share of industrial GDP

Given the complex determinants of air quality, we cannot consider that air quality is endogenous in one factor. Through an observation on the reality, however, there will be a drastic improvement in air quality when the government shuts down industrial activity on a broad scale. Hence, we assume that air quality is endogenous in the local level of industrialization. Meanwhile, the regional level of industrialization may also influence employee compensation, making it necessary to consider the endogeneity problem of regional economic structure.

Theoretically, if air quality and employee compensation are endogenous in the local level of industrialization, there will be significant differences in the relationship between air quality and

Table 10: Test Results Grouped by Local Levels of Industrialization

		(1)	(2)
Variable	Symbol	High ratio of industrialization	Low ratio of industrialization
Air quality index (AQI)	Air_{t-1}	-0.167** (-2.460)	-0.192** (-2.309)
SOE	Soe_t	0.174*** (6.585)	0.120*** (5.061)
Non-labor-intensive	$Nlabor_t$	0.451*** (18.014)	0.376*** (16.757)
Cash on hand	$Cash_t$	0.369*** (5.091)	0.359*** (4.307)
Return on equity	Roe_t	0.279* (1.737)	0.189 (1.011)
Equity concentration	Shr_t	0.002** (2.537)	0.002*** (2.923)
Debt-to-asset ratio	Lev_t	0.019 (0.305)	-0.036 (-0.579)

Company size	$Size_t$	-0.019 (-1.347)	-0.017 (-1.385)
Executive pay	$Lgcom_t$	0.149*** (8.091)	0.165*** (9.493)
Housing price growth rate	$Ghouse_t$	-0.246** (-2.325)	0.643*** (6.704)
Percentage of elderly population	$Oldratio_t$	3.751*** (5.405)	2.614*** (4.789)
Economic growth rate	Gdp_t	-0.024*** (-3.981)	0.000 (0.064)
Consumer price index	Cpi_t	-0.009 (-0.559)	-0.042*** (-2.859)
Constant term	Cons	8.349*** (23.290)	8.189*** (28.680)
Year	Year	Yes	Yes
Industry	Ind	Yes	Yes
Chi2 test	Chi2	0.290	
Observed value	N	10924	6891
Goodness of fit	adj. R-sq	0.370	0.375

Note: Dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

employee compensation in regions with different levels of industrial development. Yet as shown in the grouped test results of annual median level of industrialization (see Table 10), there is no significant difference between the two samples with respect to the relationship between air quality and employee compensation.

4.6.3 Regression grouped by the speed of economic development

Economic development is often accompanied by worsening air quality. To avoid the impact of economic growth rate on air quality's endogeneity, we divide all cities into two types according to the annual median GDP growth rate: those above the median growth rate (rapid economic growth) and those below (slow economic growth). Table 11 shows the results of the grouped observations:

As shown in the above table, there is a significant negative correlation between air quality and employee compensation in regions with rapid or slow economic growth rates, and such correlation demonstrates no significant difference between the two groups. Data suggest that economic growth rate is not an endogenous factor of air quality.

4.6.4 Endogeneity discussion based on the intensity of environmental regulation

Local environmental regulatory intensity is likely to become an endogenous source of air quality and employee compensation. Local government regulatory intensity is determined at two levels: (i) the *National Environmental Protection Regulations and Environmental Economic Policy Planning for the 12th Five-Year Plan Period* enacted and implemented at the end of 2011 and the *Environmental Quality*

[12] This document was enacted and implemented beginning on November 1, 2011. For the convenience of examining the event shock's impact on the relationship between air quality and employee compensation, it may be deemed as enacted in 2012.

Table 11: Test Grouped by Economic Growth Rates

		(1)	(2)
Variable	Symbol	Rapid economic growth	Slow economic growth
Air quality index (AQI)	Air_{t-1}	-0.157* (-1.841)	-0.136* (-1.861)
SOE	Soe_t	0.161*** (4.993)	0.143*** (6.518)
Non-labor-intensive	$Nlabor_t$	0.507*** (16.476)	0.304*** (14.962)
Cash on hand	$Cash_t$	0.386*** (4.478)	0.312*** (4.633)
Return on equity	Roe_t	0.351* (1.783)	0.162 (1.019)
Equity concentration	Shr_t	0.002** (2.325)	0.002*** (2.760)
Debt-to-asset ratio	Lev_t	0.039 (0.517)	-0.041 (-0.767)
Company size	$Size_t$	-0.026 (-1.598)	-0.003 (-0.253)
Executive pay	$Lgcom_t$	0.156*** (7.568)	0.145*** (8.586)
Housing price growth rate	$Ghouse_t$	-0.049 (-0.707)	0.042 (0.485)
Percentage of elderly population	$Oldratio_t$	5.077*** (6.095)	1.331*** (2.686)
Level of industrialization	$Indratio_t$	-0.303* (-1.755)	-0.750*** (-5.435)
Consumer price index	Cpi_t	-0.044*** (-3.185)	0.074*** (4.098)
Constant term	Cons	8.870*** (24.309)	8.816*** (19.816)
Year	Year	Yes	Yes
Industry	Ind	Yes	Yes
Chi2 test	Chi2	0.080	
Observed value	N	10138	7677
Goodness of fit	adj. R-sq	0.358	0.380

Note: All dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

Standard[12] enacted in early 2011, which were followed by stronger environmental regulatory intensity; (ii) the intensity of law enforcement by local governments. Accordingly, we define the enactment of relevant environmental regulations in 2012 as an external event shock to examine the event's impact on the relationship between air quality and employee compensation to mitigate endogeneity. In addition, we divide samples into those with strong and weak local government law enforcement to examine how

Table 12: Endogeneity Test Based on Law Enforcement Intensity

		(1)	(2)	(3)	(4)
Variable	Symbol	After the enactment of regulatory laws	Before the enactment of regulatory laws	High law enforcement intensity	Low law enforcement intensity
Air quality index (AQI)	Air_{t-1}	-0.369*** (-3.904)	-0.132* (-1.727)	-0.608*** (-4.265)	-0.058 (-0.767)
SOE	Soe_t	0.113*** (5.199)	0.167*** (5.951)	0.168*** (4.942)	0.143*** (4.622)
Non-labor-intensive	$Nlabor_t$	0.250*** (12.778)	0.469*** (17.432)	0.405*** (13.722)	0.390*** (12.856)
Cash on hand	$Cash_t$	0.371*** (4.830)	0.367*** (4.745)	0.277*** (3.336)	0.422*** (4.415)
Return on equity	Roe_t	0.030 (0.176)	0.300* (1.746)	0.095 (0.420)	0.439** (2.574)
Equity concentration	Shr_t	0.001** (2.303)	0.002** (2.489)	0.002* (1.648)	0.002** (2.299)
Debt-to-asset ratio	Lev_t	0.027 (0.475)	0.011 (0.157)	-0.008 (-0.104)	0.082 (1.122)
Company size	$Size_t$	-0.002 (-0.153)	-0.021 (-1.400)	-0.029 (-1.596)	-0.001 (-0.037)
Executive pay	$Lgcom_t$	0.147*** (8.659)	0.151*** (7.941)	0.153*** (5.948)	0.123*** (6.220)
Housing price growth rate	$Ghouse_t$	0.172 (1.585)	-0.069 (-1.121)	0.206* (1.928)	-0.159* (-1.735)
Percentage of elderly population	$Oldratio_t$	1.834*** (3.717)	4.422*** (5.927)	4.352*** (5.951)	-0.477 (-0.576)
Level of industrialization	$Indratio_t$	-0.491*** (-3.772)	-0.287* (-1.737)	0.742*** (3.021)	-0.765*** (-3.820)
Economic growth rate	Gdp_t	-0.011 (-1.482)	-0.019*** (-3.134)	-0.061*** (-4.191)	0.014** (2.553)
Consumer price index	Cpi_t	0.218*** (6.944)	-0.035*** (-2.864)	-0.004 (-0.231)	-0.030** (-2.282)
Constant term	Cons	9.162*** (20.858)	8.688*** (21.673)	9.356*** (23.452)	9.082*** (19.550)
Year	Year	Yes	Yes	Yes	Yes
Industry	Ind	Yes	Yes	Yes	Yes
Chi2 test	Chi2	5.390**		13.430***	
Observed value	N	4346	13469	8931	8884
Goodness of fit	adj. R-sq	0.292	0.365	0.347	0.398

Note: All dependent variables for regression are employee compensation Lgwage. Numbers in parentheses are T values. *** p<0.01, ** p<0.05, * p<0.1.

the intensity of local government law enforcement influences the relationship between air quality and employee compensation. Table 12 shows the regression results:

As shown in Equations (1) and (2) in the above table, there is a significant difference between the regression coefficient -0.369 after the enactment of regulatory laws and the regression coefficient -0.132 before the enactment of regulatory laws. The implication is that tighter law enforcement after the enactment of regulatory documents would significantly boost the negative correlation between air quality and employee compensation. This result is logically consistent with the results of Equations (3) and (4).

5. Rough Estimate of Air Quality Change's on the Labor Cost Effects

As shown in Table 2, with other conditions being equal, there is a 14.3% difference in urban employee average compensation between cities with extremely poor air quality (index is 0) and those with extremely good air quality (index is 1). For the average employee compensation of 99,380 yuan, there is an annual employee salary difference of 14,210 yuan due to extreme air quality difference. From statistical yearbooks, we have collected the numbers of urban employees during sample period for various provinces, and estimated the labor cost effects of extreme air quality changes with the following statistical approaches, respectively:

(i) We have obtained a result of rough statistical approach by multiplying employee annual salary difference of 14,210 yuan by the number of urban employees in various provinces during the sample period. Total labor cost difference for companies nationwide attributable to extreme air quality changes between 2005 and 2015 amounts to 22,586.001 billion yuan. Annual and provincial estimation results are shown in Panels A and B of Table 13, respectively.

(ii) We calculate mean employee compensation in various provinces and years according to the samples of listed companies, then multiply the result by 14.3% to obtain the labor cost difference for companies in various provinces attributable to extreme air quality changes, and then multiply this difference by the number of urban employees in various provinces and years, which gives us a result of 20,053.408 billion yuan. Annual estimation results are shown in Column 3, Panel A of Table 13, and provincial estimation results are shown in Column 3, Panel B of Table 13, respectively.

By the above two statistical approaches, labor cost difference for companies throughout China

Table 13: Panel A: Yearly Estimation Results (in 100 million yuan)

Year	Approach 1	Approach 2	Year	Approach 1	Approach 2
2005	16,099.55	9,328.92	2011	20,294.73	19,047.91
2006	16,535.68	10,469.30	2012	21,457.17	19,519.20
2007	16,974.75	12,847.81	2013	24,898.14	24,191.50
2008	17,211.53	14,247.03	2014	25,844.67	26,591.92
2009	17,778.27	15,186.11	2015	25,540.38	27,775.44
2010	23,225.15	21,328.94	Total	225,860.01	200,534.08

Source: Compiled and estimated by authors.

Table 13: Panel B: Estimation Results by Region (in 100 million yuan)

Province	Approach 1	Approach 2	Province	Approach 1	Approach 2
Anhui	6,638.35	4,542.73	Jiangxi	5,769.23	3,528.63
Beijing	9,838.81	12,399.31	Liaoning	9,020.27	8,566.82
Fujian	8,330.40	6,886.86	Inner Mongolia	4,126.63	3,780.85
Gansu	3,309.42	1,653.24	Ningxia	1,017.46	656.90
Guangdong	21,060.61	19,997.97	Qinghai	677.80	380.90
Guangxi	5,332.83	5,372.04	Shandong	16,481.79	11,744.02
Guizhou	3,754.79	2,763.93	Shanxi	6,157.57	4,066.49
Hainan	1,344.55	1,800.21	Shaanxi	6,199.63	5,126.02
Hebei	8,724.89	5,924.53	Shanghai	7,592.85	13,483.66
Henan	13,166.62	8,411.45	Sichuan	9,414.79	7,532.02
Heilongjiang	7,235.29	4,574.96	Tianjin	3,651.32	4,919.25
Hubei	9,032.13	7,114.56	Tibet	287.46	430.20
Hunan	7,992.15	5,472.95	Xinjiang	4,130.81	3,661.56
Jilin	4,507.37	2,786.57	Yunnan	5,464.88	4,349.54
Jiangsu	16,606.30	17,524.50	Zhejiang	14,177.21	15,377.58
Chongqing	4,815.79	5,703.82	Total	225,860.01	200,534.08

Source: Collected by authors.

attributable to extreme air quality changes roughly falls in the range between 20 trillion and 23 trillion yuan.

6. Conclusions

This paper finds that air quality is significantly negatively correlated with employee compensation, i.e. worse air quality will prompt employees to ask for more compensation; on the contrary, improving air quality will spare firms significant labor cost. Adjusting employee compensation according to changing air quality helps increase firm value.

Further research suggests that in regions with a strong rights awareness, employees are more sensitive to air quality changes. Clean air offers a weaker non-monetary incentive for employees from labor-intensive companies than those from non-labor-intensive ones. Worsening air quality entails a greater compensation premium to private companies than to SOEs. The above study provides empirical support to clean air as employees' non-monetary benefit, and contributes to theoretical literature on how air quality influences firm behavior, thus broadening the scope of research on how natural environment influences employee compensation. More importantly, this study verifies China's policy principle that "lucid waters and lush mountains are invaluable assets" from a labor cost perspective. During the sample period, labor cost difference attributable to extreme air quality changes in various provinces is roughly estimated to be in the range between 20 trillion yuan and 23 trillion yuan.

Firms should proactively protect employee interest, and incentivize those working under poor air quality. Employees are stakeholders who create and strive to maximize firm value. Worsening air quality will harm employee health. In this sense, firms should proactively improve employees' working environment to encourage their exertion and maximize firm value.

References:

[1] Becker, Gary S. 1962. "Investment in Human Capital: A Theoretical Analysis." *Journal of Political Economy,*70(5):9-49.

[2] Boustan, Leah P., M. E. Kahn, and P. W. Rhode. 2012. "Moving to Higher Ground: Migration Response to Natural Disasters in the Early Twentieth Century." *American Economic Review,* 102(3):238-244.

[3] Chang, Tom Y., W. Huang, and Y. X. Wang. 2018. "Something in the air: Pollution and the Demand for Health Insurance." *The Review of Economic Studies,* 85(3):1609-1634.

[4] Chay, Kenneth, C. Dobkin, and M. Greenstone. 2003. "The Clean Air Act of 1970 and adult mortality." *Journal of Risk and Uncertainty,* 27(3):279-300.

[5] Chen, Dong H., C. L. Fan, and Y. J. Shen. 2015. "CEO and Employee: Comparison and Interaction of Incentive Effectiveness." *Management World, no.*5:160-171.

[6] Chen, Dong H., C. L. Fan, Y. J. Shen, and Y. H. Zhou. 2010. "Employee Incentive, Wage Rigidity and Firm Performance: Empirical Evidences from Chinese Unlisted SOEs." *Economic Research Journal, no.*7:116-129.

[7] Chen, Dong H., F. S. Chen, Y. J. Shen, and H. F. You. 2011. "CEO Turnover, Employee Wage and Implicit Contract: Empirical Evidence from China Listed Companies." *Economic Research Journal, no.*12:100-111.

[8] Chen, Dong H., X. Y. Chen, and H. L. Wan. 2005. "Regulation and Non-pecuniary Compensation in Chinese SOEs." *Economic Research Journal, no.*2:92-101.

[9] Chen, Yuyu, A. Ebenstein, M. Greenstone, and H. Li. 2013. "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy." *Proceeding of the National Academy of Sciences of the United States of America,*110(32): 12936-12941.

[10] China Institute of City Competitiveness. 2015. *China city competitiveness yearbook.* Hongkong: China City Competitiveness Research Society Press.

[11] Cropper, Maureen. 2010. *What are the Health Effects of Air Pollution in China? Is Economic Growth Sustainable*? UK: Palgrave Macmillan.

[12] Deng, Xin, and H. Gao. 2013. "Nonmonetary Benefits, Quality of Life, and Executive Compensation." *Journal of Financial and Quantitative Analysis,* 48(1):197-218.

[13] Dittmer, Lowell. 1987. *China's Continuous Revolution: The Post-liberation Epoch, 1949-1981*. American: University of California press.

[14] Dominici, Francesca, R. D. Peng, M. L. Bell, M. L. Pham, A. McDermott, S. L. Zegerand J. M. Samet. 2006. "Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases." *Journal of the American Medical Association,* 295(10):1127-1134.

[14] Ebenstein, Avraham, M. Fan, M. Greenstone, G. He, P. Yin, and M. Zhou. 2015. "Growth, Pollution, and Life Expectancy: China from 1991-2012." *American Economic Review,* 105(5)226-231.

[16] Fang, Jun X. 2011. "Has the Proportion Reached by the Income Obtained by labor been Declining?—My Discovery from China's Listed Companies." *Management World, no.*7:31-41.

[17] Fehr, Ryan, K. C. Yam, W. He, J. T. Chiang, and W. Wei. 2017. "Polluted Work: A self-control Perspective on Air Pollution Appraisals, Organizational Citizenship, and Counterproductive Work Behavior." *Organizational Behavior and Human Decision Processes,*143(1):98-110.

[18] Fei, Xiaotong. 2015. *Rural China, Fertility System, Rural Reconstruction.* Beijing: The Commercial Press.

[19] Jensen, Michael C., and K. J. Murphy. 1990."Ceo Incentives—It's Not How Much You Pay, But How." *Harvard Business Review,* 68(3):138-153.

[20] Li, Chao, and H. Li. 2017. "The Effect of Air Pollution on Inventory - Evidence From Chinese Manufacturing Enterprises." *Management*

*World, no.*8:95-105.

[21] Li, Wen J., and Y. M. Hu. 2012. "Who is Encouraged by Pay Dispersion in State-owned Enterprises?" *Economic Research Journal, no.*12:125-136.

[22] Lu, Jackson G., J. J. Lee, F. Gino, and A. D. Galinsky. 2018. "Polluted Morality: Air Pollution Predicts Criminal Activity and Unethical Behavior." *Psychological Science,* 29(3):340-355.

[23] Lu, Zheng F., X. Y. Wang, and P. Zhang. 2012. "Do Chinese State-Owned Enterprises Pay Higher Wage?" *Economic Research Journal, no.*3:29-40.

[24] Marx, Karl. 1867. *Das Kapital(volumes I)*. Beijing: People's Publishing House, Translated in 2004.

[25] Maslow, Abraham H. 1943. *Motivation and Personality.* Beijing: Renmin university press.

[26] Mathios, Alan D. 1989. "Education, Variation in Earnings, and Nonmonetary Compensation." *Journal of Human Resources,* 24(3):456-468.

[27] Maureen, Cropper Cronqvist, Henrik, F. Heyman, M. Nilsson, H. Svaleryd and J. Vlachos. 2009. "Do Entrenched Managers Pay Their Workers More?" *The Journal of Finance,* 64(1):309-339.

[28] Myers, Dowell.1987. "Internal Monitoring of Quality of Life for Economic Development." *Economic Development Quarterly,* 1(3):268-278.

[29] Pagano, Marco, and P. Volpin. 2005. "Managers, Workers, and Corporate Control." *Journal of Finance,* 60(2):843-870.

[30] Roback, Jennifer.1982. "Wages, Rents, and the Quality of Life." *Journal of Political Economy,* 90(6):1257-1278.

[31] Schmenner, Roger W. 1982. *Making Business Location Decisions*. Englewood Cliffs, NJ: Prentice-Hall.

[32] Schultz, Theodore W. 1961."Investment in Human Capital: Reply." *American Economic Review,*51(5):1035-1039.

[33] Shen, Yong J., C. L. Fan, D. H. Chen, and J. Liu. 2017. "Explicit Contract, Employee Rights Protection and the Rise in the Labor Cost—Exploring the Role of the Labor Contract Law." *China Industrial Economics, no.*2:119-137.

[34] Shen, Yong J., J. W. Liu, M. F. Sun, and Y. X. Shen. 2016. "The Harmony of Labor Relations and Firm Value: A Case Study of Wang Chunhua." *Journal of Accounting and Economics, no.*3:99-112.

[35] Slaughter, Sandra A., S. Ang, and W. F. Boh. 2007. "Firm Specific Human Capital and Compensation Organizational Tenure Profiles: An Archival Analysis of Salary Data for IT Professionals." *Human Resource Management,* 46(3):373-394.

[36] Wang, Dingding. 2016. "The Political, Economic and Social Effects of Long-term Haze." National Institute of Development, Peking University.

[37] Wang, Xiong Y., and J. Hen. 2012. "Executive power and Employee Compensation: Based on the Perspective of Over-employees and compensation." *Proceedings of the 25th Theory Seminar of Financial Cost Branch of Chinese Accounting Society*.

[38] Wang, Xiong Y., and Y. Q. Huang. 2017. "Foreign Direct Investment and Labor Share in the Listed Companies: Looting a Burning House or Icing on the Cake." *China Industrial Economics, no.*4:137-156.

[39] Wei, Xia H., Z. Q. Dong, and J. L. Huang. 2013. "Does Labor Union Improve Labor Share? Theoretical Analysis and Evidence from Private Firms in China." *Economic Research Journal, no.*8:16-28.

[40] Wei, Xia H., Z. Q. Dong, and Z. Jin. 2015. "Have Unions Improved the Structure of Employment Terms? -- Evidence from National Sample Survey of Non-SOE." *Management World,* 260(5):60-70.

[41] Yao, Yang, and N. Y. Zhong. 2013. "Unions and Workers' Welfare in Chinese Firms." *Journal of Labor Economics,* 31(3):633-667.

[42] Zhou, Zhe, B. Liu, and Z. C. Liu. 2012. "Regional Labor Mobility, Asset Specificity and Employee Salary: An Empirical Analysis Based on Industry and Provincial Panel Data of China." *Nankai Economic Studies, no.*5:81-95.