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Air Pollution and Medical Insurance: From a Health-Based Perspective

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Abstract: Using the China Health and Retirement Longitudinal Study (CHARLS), this paper quantifies the causal effects of air pollution on the demand for medical insurance. Results suggest that the rise in air pollution is associated with an increased probability of purchasing medical insurance. Furthermore, residents are more inclined to have basic medical and commercial insurance, rather than critical illness insurance. In addition, the evidence of two possible channels through which air pollution is related to purchasing insurance are found, including causing chronic diseases and depression. This study provides empirical evidence for China and other developing countries to improve the medical security system and promote the national health movement.

Keywords: air pollution; medical insurance; resident health

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1. Introduction

The harmfulness of air pollution to residents' health has been increasingly prominent. With the rapid development of national economy, the ecological environment is facing severe challenges. According to statistics, in 2020, 40% of Chinese cities did not meet the State Council's air quality standards, which mainly includes Beijing–Tianjin wing and surrounding areas, the Fenwei Plain, and the Yangtze River Delta [1]. Air pollution caused by pollutant emissions from industrial production includes inhalable particulate matter and various toxic compounds, sulfur oxides and nitric oxide. According to the World Health Organization (WHO) standards, China's average $PM_{2.5}$ concentration did not meet the standard in 2019, meanwhile it was 33 mg/m^3 in 2020, which is still far higher than the international safety value of 10 mg/m^3 [2]. $PM_{2.5}$ refers to solid or liquid particles suspended in the air with an aerodynamic diameter of no more than 2.5 um, which occupies a considerable proportion of the air particles. Because of the complex structure as well as a large surface area, $PM_{2.5}$ is easier to absorb heavy metals and organic substances harmful to the human body, which means higher toxicity [3]. Due to long-term exposure to the harsh air environment, individual health cannot be guaranteed, and sometimes even life-threatening emergencies happen. A WHO survey found that about 1610 of every one million deaths in China were caused by air pollution. However, the impact of air pollution not only increases mortality, but it also increases diseases and depression, which seriously affect resident's quality of life. Studies have found that high concentrations of PM2.5 in the air can stimulate a variety of diseases and lead to the deterioration of chronic diseases [4,5]; the occurrence of extreme meteorological disasters such as haze also seriously affects individuals' psychology and emotion [6,7]. In recent years, the incidence of chronic diseases and depression in China has continued to rise, which has aroused widespread attention.

People's health is the symbol of country's prosperity, while the social security system is an effective guarantee for people's health. The Chinese medical insurance system was established in the 1990s. After more than 20 years of exploration and development, it has formed a system consisting of urban employee medical insurance, urban resident medical

insurance, and new rural cooperative medical insurance [8]. The main function of medical insurance is to improve the health of insured persons by increasing the proportion of medical insurance reimbursements [9]. In 2020, every insured person in China enjoyed 2.6 times medical discount on average which amount to around CNY 1,580 [10]. It shows that the Chinese medical insurance system can basically meet the health protection needs of the individuals. Because medical insurance system guarantees the insured be available to medical treatment timely, the medical insurance system can relieve the insured's psychological pressure when sick.

As the air pollution problem has become a significant issue recently, individuals have gradually realized their health is threatened, and have begun to take measures that prevent and reduce the impact of pollution [11]. Furthermore, related studies have confirmed that severe air pollution has increased individuals' daily medical expenditures, which means individuals' consumption of medical care is rising. As previously mentioned, medical insurance plays a role in preventing health risks and reducing medical costs. At present, commercial health insurance covering serious diseases caused by air pollution have also appeared on the market. Even if residents do not choose to purchase this type of insurance, they can still insure relevant physical insurance for the risk of chronic respiratory diseases at any time. The above measures provided protection for residents to prevent health losses caused by air pollution. Therefore, do individuals consciously insure their health considering the risk that may be caused by air pollution? Besides, is there any difference in the preference when individuals take out insurance? Meanwhile, what is the internal mechanism of air pollution affecting individuals' insurance? These issues are discussed in this paper.

Using microdata from the China Health and Retirement Longitudinal Study (CHARLS), this paper pays attention to the impact of air pollution on individuals' demand of medical insurance. Specifically, this paper attempts to make contributions in the following aspects. First, we discuss the influence of air pollution on different types of insurance. Compared with existing studies that mostly only focus on basic medical insurance or commercial health insurance, we analyze the individuals' willingness to purchase basic insurance, commercial insurance and critical illness insurance. Second, we clarify the impact mechanism from a health perspective. Different from previous literature that pays more attention to individuals' physical health, this paper explores the internal mechanism from the perspectives of residents' physical and mental health. Finally, we provide a reference for the government to formulate health protection strategies. We find that supplementary medical insurance has not attracted residents' attention enough, especially critical illness insurance. This shows relevant departments that the current insurance system should be advanced in order to play its due role in maintaining the health of the individuals.

The rest of this paper is arranged as follows: the second part reviews relevant literature; the third part introduces data sources and the construction of measurement models; the fourth part introduces the main empirical results and robustness tests; the fifth part discusses the heterogeneity of air pollution affecting individuals' insurance features; the sixth part is the test of the influence mechanism; finally, the conclusions and policy recommendations of this article are proposed.

2. Literature Review

The literature related to this article can be divided into three categories: the impact of air pollution on individual health and behavior, the influencing factors of purchasing medical insurance, and the impact of air pollution on medical insurance.

- The impact of air pollution on individual health and behavior

The negative effects of air pollution on individual's physical health have been discussed in a large body of literature. The elderly, in particular, are more sensitive to air pollution due to physical degradation [12]. These effects include morbidity, mortality, cognitive performance, hospitalization, and life expectancy [13,14]. Studies have also pointed out that air pollution will increase the death rate of COVID-19. For example, the COVID-19

death rate caused by air pollution is among the highest over the world in China which is a highly polluted environment (this article assumes that residents' fear of COVID-19 did not affect the possibility of insuring due to air pollution) [15]. Because particles with small size in the air are more likely to invade the human body, the damage of air pollution to resident's respiratory system is common and serious. A study covering 370,000 cancer patients showed that the incidence of lung cancer and laryngeal cancer was significantly related to $PM_{2.5}$ concentration [16]; at the same time, a disease assessment project issued by WHO also showed that haze pollution in China would cause 1.2 million premature deaths [17]. However, only a small amount of literature has studied how air pollution affects people's psychological and social behavior [6,11]. At present, the impact of air pollution on individuals' mood is mainly studied from the following aspects. Chronic diseases caused by air pollution will have long-term negative effects on individual's psychology [18,19]. Long-term worry and tension undoubtedly increase the individual's mental pressure. However, media's reports on harsh air environment will also increase individual's concern about the risk of illness. Under the media coverage of air pollution, even if there is no illness, people's worry about future illnesses will increase [20,21].

Individual's response to environmental pollution is strong and rapid. Research has explored individual's avoidance behavior caused by air pollution. In the short term, these behaviors include reducing outdoor activities [22], using indoor air purifiers [23], protective masks [11], and even using drugs [24]; in the short term, it can be seen that individual's avoidance behavior mainly focuses on relocation and site selection [25,26]. Some scholars also found that air pollution increased individual's consumption of medical care [22], but there is still a lack of research on whether air pollution will affect residents' consumption in medical insurance.

- The influencing factors of purchasing medical insurance

"Adverse selection" is widely discussed in the field of insurance, which refers to the positive correlation between individual's insuring and health risk [27]. Research on "adverse selection" in the Chinese insurance market (including basic medical insurance and commercial health insurance) is also abundant [9]. Most scholars believe that "adverse selection" behavior is obvious, that is, individuals with poor health condition are more inclined to buy insurance. In addition to objective physical health, some scholars study the individuals' insuring behavior from the perspective of subjective emotions [28,29]. They believe that the negative emotions such as fear, anxiety, and awareness of risk will increase the possibility of individuals making insurance decisions in order to reduce their risk taking.

Furthermore, there are other personal and social factors that affect individual's insurance. Personal-level factors mainly refer to individual socioeconomic characteristics and risk preferences [30–33]; social-level factors refer to the availability and adequacy of the social medical security system [34,35]. In terms of domestic research, a representative article comes from Liu Hong [36], who believes that the main factors affecting individual's insurance are personal health status, economic status, risk appetite, expected medical needs, and medical insurance market policies.

- The impact of air pollution on medical insurance

There are few studies about the influence of air pollution on medical insurance, thereby we can only find the following four articles at present. Dou [37] and Chang et al. [38] studied the causal relationship between daily air pollution and commercial medical insurance subscriptions as well as cancellations; Yuan and Liu [39] explored the short-term and long-term effects of air pollution on insurance coverage using commercial insurance annual data. The types of objects the above literature focuses on are all commercial health insurance, which leads to limitations. The reasons are as follows. First of all, commercial insurance products are generally aimed at healthy people aged under 55 or 60. Thus, it is not available for elderly to be insured. Second, the premium is determined according to the health status of the insured. Therefore, it is difficult for low-income people with health

problems to afford the expensive commercial insurance. All in all, the previous literature using commercial insurance as a research object has neglected a large number of samples of vulnerable groups.

Chen et al. [40] replaced commercial insurance with social medical insurance as the research object to discuss the relationship between air pollution and insurance coverage. Nevertheless, the use of generalized social medical insurance is not appropriate yet. This is mainly due to two reasons. First, there are compulsory insurance types in the social medical insurance that is not suitable as a dependent variable. Second, supplementary medical insurance represented by commercial and critical illness insurance worth studying for its great market potential. Based on the above analysis, this paper takes social and commercial insurance into consideration, and adds critical illness insurance as a basis for measurement to compare the heterogeneous impact of air pollution on varies insurance. At last, we propose policy opinions to promote the docking of basic insurance and supplementary medical insurance.

3. Model Design and Data Description

3.1. Model Setting

In this article, we mainly examine the impact of air pollution on individual's interest in buying medical insurance and estimate the following econometric model Equation (1):

$$\text{Insurance}_{ij} = \alpha_0 + \alpha_1 \text{pollution}_j + \alpha_2 X_{ij} + \alpha_3 Z_j + \xi_{ij} \quad (1)$$

where i denotes the respondent, j indicates the county. Insurance_{ij} denotes whether respondent i will buy medical insurance or not. Pollution_{ij} is for air pollution measured by $PM_{2.5}$. α_1 captures the air pollution effect on medical insurance. Since the insurance record reflects respondent's insurance status in the previous year, we use the lagging $PM_{2.5}$ data to reflect air pollution. If α_1 is positive, it means air pollution will trigger residents to buy medical insurance. X_{ij} includes a series of control variables at the city and individual level. The wave fixed effects are also added to capture the wave attributes, which may affect the demand for medical insurance. ξ_{ij} is the error term. We use the ordered Probit model to estimate Equation (1). This model was first proposed by Mckelvey and Zavoina [41] and has been widely used in discrete ordinal variable estimation models, which is consistent with the type of the explained variables in this paper.

3.2. Data Introduction

- Air pollution

This paper selects concentration of $PM_{2.5}$ (unit: ug/m^3) as an air pollution indicator for two reasons. First, not only the bacteria and viruses carried by particulate matter, but also microplastics, as one kind of suspended particulate matter that can absorb carcinogenic polycyclic aromatic hydrocarbons (PAH), will have harmful effects on the human body [22,42]. Second, haze caused by particulate matter can also affect the emotion of individual and cause psychological unhealthy [21]. The data come from the global annual $PM_{2.5}$ satellite raster data calculated by Van Donkelaar et al. [43]. Compared with the point source data of landmark detection, the satellite observation data not only have a wider coverage in time and space, but is also relatively more objective and accurate, which can avoid a certain degree of endogenous problems caused by human measurement errors.

- Individual data

Medical insurance and personal-level control data come from "China Health and Retirement Longitudinal Study (CHARLS)" supported by HIN of Peking University. The survey mainly collects micro-samples of individuals and families aged 45 and above. In the questionnaire, a special column is set up to survey the medical insurance status, with the item "Do you have medical insurance?" We define the individual who buys medical insurance as one and the rest as zero. Besides, we select respondents' health, economic status, risk appetite and expected medical needs as the personal-level control variable. The

specific variable description and their descriptive statistics are shown in Tables 1 and 2. Wave 2011, 2013, 2015, and 2018 are selected for the reason that social medical insurance system was basically covered since 2011 in China. We delete those data under the age of 45. At last, 46,012 valid samples from 28 provinces are finally obtained.

Table 1. Description of variables.

	Variable Symbol	Variable Meaning
Interpreted variable	insurance	Whether the investigator has medical insurance, yes = 1, no = 0
Core explanatory variable	pollution	Annual average of $PM_{2.5}$ concentration
Control variables	age	The age of investigator
	gender	The gender of investigator
	selfhealth	The self-evaluated health of investigator, unhealthy = 1, less unhealthy = 2, general = 3, relatively healthy = 4, very healthy = 5
	education	Investigator's years of education
	work	Whether the investigator has a job, yes = 1, no = 0
	hukou	Whether the investigator has urban household registration, yes = 1, no = 0
	income	Investigator's annual average household income
	risk	Whether the investigator smokes or drinks alcohol, yes = 1, no = 0
	marriage	Whether the respondent lives with his spouse, yes = 1, no = 0
	medicine	Whether the respondent has medical needs recently, yes = 1, no = 0
	gdp	Gross domestic product of cities
	density	Population density of cities
	doctor	Average number of doctors per 10,000 people of cities
	wastes	Waste innocuous treatment rate of cities
	SO2	Industrial sulfur dioxide emissions (10,000 tons) of cities

Notes: These contents in the table arranged by the author.

Table 2. Descriptive statistical analysis.

Variable	Observation	Mean	Standard Deviation	Min	Max
insurance	46,012	0.956	0.205	0	1
$PM_{2.5}$	46,012	47.337	20.806	4.190	96.810
toage	46,012	61.637	9.749	45	109
gender	46,012	0.495	0.500	0	1
selfhealth	46,012	3.324	1.062	1	5
education	46,012	5.558	4.278	0	22
work	46,012	0.685	0.464	0	1
hukou	46,012	0.783	0.412	0	1
lnincome	46,012	8.326	1.874	3.219	11.918
risk	46,012	0.436	0.496	0	1
marriage	46,012	0.817	0.387	0	1
medicine	46,012	0.284	0.451	0	1
lngdp	46,012	16.868	0.895	14.727	19.605
density	46,012	5.918	0.940	2.281	7.743
doctor	46,012	21.900	10.311	5.963	94.655
wastes	46,012	91.162	15.782	19.650	100
lnSO2	46,012	10.432	1.131	6.513	13.100

Notes: This table reports the summary statistics of main variables.

- City data

The city-level data come from the China City Statistical Yearbook, which help to control the influence of factors such as city size, public service status, and ecological environment status on individual's insurance behavior. Likewise, Tables 1 and 2 show the specific variable description and their descriptive statistics.

- Ventilation coefficient

This article uses a ventilation coefficient as an instrumental variable of air pollution when assessing the impact of air pollution on individuals. Data come from the National Meteorological Center Station.

4. Results and Discussion

4.1. Basic Empirical Results

We first use ordinary least squares (OLS) to test the impact of air pollution on individual's purchase of medical insurance. The results are shown in Table 3. Under the background of uncontrolled individual and urban characteristics, the results in column (1) show that the variable pollution coefficient is significantly positive at the 1% level, initially indicating that air pollution has an effect on individual's purchasing medical insurance, which means, worsening air pollution will increase individual's demand of medical insurance. After controlling individual characteristic information and city-level variables, the results in column (2) show that the coefficient of air pollution is still significantly positive. On average, for every increase in air pollution by one standard deviation (20.81), the probability of individual buying medical insurance will increase 0.49 percentage points. Column (3) further adds a square term of air pollution to examine whether air pollution has a nonlinear effect on individuals' purchase of insurance. The results show that the coefficient of the square term of air pollution is not significant, which confirm there is no "U" (or inverted "U") relationship between air pollution and individuals' purchase of medical insurance.

Table 3. The impact of air pollution on the demand of medical insurance.

Variables	Insurance		
	(1)	(2)	(3)
pollution	0.0021 ***	0.0049 ***	0.0075 ***
	(4.31)	(7.35)	(3.17)
pollution ^{2}			−0.0000274
			(−1.16)
Individual control variable	NO	YES	YES
Urban control variable	NO	YES	YES
N	46,012	46,012	46,012

Notes: Standard errors in parentheses. *** indicates statistical significance at 1% respectively.

4.2. Robustness Test

- Transform variable measurement index

With the increase of individuals' demand for health protection, insuring one kind of medical insurance alone can no longer meet their needs. More and more residents begin to seek supplementary medical insurance [39] in order to reduce financial burden of possible illness in the future. The number of individuals insured with two or more insurances continues to rise, and such a phenomenon plays a protective effect against the unavoidable air pollution hazards. Based on the benchmark regression, this paper examines whether air pollution will affect individuals to take out multiple insurances. The results in column (1) of Table 4 show that the impact of air pollution on individual's demand of multiple insurances is significantly positive, which means under the influence of air pollution, people have

enhanced awareness of insuring multiple insurances. The test results prove that people in areas with severe air pollution are more inclined to be insured.

Table 4. Robustness test.

Variable	Insurance	Insurance	Insurance	Insurance	Pollution	Insurance
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	2SLS Stage1	2SLS Stage2
pollution	0.0052 ***	0.0054 ***	0.0042 *	0.0048 ***		0.0078 ***
	(8.05)	(7.62)	(1.86)	(7.09)		(2.13)
ventilation				−0.00002	−0.0061 ***	
				(−0.81)	(−40.87)	
Individual control variable	YES	YES	YES	YES	YES	YES
Urban control variable	YES	YES	YES	YES	YES	YES
N	46,012	41,645	46,012	46,012	46,012	46,012

Notes: Standard errors in parentheses. *, and *** indicates statistical significance at 10% and 1% respectively.

- Transform regression sample

SCHARLS survey respondents are mainly people over 45 years old, and the average age of the sample is 61.64 years old. There are several samples that are too old to take care of themselves completely, and their insurance decisions are not made by themselves but their guardian, which cannot reflect the respondents' subjective willingness to insure. In addition, due to the lower disposable income, the elderly are not highly motivated to cover medical insurance compared with other ages. Therefore, using these samples may lead to underestimation of the final result. Based on this, we removed such samples that are over 75 years old and reperformed the formula regression test. The regression results in column (2) of Table 4 show that after controlling the sample size, the coefficient becomes larger and is significantly positive, which means the effect of air pollution on the demand of medical insurance is underestimated before, as well as further illustrates the impact of air pollution on individual's insurance.

- Add city dummy variables

Although city-level variables representing urban characteristics have been added to the benchmark regression equation, individual's insurance may still be affected by the urban fixed effects which cannot be replaced by urban characteristic variables. Therefore, we added urban dummy variables in Equation (1) to re-estimate the impact of air pollution on individual's demand of medical insurance. The empirical results in column (3) of Table 4 show that after controlling the fixed effects, the coefficient of the main explanatory variables is still significantly positive, indicating that higher levels of air pollution will promote residents to purchase medical insurance.

- Use the two-stage least squares method

The possible endogenous problems are also worth discussing. The main endogenous problem here is the problem of missing variables. For solution, an instrumental variable approach is used, and the empirical equations are Equations (2) and (3):

$$\text{Insurance}_{ij} = \alpha_0 + \alpha_1 \text{pollution}_j + \alpha_2 X_{ij} + \alpha_3 Z_j + \delta_{ij} \quad (2)$$

$$\text{Pollution}_j = \beta_0 + \beta_1 \text{ventilation}_j + \beta_2 X_{ij} + \beta_3 Z_j + \mu_{ij} \quad (3)$$

As previously mentioned, this article has controlled many variables at the level of individuals and cities, but there are still many factors (such as residents' ability, preference, personality traits) affecting individual's demand of insurance, which may be difficult to list exhaustively. In order to alleviate the bias caused by such situation, existing literature

uses ventilation coefficient as an instrumental variable to perform two-stage least squares analysis (2SLS) when assessing the impact of air pollution on individuals.

The correlation between instrumental and endogenous variables (air pollution) is under consideration, column (5) of Table 4 reports the first stage result of the 2SLS estimation. It can be seen that the ventilation coefficient has a significant negative impact on air pollution. Meanwhile, the Cragg–Donald Wald statistic reported by the weak instrumental variable test is greater than the critical value at the 10% significance level, indicating that the ventilation coefficient is not a weak instrumental variable of air pollution.

In terms of instrumental variable exogeneity, we introduce an instrumental variable ventilation into the equation to re-estimate. The results in column (4) show that the coefficient of instrumental variable is not significant, indicating that there is no correlation between ventilation and individuals' insuring. Meanwhile, the report in column (6) shows that with the instrumental variables, air pollution has a significant positive impact on individual's insurance investment. Therefore, the previous empirical conclusions are confirmed again: the possibility of individual's insuring increased when facing severe air pollution.

4.3. Heterogeneity Analysis

There are reimbursement restrictions on the scope and amount within Chinese basic medical insurance system at present yet. For example, personal hospitalization expenses are set with threshold, co-payment and capping lines; some new drugs, imported drugs, and several medical items are not covered by basic medical insurance. It is inconvenient for patients to seek medical treatment with such restrictions, especially for the treatment of serious diseases. Considering the relatively limited compensation scope, some residents will purchase medical insurance with other function and attribute on the basis of basic insurance, in order to decline the burden of future medical expenditure [44]. Based on this, we further discuss whether there is preference in insurance choice for the purpose of avoiding health hazards of air pollution. We divided the general social medical insurance considered in the benchmark regression into basic, commercial and critical illness insurance, trying to investigate whether there are differences in resident's attitude towards these types of medical insurance in an air pollution environment.

The regression results obtained are shown in columns (1)–(3) of Table 5. The results show that air pollution promotes the purchase of basic medical insurance and commercial health insurance, but in terms of coefficient size and significance level, the coefficient of basic insurance is greater and more significant than commercial insurance, which means that under the same environmental pollution, people prefer social basic medical insurance to commercial medical insurance. This may be due to two reasons. Compared with basic medical insurance, commercial insurance has a higher price. The sample of senior respondents selected in this article is also unique. Their low disposable income often discourages them from purchasing high-value commercial insurance. Conversely, the insurance company will conduct a health screening before accepting the insurance policy. Individuals who suffer from major illnesses are often excluded from those who can purchase commercial insurance.

At the same time, in the regression results of the critical illness medical insurance, it is found that the coefficient of air pollution on the demand of serious illness insurance is negative, indicating that being in air pollution will inhibit residents from buying serious illness insurance. It may be because individuals' insufficient awareness of serious illness insurance. Different from social and commercial insurance, critical illness insurance protects participants suffering from major diseases, which is a deeper level of medical protection. Here, we divide air pollution avoidance behavior into three kinds, including short-term, medium-term and long-term behaviors. We believe that when people face pollution problems, most people will take short-term evasive behaviors, such as using protective masks and air purifiers; some people will further adopt mid-term evasive measures such as buying general medical insurance; while with the above protection, individual

may subjectively ignore and reduce long-term avoidance measures, resulting in reduced insurance coverage for major illness. Such a phenomenon also indicates that individuals' prevention awareness of air pollution is still not enough. Currently, although the popularity of basic medical insurance has been high, critical illness insurance has not attracted enough attention. Failure to be understood by public, critical illness insurance has not fully played its due role in maintaining the health of individuals.

Table 5. Heterogeneity analysis.

	Social Insurance	**Commercial Insurance**	**Critical Illness Insurance**
	(1)	**(2)**	**(3)**
pollution	0.0053 ***	0.0019 **	−0.0002 ***
	(9.24)	(2.37)	(−3.37)
education	−0.0021	0.0359 ***	0.0009 ***
	(−0.78)	(9.80)	(3.06)
selfhealth	0.0159 *	−0.0526 ***	−0.0009
	(1.70)	(−4.14)	(−0.9)
Individual control variable	YES	YES	YES
Urban control variable	YES	YES	YES
N	46,012	46,012	43,993

Notes: Standard errors in parentheses. *, ** and *** indicates statistical significance at 10%, 5% and 1% respectively.

The health hazards of air pollution to residents are often chronic and long term and have longer treatment time and cost. Therefore, commercial and critical illness insurance can better solve the risks caused by air pollution theoretically. However, through our regression results, we unfortunately find that residents subjectively prefer public medical insurance and are less enthusiastic about insuring supplementary insurance. Besides, it can be seen from empirical evidence that there are effects of education level on individuals' demand of different types of insurance. The higher level of education, the more likely individuals to purchase supplementary medical insurance to avoid possible risks of pollution. At the same time, there is an impact of self-rated health on residents' insuring. Individuals with poor self-health tend to cover commercial health insurance while others are more likely to buy social insurance.

4.4. Analysis of Mechanism

The damage of air pollution to the health of individuals is not only death rate, prevalence and other loss of physical health, but also emotional stress and mental illness. In order to test whether air pollution causes residents to purchase medical insurance by increasing their health losses, this paper constructs an intermediary effect test model Equations (4)–(6):

$$\text{Insurance}_{ij} = \alpha_0 + \alpha_1 \text{pollution}_j + \alpha_2 X_{ij} + \alpha_3 Z_j + \xi_{ij} \quad (4)$$

$$M_{ij} = \gamma_0 + \gamma_1 \text{pollution}_j + \gamma_2 X_{ij} + \gamma_3 Z_j + \mu_{ij} \quad (5)$$

$$\text{Insurance}_{ij} = \theta_0 + \theta_1 \text{pollution}_j + \theta_2 M_{ij} + \theta_3 X_{ij} + \theta_4 Z_j + \sigma_{ij} \quad (6)$$

The idea of testing the mediation effect is as follows: first, we estimate Equation (4) (settings are consistent with Equation (1)), and further estimate Equations (5) and (6) on the basis that the coefficient α_1 is significant. M is the intermediary factor we care about, representing individual's physical and mental health status respectively. The physical health status is measured by respondent's chronic diseases; the mental health status is measured by the frequency of respondent's feeling of depress. M plays a part of the mediating effect if the coefficient γ_1 in Equation (5) and θ_1 in Equation (6) are significant. If the coefficient θ_2 in Equation (6) is not significant, it means M plays a completely mediating effect. Besides, if at least one of the coefficients γ_1 and θ_1 is not significant, the Sobel test

needs to be further conducted on the coefficient cross term $\gamma_1 \times \theta_1$. If the Sobel Z statistic is significant, it indicates that the mediation effect exists.

As shown in the model (1) in Table 6, the coefficient of the main explanatory variable is significantly positive, indicating that a higher degree of air pollution will increase the likelihood of individuals suffering from chronic diseases. In column (3) of Table 6, the coefficients of disease and air pollution are both significantly positive, which means physical health status is part of the mediating effect of air pollution increasing individual's insuring. In the model (2) in Table 6, the coefficient of the main explanatory variable is significantly positive, indicating that higher air pollution will increase the frequency of individual's frustration. In column (6), the coefficient of depression is significantly negative, while the coefficient of air pollution is significantly positive, indicating that air pollution causes depression, which leads to less insurance. Mental health status plays a part of the intermediary role.

Table 6. Mechanism test.

	Model (1)			**Model (2)**		
	Insurance	**Disease**	**Insurance**	**Insurance**	**Depression**	**Insurance**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
pollution	0.0050 ***	0.0021 ***	0.0004 ***	0.0049 ***	0.0007 **	0.0004 ***
	(7.35)	(5.13)	(7.24)	(047.)	(2.13)	(7.10)
disease			0.0036 ***			
			(5.36)			
depression						−0.0023 **
						(−2.38)
Individual control variable	YES	YES	YES	YES	YES	YES
Urban control variable	YES	YES	YES	YES	YES	YES
N	46,012	46,012	46,012	43,628	43,628	43,628

Notes: Standard errors in parentheses. ** and *** indicates statistical significance at 5% and 1% respectively.

In order to ensure the robustness of the conclusion, we constructed the Sobel Z statistic to examine whether the coefficient cross term $\gamma_1 \times \theta_1$ is significant. The results show that the Sobel Z statistic is 3.706 and −2.128, respectively, which are significant at the 1% and 5% levels and further confirms the mediating effect exists. It can be seen that air pollution increases or inhibits an individual's motivation to purchase medical insurance through two ways: increasing individual's prevalence of disease and causing depression.

Individual's insuring behavior is affected by subjective and objective factors. Medical insurance is needed by groups suffering from chronic diseases in order to reduce daily medical expenditures; thus, this group of people is more likely to pay for medical insurance. However, depressed group always neglect physical examination or health care, which leads to underestimation of the protective function of insurance. Thus, this group will have a tendency to reduce insurance. The above two reasons comprehensively affect individual's demand of medical insurance. We empirically find that the overall effect of air pollution is still to promote individual's participation in insurance behavior.

5. Conclusions and Policy Implications

Based on the data provided by CHARLS, this paper assesses the impact of air pollution on individual's demand of medical insurance. The results show that air pollution will affect the probability of insuring. The harsher the air environment, the more likely an individual is to be insured. In the heterogeneity test, we find that the positive impact of air pollution on individual's insurance is mainly reflected in the purchase of basic medical insurance, followed by commercial health insurance. However, it will inhibit residents from insuring critical illness insurance in poor air condition. Facing the hazards of air pollution, individual's awareness of insurance still needs to be strengthened. The mechanism test

shows that high air pollution will cause chronic disease and depression, thereby reducing the health of residents, and further affecting residents' insurance behavior.

Here, we give our advice. First of all, a cycle mechanism of health and insurance needs to be established. The health of residents is of great significance in their work and life, especially psychological health. However, the mental depression caused by air pollution is easily overlooked by the public. We find that negative emotions can reduce individuals' insurance coverage, which is not good for the maintenance of their physical and mental health. Once caught in this vicious cycle, it will cause a serious blow to the national economy. Therefore, through psychological disease screening, relevant state departments should protect people's health at the psychological level, and then promote the development of social security.

Second, it is better to actively promote the dual insurance model of "basic and commercial health insurance" or "basic and critical illness insurance". The impact of air pollution on the health of residents is often irreparable. Once a major disease is caused, it is difficult for patients only insured with basic insurance to obtain a radical cure. However, we found that, compared with basic insurance, the insurance rate of commercial and critical illness insurance is still lower at this stage, indicating that the attention residents pay to supplementary medical insurance is not enough. Thence, relevant departments can promote the "dual insurance" concept to encourage residents to choose commercial or critical illness insurance as a supplement on the basis insurance, as to better avoid health risks caused by air pollution.

Third, it is necessary to optimize the allocation of medical insurance for residents' health risks caused by air pollution. The conclusion of this paper confirms that air pollution is closely related to the loss of residents' health. Therefore, it is better for relevant departments to increase medical insurance reimbursements for diseases caused by air pollution in order to better benefit the health of residents or to set up additional compensation mechanisms for related diseases in areas with severe air pollution to achieve more adequate medical insurance protection.

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References

1. Bulletin of the Chinese Environment in 2020. Available online: http://www.cnemc.cn/jcbg/zghjzkgb/ (accessed on 27 May 2021).
2. Overview of the National Ecological Environment Quality. Available online: https://www.mee.gov.cn/hjzl/sthjzk/zghjzkgb/ (accessed on 26 May 2021).
3. Liao, L.P.; Du, M.Z.; Chen, Z.F. Air pollution, health care use and medical costs: Evidence from China. *Energy Econ.* **2021**, *95*, 105132. [CrossRef]
4. Chen, Y.; Ebenstein, A.; Greenstone, M.; Li, H.B. Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 12936–12941. [CrossRef] [PubMed]
5. Zivin, J.G.; Neidell, M. The Impact of Pollution on Worker Productivity. *Am. Econ. Rev.* **2012**, *102*, 3652–3673. [CrossRef]
6. Jacson, G.; Lu, J.J.; Lee, F.G.; Adam, D.G. Polluted Morality: Air Pollution Predicts Criminal Activity and Unethical Behavior. *Psychol. Sci.* **2018**, *29*, 340–355.

7. Schmitt, M. Subjective Well-Being and Air Quality in Germany. *Schmollers Jahrb.* **2013**, *133*, 541–569.
8. Lu, X.L. An empirical study on the utilization level of medical insurance and medical service of Chinese urban and rural residents. *J. World Econ.* **2017**, *40*, 169–192.
9. Zang, W.B.; Chen, C.; Zhao, S.Y. Social medical insurance, disease heterogeneity and medical expenses. *J. Econ. Res.* **2021**, *55*, 64–79.
10. Bulletin of Chinese Medical Security in 2020. Available online: http://www.nhsa.gov.cn/art/2021/6/8/art_7_5232.html (accessed on 8 June 2021).
11. Zhang, J.; Mu, Q. Air pollution and defensive expenditures: Evidence from particulate-filtering facemasks. *J. Environ. Econ. Manag.* **2017**, *92*, 517–536. [CrossRef]
12. Cesur, R.; Tekin, E.; Ulker, A. Can natural gas save lives? Evidence from the development of a fuel delivery system in a developing country. *J. Health Econ.* **2018**, *5*, 91–108. [CrossRef]
13. Berend, N. Contribution of air pollution to COPD and small airway dysfunction. *J. Respirol.* **2016**, *21*, 237–244. [CrossRef]
14. Luechinger, S. Air pollution and infant mortality: A natural experiment from power plant desulfurization. *J. Health Econ.* **2014**, *37*, 219–231. [CrossRef] [PubMed]
15. Pozzer, A.; Dominici, F.; Haines, A.; Witt, C.; Münzel, T.; Lelieveld, J. Regional and global contributions of air pollution to risk of death from COVID-19. *J. Cardiovasc. Res.* **2020**, *116*, 2247–2253. [CrossRef] [PubMed]
16. Guo, Y.; Zeng, H.; Zheng, R.; Li, S.; Barnett, A.G.; Zhang, S.; Zou, X.; Huxley, R.R.; Chen, W.; Williams, G. Lung cancer incidence and ambient air pollution in China: A spatial age-period cohort study 1990–2009. *Lancet* **2015**, *386*, S5. [CrossRef]
17. Global Burden of Disease. Available online: https://www.who.int/publications/i/item/9789241563710 (accessed on 2 March 2021).
18. Fleehart, S.; Fan, V.S. Prevalence and correlates of suicide ideation in patients with COPD: A mixed methods study. *Int. J. Chronic Obstr. Pulm. Dis.* **2015**, *10*, 1321–1329.
19. Jee, S.H.; Kivimaki, M. David Batty. Cardiovascular disease risk factors in relation to suicide mortality in Asia: Prospective cohort study of over one million Korean men and women. *Eur. Heart J.* **2011**, *32*, 2773–2780. [CrossRef]
20. Reser, J.P.; Swim, J.K. Adapting to and coping with the threat and impacts of climate change. *Am. Psychol.* **2011**, *66*, 277–289. [CrossRef]
21. Marques, S.; Lima, M.S. Living in grey areas: Industrial activity and psychological health. *J. Environ. Psychol.* **2011**, *31*, 314–322. [CrossRef]
22. Zeng, X.G. Xie, F. Behavioral choices and willingness to pay for reducing PM2.5 health risks: A case study of Beijing residents. *J. Chin. Popul. Resour. Environ.* **2015**, *25*, 127–133.
23. Currie, J.; Neidell, M.; Schmieder, J.F. Air pollution and infant health: Lessons from New Jersey. *J. Health Econ.* **2009**, *28*, 688–703. [CrossRef]
24. Chay, K.Y.; Greenstone, M. The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in pollution Shocks Induced by a recession. *Q. J. Econ.* **2003**, *118*, 1121–1167. [CrossRef]
25. Banzhaf, H.S.; Walsh, R.P. Do People Vote with Their Feet? An Empirical Test of Tiebout's Mechanism. *Am. Econ. Rev.* **2008**, *98*, 843–863. [CrossRef]
26. Qin, Y.; Zhu, H. Run away? Air pollution and emigration interests in China. *J. Popul. Econ.* **2018**, *31*, 235–266. [CrossRef]
27. Chiappori, P.A.; Salanie, B. Testing for Asymmetric Information in Insurance Markets. *J. Political Econ.* **2000**, *108*, 56–78. [CrossRef]
28. Langford, I.H.; Marris, C. Simultaneous Analysis of Individual and Aggregate Responses in Psychometric Data Using Multilevel Modeling. *Risk Anal.* **1999**, *19*, 675–683. [CrossRef]
29. Tversky, A.; Kahneman, D. Advances in prospect theory: Cumulative representation of uncertainty. *J. Risk Uncertain.* **1992**, *5*, 297–323. [CrossRef]
30. Hopkins, S.; Kidd, M.P. The determinants of the demand for private health insurance under Medicare. *Appl. Econ.* **1996**, *28*, 1623–1632. [CrossRef]
31. Liu, T.C.; Chen, C.S. An analysis of private health insurance purchasing decisions with national health insurance in Taiwan. *Soc. Sci. Med.* **2002**, *55*, 755–774. [CrossRef]
32. Doiron, D.; Jones, G.; Savage, E. Healthy, wealthy and insured? The role of self-assesed health in the demand for private health insurance. *Health Econ.* **2008**, *17*, 317–334. [CrossRef]
33. Fang, H.; Michael, P.K.; Silverman, D. Sources of Advantageous Selection: Evidence from the Medigap Insurance Market. *J. Political Econ.* **2008**, *116*, 303–350. [CrossRef]
34. Cutler, D.M.; Gruber, J. Does Public Insurance Crowd Out Private Insurance. *Q. J. Econ.* **1996**, *111*, 391–430. [CrossRef]
35. Sheppard, L.S.; Thomas, C.B.; Gail, A.J. Medicaid and crowding out of private insurance: A re-examination using firm level data. *J. Health Econ.* **2000**, *19*, 61–91. [CrossRef]
36. Liu, H.; Wang, J. Research on Chinese Residents' Medical Insurance Purchase Behavior: Based on the Perspective of Commercial Health Insurance. *J. Econ. (Q.)* **2012**, *11*, 1525–1548.
37. Dou, C.B. Economic analysis of the health affects of air pollution. Doctoral Dissertation, Southwest University of Finance and Economics, Chengdu, China, 2012.
38. Chang, T.Y.; Huang, W.; Wang, Y.X. Something in the Air: Pollution and the Demand for Health Insurance. *Rev. Econ. Stud.* **2018**, *85*, 1609–1634. [CrossRef]

39. Yuan, C.; Liu, S.T. Air pollution, risk perceptions and Chinese Commercial Health Insurance consumption. *Insur. Res.* **2020**, *8*, 88–102.
40. Chen, F.L.; Chen, Z.F. Air pollution and avoidance behavior: A perspective from the demand for medical insurance. *J. Clean. Prod.* **2020**, *259*, 120970. [CrossRef]
41. Richard, D.M.; William, Z. A statistical model for the analysis of ordinal level dependent variables. *J. Math. Sociol.* **1975**, *4*, 103–120.
42. Lang, Y. *Influence of Microplastics on Environmental and Human Health: Key Considerations and Future Perspectives*; CRC Press: Boca Raton, FL, USA, 2021; p. 11.
43. Zhu, T.T.; Jing, Q.; Aaron, V.D. Does exposure to air pollution increase the risk of acute care in young children with asthma? An Ontario, Canada study. *Environ. Res.* **2021**, *199*, 111302.
44. Yao, Y.; Liu, B.; Liu, G.E.; Zang, W.B. Medical Insurance, Household Registration System and Utilization of Medical Services: An Empirical Analysis Based on CHARLS Data. *J. Insur. Res.* **2014**, *6*, 105–116.