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Green Finance and Health: How Does Implementing Carbon Emissions Trading Affect Mental Health?

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Abstract: The issue of environmental pollution is hindering the well-being of Chinese citizens, posing a critical challenge to economic development. Existing studies on the impact of carbon emissions trading policies have largely overlooked their potential effects on the mental health and life satisfaction of residents. Therefore, this paper aims to broaden the existing research by investigating the influence of China's carbon emission trading policy on mental health using a nationwide longitudinal survey and employing the Difference-in-Differences (DID) model. Moreover, it examines the moderating effect of government in this relationship. The results show that (1)policies involving carbon emissions trading can improve residents' quality of life and lessen depressive symptoms; (2)the effects are more pronounced for rural residents than for urban residents, and (3)performance evaluation of the government is important in moderating the relationship between carbon emissions trading and residents' mental health.

Keywords: Carbon Emissions Trading, Mental Health, Life Satisfaction, Green Finance

1. Introduction

Numerous studies have extensively documented the adverse health effects of air pollution, including increased morbidity, cardiovascular diseases, and respiratory diseases [1][2][3]. Additionally, while the impact of environmental pollution, particularly land, air, and water pollution, on social issues has been recognized , few studies have been conducted on the impact on intangible outcomes such as mental health [4]. Previous studies examining the relationship between air pollution and mental health have primarily relied on data concerning air pollution and psychiatric disorders or air pollution and happiness [5][6]. Few studies have utilized well-matched air pollution and survey data [7]. Furthermore, research into how carbon emission trading laws affect the mental health of locals is sparse. The carbon emissions trading market, a novel institutional innovation in China, helps the government achieve its goals of carbon neutrality and peaking carbon emissions by regulating and reducing greenhouse gas emissions. Previous studies on carbon emissions trading policy have primarily focused on its impact on carbon emission reduction and the physical health of the population [8][9].

This paper aims to broaden the existing research regarding the impact of environmental pollution on mental health and the influence of carbon emissions trading policies in China. To achieve this, a national longitudinal survey with detailed measures of mental health and life satisfaction is combined with the 2011 notice of the National Development and Reform Commission (NDRC) that proposed

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the exploration of local pilot carbon markets in several provinces and cities. The Difference-in-difference (DID) method is applied to empirically analyze the effect of the carbon pilot market policy on residents' mental health. This study contributes to the existing literature in multiple ways. To begin, it broadens and enriches earlier research by investigating the influence of China's carbon emissions trading strategy on people's mental health, focusing on mental health improvement, and using market-oriented environmental rules as an example. Secondly, it offers a novel research perspective by directly testing the link between carbon emissions trading policy and key psychological outcome variables such as mental health and life satisfaction.

2. Data Sources, Variables, and Models

2.1. Data Sources

Taking into account the availability, completeness, and accuracy of the data, this study utilizes relevant information sourced from the China Family Panel Studies (CFPS) and the statistical yearbooks of various provinces and cities. The CFPS is a comprehensive survey conducted by Peking University's Institute of Social Science Survey, funded by Peking University, and consists of data collected in 2010, 2012, 2014, 2016, and 2018, which is in line with the period that carbon emissions trading policy is implemented in [10]. The survey encompasses 162 counties across 25 provinces in China and investigates various aspects such as economic activities, educational achievements, family dynamics, relationships, and health. It covers a broad range of topics concerning Chinese communities, families, and individuals, including indicators of mental health and life satisfaction.

2.2. Variables' Selection

2.2.1. Explained variable.

The explained variable in this study is life satisfaction (Satis) and depressive symptoms (Depression). To construct this explanatory variable, the article employs two types of CFPS mental health and life satisfaction assessments. According to Stone and Mackie , the concept of life satisfaction captures the extent to which individuals' particular experiences match with their long-term objectives and expectations for their lives as a whole [11]. Each respondent in all five waves of the CFPS was asked to score their general life satisfaction on a scale of 1 (not satisfied at all) to 5 (very satisfied), as developed by Menz and Ferreira et al. [6][12]. The second explained variable is depressive symptoms, which can show the mental health state of the respondent, as suggested by Aggarwal et al. [13]. Questions about emotional states were included in all four rounds of the questions on the CES-D scale. Respondents chose to answer, depending on their circumstances and assigned a value of 1 to 5, respectively. Therefore, the higher the value from 1 to 4, the more emotionally depressed the respondent is.

2.2.2. Explanatory variables.

The carbon emissions trading policy (DID) is used as an explanatory variable in the analysis, which is the carbon trading pilot dummy variable taking 1 for pilot areas after 2014, and otherwise taking 0 to assess its effects on the level of mental health among individuals.

2.2.3. Control variables.

In addition to the independent variables, several other factors have been discovered as potentially impacting the dependent variables. If these factors are ignored, the regression findings may become less accurate. As a result, the following variables were chosen for analysis in this paper: gender, age,

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health status, years of education, marital status, political status, income status, family status, residential status, and geographical status. Table 1 contains variable definitions, while Table 2 shows descriptive statistics for variables used in this work.

Table 1: Definitions of variables

Variable Name	Variable Description
satis	life satisfaction
depression	depressive emotional states
did	carbon trading pilot dummy variable
gov	evaluation of government's performance
gender	gender
age	age
health	self-assessment of health
edu	years of education
married	marital status
party	whether or not a party member
chronic	presence of chronic diseases
income	logarithm of household income
asset	logarithm of household net worth
size	total family size
houseown	whether or not owns a property
urban	urban or rural area

Table 2: Descriptive statistics of variables

	N	Mean	SD	Min	Median	Max
satis	111507	3.623	1.033	1	4	5
depression	111507	1.696	0.756	1	2	4
did	111507	0.108	0.31	0	0	1
gov	111507	3.479	0.912	1	4	5
gender	111507	0.493	0.5	0	0	1
age	111507	46.005	15.49	16	46	80
health	111507	3.19	1.283	1	3	5
edu	111507	6.779	4.848	0	9	22
married	111507	0.822	0.383	0	1	1
party	111507	0.084	0.277	0	0	1
chronic	111507	0.156	0.363	0	0	1
income	111507	10.238	1.953	0	10.597	12.794
asset	111507	11.821	2.452	0	12.182	15.429
size	111507	4.331	1.913	1	4	26
houseown	111507	0.889	0.315	0	1	1
urban	111507	0.456	0.498	0	0	1

2.3. Model for DID

This study creates a panel data set by utilizing the early implementation phase of China's carbon emissions trading legislation. It designates seven provinces and cities as the experimental group, with the remaining provinces and cities serving as the control group. Four cities (Beijing, Tianjin, Shanghai,

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and Chongqing) and three provinces (Hubei, Guangdong, and Fujian) make up the experimental group. The difference-in-differences model is shown below:

$$Satis_{i,t} = \alpha_0 + \alpha_1 DID_{i,t} + \sum_k \alpha_k Controls_{k,i,t} + \gamma_i + \delta_t + \varepsilon \quad (1)$$

$$Depression_{i,t} = \alpha_0 + \alpha_1 DID_{i,t} + \sum_k \alpha_k Controls_{k,i,t} + \gamma_i + \delta_t + \varepsilon \quad (2)$$

Where $Satis_{i,t}$ and $Depression_{i,t}$ are explained variable representing respectively for life satisfaction and depressive emotional state; $DID_{i,t}$ is the core explanatory variable, which is a dummy variable for the carbon trading policy, and has a value of 1 for the year in which the carbon trading policy was implemented and then a value of 0 otherwise. $\sum_k \alpha_k Controls_{k,i,t}$ represents the control variable. γ_i and δ_t represent the individual and time fixed effects, respectively, and ε represents the random error term.

3. Empirical Result

3.1. Results of DID

Table 3 shows the regression results for the effects of the carbon emissions trading program on citizens' mental health. (1) is a difference-in-differences model for life satisfaction that controls only for individual and time fixed factors. (2), in addition to (1), includes control variables. (3), on the other hand, represents the difference-in-differences model for depressive symptoms without control variables, controlling only for individual and time fixed effects. In addition to (3), (4) adds control variables.

Table 3 shows that the estimated coefficients for the policy of trading carbon emissions on satisfaction are positive and statistically significant at the 1% level, even when control variables are included. This shows that residents of pilot provinces and towns where carbon emissions trading was put into place were much happier with their lives and had better mental health overall than residents of non-pilot provinces. Thus, putting the carbon emission trading pilot policy into place improves the well-being of the people. Also, the estimated coefficients for the policy of trading carbon emissions on depressive symptoms are negative and statistically significant at the 1% level, even when control factors are included. This suggests that residents of pilot provinces and cities with carbon emissions trading are less likely to show signs of depression than residents of non-pilot provinces. Consequently, putting the carbon emission trading pilot policy into place helps reduce depression and improve the mental health of the community as a whole.

Table 3: DID regression results

	(1)	(2)	(3)	(4)
	satis	satis	depression	depression
did	0.048***	0.055***	-0.029**	-0.033***
	(3.127)	(3.584)	(-2.398)	(-2.744)
age		-0.013		0.016**
		(-1.555)		(2.491)
health		0.099***		-0.082***
		(27.932)		(-29.598)
edu		-0.025***		-0.011***
		(-8.749)		(-5.095)
married		0.008		-0.097***

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Table 3: (continued).

		(0.433)		(-7.017)
party		0.025		0.059**
		(0.828)		(2.540)
chronic		0.005		0.109***
		(0.474)		(14.483)
income		0.004*		-0.001
		(1.926)		(-0.762)
asset		0.002		-0.002
		(1.573)		(-1.376)
size		0.001		-0.000
		(0.416)		(-0.130)
houseown		0.041***		0.008
		(3.344)		(0.804)
urban		-0.016		-0.008
		(-0.825)		(-0.525)
cons	3.490***	3.686***	1.645***	1.474***
	(571.344)	(10.303)	(347.254)	(5.326)
PID/Year	Yes	Yes	Yes	Yes
N	111507	111507	111507	111507
r2	0.081	0.091	0.008	0.024

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.2. Robustness Checks

The validity of the Difference-in-Differences (DID) method as a policy assessment approach relies on the parallel trend test. This test checks to see if the experimental group and the control group had the same change trend before the carbon emissions trading policy was put into place and if their change trends were different after the policy was put into place. So, this work uses the methods of Beck et al. for the parallel trend test. The results of the parallel trend test are shown in a graph, and the regression model is as follows [14]:

$$y_{it} = \alpha_0 + \sum_{k=-2}^{4} \beta_k * D_{i,t+k} + \sum_k \alpha_k Controls_{k,i,t} + \gamma_i + \delta_t + \varepsilon \quad (3)$$

Where $D_{i,t+k}$ is a dummy variable before and after the carbon trading pilot, with k taking a negative number to indicate k years before the carbon trading pilot and a positive number to indicate k years after the carbon trading pilot. $\sum_k \alpha_k Controls_{k,i,t}$ represents the control variable. γ_i and δ_t represent the individual and time fixed effects, respectively, and ε represents the random error term. The parallel trend test examines data from two years before the policy and four years after it was put into place (Figure 1) and the regression coefficients are at 95% confidence interval.

The results show that the effect of the carbon emissions trading policy on residents' life satisfaction did not pass the significance level test before the policy was put into place. This means that before the policy was put into place, there was no significant difference between the life satisfaction of residents in pilot cities and residents in non-pilot cities. So, the assumption that the trends are the same is true. Additionally, the effect of the carbon emissions trading policy on residents' depressive symptoms did not pass the significance level test before the policy was put into place. This means

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that there was no significant difference between residents in pilot cities and residents in non-pilot cities in terms of their depressive symptoms before the policy was put into place. Thus, assuming that there is a parallel trend for depressive symptoms is also true.

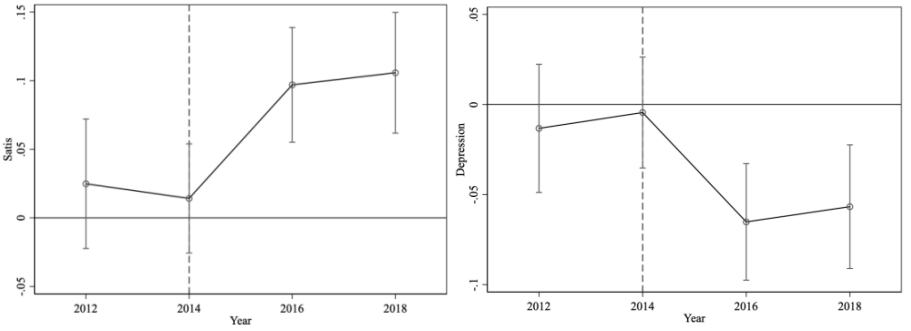

Figure 1: Parallel trend test for life satisfaction and depressive symptoms

4. Test for Heterogeneity

This study splits the research sample into urban and rural areas based on the CFPS survey and analyses the varied effects of the carbon emissions trading policy on people's mental health in these distinct locations to further investigate the pilot policy's regional heterogeneity. Table 4 summarizes the findings.

The results reveal that the effects of the carbon emissions trading policy on life satisfaction and depressive symptoms vary among residents in different regions. Specifically, the policy has a more pronounced effect in improving life satisfaction and reducing depressive symptoms among rural residents, as the estimated coefficient on DID for life satisfaction is significantly positive at the 5% level and the estimated coefficient on DID for depressive symptoms is significantly negative at the 1% level, while the impact on urban residents is relatively weaker as the estimated coefficient on DID is not significant in the sample.

Table 4: Results of regional heterogeneity

	Urban	Rural	Urban	Rural
	satis	satis	depression	depression
did	0.025	0.061**	-0.011	-0.086***
	(1.304)	(2.186)	(-0.757)	(-3.913)
age	-0.000	-0.019*	0.052***	0.004
	(-0.003)	(-1.851)	(4.403)	(0.437)
health	0.103***	0.097***	-0.082***	-0.080***
	(18.687)	(20.066)	(-19.694)	(-21.128)
edu	-0.024***	-0.026***	-0.012***	-0.011***
	(-5.479)	(-6.421)	(-3.709)	(-3.384)
married	0.052**	-0.030	-0.090***	-0.122***
	(2.021)	(-1.127)	(-4.614)	(-5.862)
party	0.028	0.037	0.029	0.076**
	(0.675)	(0.804)	(0.913)	(2.116)
chronic	0.002	0.004	0.084***	0.131***
	(0.131)	(0.285)	(7.719)	(12.132)
income	0.004*	0.002	0.001	-0.002
	(1.659)	(0.922)	(0.456)	(-0.899)

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Table 4: (continued).

asset	0.002	0.003	0.002	-0.006***
	(1.019)	(1.165)	(1.158)	(-3.502)
size	-0.005	0.004	-0.001	0.001
	(-0.973)	(0.997)	(-0.247)	(0.243)
houseown	0.035**	0.047**	0.009	0.015
	(2.117)	(2.442)	(0.691)	(0.987)
_cons	3.097***	3.965***	-0.091	2.077***
	(4.716)	(8.866)	(-0.183)	(5.925)
PID/Year	Yes	Yes	Yes	Yes
N	50851	60656	50851	60656
r2	0.093	0.090	0.024	0.026

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Test for Moderating Effect

This section will investigate whether government performance evaluation can regulate the transmission between carbon emissions trading policy and residents' mental health based on residents' evaluation of the government based on the analysis of the theoretical mechanism indicated above. As a result, this paper employs the moderating effect model to examine the aforementioned approach, using the following exact settings:

$$Satis_{i,t} = \alpha_0 + \alpha_1 DID_{i,t} + \alpha_2 GOV_{i,t} + \alpha_3 DID * GOV_{i,t} + \sum_k \alpha_k Controls_{k,i,t} + \gamma_i + \delta_t + \varepsilon \quad (4)$$

$$Depression_{i,t} = \alpha_0 + \alpha_1 DID_{i,t} + \alpha_2 GOV_{i,t} + \alpha_3 DID * GOV_{i,t} + \sum_k \alpha_k Controls_{k,i,t} + \gamma_i + \delta_t + \varepsilon \quad (5)$$

Where $GOV_{i,t}$ represents the moderating variable which represents evaluation of government's performance by residents.

The regression results are shown in Table 5. The calculated coefficients of the interaction term gov_did are significantly positive at the 1% level for life satisfaction, while the estimated coefficients of DID are likewise significantly positive at the 1% level. Furthermore, the estimated coefficients of the interaction term gov_did are significantly negative at the 5% level for depressive symptoms, whereas the estimated coefficients of DID are similarly significantly negative at the 1% level. This demonstrates that the regulating component in this process is government performance assessment.

Table 5: Results of moderating effect

	(1)	(2)
	satis	depression
did	0.050***	-0.031***
	(3.227)	(-2.624)
gov	0.065***	-0.019***
	(16.741)	(-6.468)
gov_did	0.042***	-0.020**
	(3.432)	(-2.115)
age	-0.013	0.016**
	(-1.541)	(2.485)

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Table 5: (continued).

health	0.097***	-0.081***
	(27.298)	(-29.329)
edu	-0.025***	-0.011***
	(-8.754)	(-5.107)
married	0.011	-0.098***
	(0.638)	(-7.098)
party	0.016	0.062***
	(0.545)	(2.653)
chronic	0.003	0.110***
	(0.273)	(14.566)
income	0.003*	-0.001
	(1.783)	(-0.708)
asset	0.002	-0.002
	(1.559)	(-1.370)
size	0.001	-0.000
	(0.392)	(-0.120)
houseown	0.043***	0.007
	(3.477)	(0.757)
urban	-0.017	-0.007
	(-0.904)	(-0.499)
_cons	3.456***	1.543***
	(9.668)	(5.573)
PID/Year	Yes	Yes
N	111507	111507
r2	0.095	0.025

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusion

The findings of this research indicate that: (1) Carbon emissions trading programs have the potential to improve life satisfaction and relieve depression symptoms among inhabitants; (2) The assessment of the government's performance has a major impact on the relationship between carbon emissions trading and people's mental health; (3) The impact is greater for rural residents than for urban residents. The data in this paper is confined to the province level due to data constraints. Thus, further research on more precise levels can be undertaken to assess the impact on citizens' mental health and study the impact on certain groups.

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