ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

The Impact of Emission Rights on Emission Reduction in the Yangtze River Delta Region of China

Gong Junxi[1,a,*]

[1]*International Business, Curtin Singapore, Singapore*
[a]*21413650@student.curtin.edu.au*
**Corresponding author*

Abstract: *This article delves into the profound implications of emission rights on the reduction of pollutants within the Yangtze River Delta region. By conducting a comprehensive theoretical analysis, it discerns that the implementation of an emission rights system has been instrumental in driving down emissions across the Yangtze River Delta. The empirical analysis undertaken in this study focuses on urban industrial sulfur dioxide emissions within the region, utilizing the double difference model as a key analytical tool. Through meticulous examination, the research unequivocally demonstrates the efficacy of the emission rights system in fostering substantial reductions in pollution levels within the Yangtze River Delta. This empirical evidence underscores the pivotal role of policy interventions, such as emission rights mechanisms, in steering industrial practices towards more environmentally sustainable trajectories. Ultimately, this study reinforces the importance of proactive policy measures in curbing environmental degradation and advancing towards a greener, more sustainable future for the Yangtze River Delta and beyond.*

Keywords: *Pollution right; emission reduction; difference-in-differences model; Yangtze River Delta region*

1. Introduction

1.1 Research background and research significance

Emission permits refer to the approved quantity and allocation of pollutants emitted by polluting enterprises as granted by environmental protection supervisory authorities. Given the finite nature of natural resources, emission permits have become particularly crucial amidst China's proactive supply-side reforms. The Yangtze River Delta region, as one of China's most economically developed areas, has served as a pioneer in numerous emission permit policy reforms. Despite vigorous environmental governance efforts and the implementation of emission permits by the Chinese government, the Yangtze River Delta region continues to grapple with significant environmental challenges.

In terms of air pollution, the Yangtze River Delta region stands as a primary acid rain control zone in China, with a considerable portion still experiencing heavy acid rain pollution. The entrenched economic losses and health hazards caused by acid rain persist. Concerning water pollution, occurrences of black and malodorous water bodies and eutrophication are observed in the Yangtze River Delta region, alongside persistent high levels of urban sewage discharge and sluggish progress in pollution control measures in the Taihu Lake basin. Regarding soil pollution, regional distribution of soil pollution is evident in the Yangtze River Delta region, with issues such as soil salinization and excessive heavy metal concentrations escalating.

On a global scale, emission permit policies have become universally recognized as crucial environmental economic policies, demonstrating significant effectiveness in addressing environmental pollution (Bell and Russell, 2018)[1].

1.2 Research methods and research content

The aim of this study is to investigate the specific mechanisms through which emission permits contribute to emissions reduction in the Yangtze River Delta region and assess their effectiveness. By

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

comprehensively analyzing the underlying mechanisms, successful dissemination of emission permits to other regions can be facilitated, thereby promoting improved emissions reduction outcomes. Building upon relevant viewpoints and previous literature, this study, in order to better understand the impact of emission permits on emissions reduction in the Yangtze River Delta region, divides the analysis into two phases: the period before the implementation of the emission trading system (2001–2006) and the formal implementation across the entire region thereafter (2007–2015). Industrial sulfur dioxide emissions, representative of pollutant emissions, are used as the benchmark for measuring emissions reduction effects.

2. Theoretical Basis

The effectiveness of emission permit policies can be succinctly explained using the well-known Coase Theorem in economics (Cooter, 1989)[2]. The Coase Theorem posits that in situations where transaction costs are zero or close to zero and property rights are well-defined, regardless of the initial allocation of property rights, the market equilibrium will ultimately achieve Pareto optimality in resource allocation. Coase himself identified the fundamental cause of externalities as the lack of clear property rights. Under the condition of clearly defined and strictly protected property rights, market transactions can achieve Pareto optimality, and the market itself possesses strong corrective abilities for externalities. Moreover, from a historical perspective of market development, the lack of clear property rights can easily lead to market failure. Given the presence of rational actors, each enterprise seeks to maximize its own interests. If emissions are not included in their operating costs, it inevitably leads to indiscriminate environmental degradation. However, emission permit trading occurs within the framework of legally defined property rights, thereby effectively promoting emissions reduction. Therefore, the Coase Theorem provides the most direct theoretical basis for the implementation of emission permit trading systems.

The innovation of this study lies in its investigation of the impact of pollutant emission trading policies on local emissions reduction using the mainstream method of employing the difference-in-differences (DID) approach, while simultaneously controlling for multiple variables to establish a reasonable model for empirical analysis of the policy's effects. Typically, policy assessments have focused on national or provincial levels. However, this study innovatively examines the Yangtze River Delta region, utilizing the natural experiment of the pollutant emission trading system pilot, which was implemented in 2007. The study employs a double-difference fixed-effects model to estimate the effects of the pollutant emission trading policy, treating Jiangsu and Zhejiang as treatment groups and Shanghai and Anhui as control groups, analyzing provincial-level data. Furthermore, the sample is divided into two periods: pre-implementation of the pollutant emission trading system (2001–2006) and post-implementation (2007–2015), to investigate the effectiveness of the policy over time.

3. The Development History Of China’s Emission Rights

China's emission trading policy can be divided into three stages: initiation, exploration, and enhancement (Zhou et al., 2019)[3]. The period from 1987 to 2000 marked the initiation stage of emission trading implementation in China, primarily led by the former Chinese Environmental Protection Agency. During this time, a series of pollution prevention measures were promulgated, laying the practical foundation for future emission trading practices (K. Zhang and Wen, 2008)[4]. The period from 2001 to 2006 represented the exploration stage of the emission trading system in China. The "10th Five-Year Plan" for environmental protection in China proposed the implementation of the total quantity control principle and emphasized the significant role of the emission trading system in reducing air pollution. Subsequently, China initiated comprehensive emission trading system pilot projects in some provinces and cities, such as Taiyuan and Jiaxing in Zhejiang. Furthermore, in April 2006, the Japanese company JDM purchased the largest international cross-border carbon dioxide emission rights transaction from Zhejiang Juhua Co., Ltd., and provided assistance in funds, technology, and equipment for energy conservation and emission reduction. This event greatly promoted the development of China's emission trading, leaving a profound impact (Wang et al., 2021)[5].

The period after 2007 is defined as the enhancement stage of the implementation of China's emission trading system. Since 2007, China has not only actively expanded the pilot scope of the emission trading system but also introduced many supporting policies and regulations. The speed and depth of these developments were unprecedented. In the seven years from 2007 to 2013, each pilot area issued nearly 10 policy and technical documents on average per year. Consequently, China's emission trading system

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

rapidly matured.

In terms of transaction volume in the emission trading market, the total volume of carbon emission trading from 2007 to 2013 exceeded 4 billion yuan (Zhang, 2015)[6]. Zhejiang, as a pioneer region in China's emission trading reform and carbon emission trading, had successfully completed 4,366 transactions by the end of 2014, with a total transaction amount of 852 million yuan. Hubei also achieved significant success in emission trading, conducting a total of 13 emission trading activities for sulfur dioxide, chemical oxygen demand, and four other pollutants, with a total traded emission volume of 4,897.6 tons and a transaction amount of 26.525 million yuan. Additionally, according to information released by the China National Environmental Monitoring Center, regions implementing the emission trading system experienced significant improvements in regional air quality, indicating that emission trading is conducive to regional energy conservation, emission reduction, and sustainable green development.

4. Mechanism And Research Hypothesis Of Emission Reduction Of Emission Rights In the Yangtze River Delta Region

4.1 Research hypothesis

Based on the analysis presented above, the emission trading policy has shown certain effectiveness in reducing emissions of industrial pollutants, primarily sulfur dioxide, in pilot areas. With this in mind, two hypotheses are proposed:

Hypothesis 1: Emission trading can effectively reduce emissions of industrial pollutants, represented by sulfur dioxide, in the region.

However, considering the implementation of emission trading-related policies and information dissemination, as well as the adjustment of enterprise behavior, there may be a lag in the effectiveness of the emission trading system. Therefore, a dynamic analysis of the emission trading system is necessary, leading to the formulation of Hypothesis 2.

Hypothesis 2: Emission trading has a dynamic impact on the reduction of industrial pollutants, represented by sulfur dioxide, in the region.

These hypotheses suggest that while emission trading policies have the potential to reduce industrial pollutant emissions, there might be a time lag before their effects become evident. Therefore, a dynamic perspective is essential to fully understand the impact of emission trading on emissions reduction, particularly for sulfur dioxide and other industrial pollutants.

4.2 Model building

The difference-in-difference method is a method based on natural experiments to evaluate policy effects. It can effectively reflect the effect of policy implementation and the net impact on individuals. The principle of the difference-in-difference method based on the regression model is as follows:

$$Y = D\beta_1 + T\beta_2 + D \times T\beta_3 + X\gamma_3 + \varepsilon \tag{1}$$

In the specified context, let Y represent the outcome variable (i.e., pollutant emissions), D denote the treatment variable where D=1 indicates the treated group and D=0 indicates the control group, T represents a time dummy variable with T=1 denoting the post-treatment period and T=0 denoting the pre-treatment period, X represents control variables, and ε represents the random disturbance term. The emission trading policy operates on the premise of protecting scarce resources to ensure sustainable development, promoting energy conservation and emissions reduction in relevant enterprises, and updating production technologies to reflect environmental protection requirements accurately, thereby achieving continuous emissions reduction (Deng et al., 2024)[7]. This study utilizes a difference-in-differences approach to examine the overall and dynamic sustainability effects of the emission trading system on pollutant emissions, represented by sulfur dioxide. Given that only Jiangsu and Zhejiang have been approved by relevant authorities in China as emission trading pilot areas, they are treated as the treatment group, while Shanghai and Anhui are considered the control group. The double difference model is specified as follows

$$\mathrm{pe}_{it} = \alpha_0 + \alpha_1 \mathrm{treat}_i + \alpha_2 \times \mathrm{T}_t + \alpha_3 \mathrm{treat}_i \times \mathrm{T}_t + \sum_j \alpha_j\, \mathrm{contonl}_{jit}^1 + \varepsilon_{it} \tag{2}$$

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

In this context, the dependent variable, denoted as pe, represents the amount of pollutant emissions. Treat is a dummy variable. If treat=1, the province has implemented the emission rights system. If treat=0, the province has not implemented the emission rights system. T is a dummy variable. If T=1, it means that the emission rights system has been implemented in period t. For the emission rights system, if T=0, it means that the emission rights system has not been implemented in period t. Among them, the coefficient of treat×T α3is what China needs to focus on because it can effectively reflect the impact of the emission rights system on regional emission reductions; control is the control variable. ε is the model disturbance term; i represents the region and t represents time.

5. Reduction In the Yangtze River Delta Region

5.1 Descriptive Statistics

To investigate the effect of the pollution rights system on regional emissions reduction, the differences in the means of various variables before and after the implementation of the pollution rights system, as well as between pilot and non-pilot areas, were calculated. Additionally, the samples were divided into two stages: before the implementation of the pollution rights system with compensated use and trading (2001-2006), and after the implementation (2007-2015). Please refer to Table 1 for details.

Table 1: Variable mean comparison

Variable	Average before the implementation of the system (2001-2006)			Average value after the implementation of the system (2007-2015)			Difference change
	non-pilot areas	Pilot area	Difference	non-pilot areas	Pilot area	Difference	
SO2	484220.01	1032841.3	548621.2	413645.1	838847.9	425202.8	-153418.4
PGDP	25160.6	20641.2	-4519.4	56105	58857.9	2752.9	7272.3
IND	0.4192	0.5376	0.1184	0.4293	0.51196	0.0827	-0.0357
EG	6571.05	11651.5	5080.4	10558	21865.9	11307.9	6227.5
IV	87551.5	292185.9	204634.4	135402.3	375913.9	240511.6	35877.2

From Table 1, it can be observed that after the implementation of the pollution rights system in China, there is a decrease in the difference in sulfur dioxide emissions between pilot and non-pilot areas. This initial data suggests that the pollution rights system may indeed reduce sulfur dioxide emissions, indicating the effectiveness of the policy. However, the true effectiveness needs to be further examined through empirical analysis and robustness tests.In terms of control variables, the difference in industrialization levels between pilot and non-pilot areas shows a slight decrease, which is consistent with reality. After 2007, Zhejiang and Jiangsu provinces experienced rapid industrial development, becoming major coastal industrial production provinces, while Shanghai and Anhui provinces focused more on financial services, light industry, and tourism.

Moreover, the differences in total energy consumption and pollution control investment between pilot and non-pilot areas have increased, reflecting the context of increased energy consumption and intensified pollution control investment in Zhejiang and Jiangsu due to rapid industrial development. Additionally, an overall description of variables without stratification by stage is provided in Table 2.

Table 2: Descriptive statistics of variables

Variable	Sample size	Mean	Standard deviation	Minimum value	Maximum value
SO2	60	679160.2	309601	170844	1373000
lnSO2	60	13.31966	0.4890813	12.04851	14.13251
treat	60	0.6	0.4940322	0	1
T	60	0.5166667	0.5039393	0	1
treat×T	60	0.3	0.4621248	0	1
PGDP	60	43649.23	27761.85	5732	111081
lnPGDP	60	10.43886	0.7651255	8.65382	11.61801
IND	60	0.4737334	0.0647723	0.3127422	0.5647553
EG	60	13371.7	6804.078	5118	30374
lnEG	60	9.385465	0.4781755	8.540519	10.32134
IV	60	229342.3	167127.8	45208	675944
lnIV	60	12.08259	0.742426	10.71903	13.42387

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

5.2 Variable adaptive testing

Table 3: Multicollinearity test

Variable	VIF	1/VIF
lnEG	7.1	0.14075
T	5.72	0.174894
treat×T	3.97	0.251615
treat	3.21	0.311847
lnIV	2.6	0.384801
lnPGDP	2.49	0.401891
IND	2.22	0.44958
Mean VIF	3.9	0.30219

Typically, if the Variance Inflation Factor (VIF) in multicollinearity exceeds 10, it indicates a severe multicollinearity issue. Conversely, if the VIF values are below 10, it suggests that there is no multicollinearity among the variables. The results in Table 3 indicate that the VIF values for each variable are all below 10. Therefore, there is no multicollinearity issue among the variables, and the empirical analysis can proceed accordingly.

5.3 Parallel trend test and model regression results

5.3.1 Parallel trend test

Due to the crucial prerequisite of the double-difference model, which requires that the treated group and the control group exhibit similar trends without significant differences, meeting the parallel trends assumption, this study employs quantitative analysis to validate the parallel trends. The results in Figure 1 show that the parallel trend assumption is met.

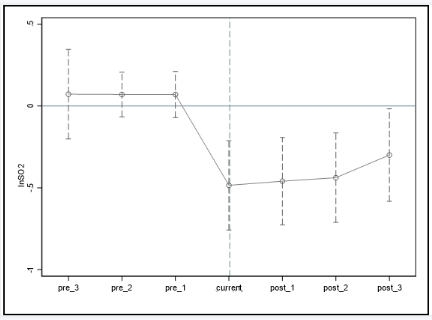

Figure 1: Parallel trend test

5.3.2 Model regression results

Table 4: Model regression results

Variable	(1)	(2)	(3)	(4)	(5)
	lnSO2	lnSO2	lnSO2	lnSO2	lnSO2
treat×T	-0.513***	-0.524***	-0.428***	-0.603***	-0.602***
	(-4.68)	(-4.75)	(-4.40)	(-7.65)	(-7.56)
treat	-0.019	-0.111	-0.094	-0.090	-0.090
	(-0.24)	(-0.94)	(-0.93)	(-1.17)	(-1.16)
lnPGDP		0.098	0.053	-0.734***	-0.749***
		(1.04)	(0.65)	(-5.25)	(-4.76)
IND			2.529***	2.239***	2.255***
			(4.39)	(5.11)	(5.02)
lnEG				1.531***	1.554***
				(6.29)	(5.82)
lnIV					0.010
					(0.22)
_cons	13.485***	12.517***	11.749***	5.791***	5.610***
	(317.31)	(13.43)	(14.29)	(5.11)	(3.96)
N	60	60	60	60	60
R2	0.416	0.417	0.566	0.751	0.746
F	23.493***	16.045***	21.020***	37.211***	30.437***

Note: The values in parentheses are t-statistics,* $p<0.1$, ** $p<0.05$, *** $p<0.01$

From the regression results in Table 4, all interaction term coefficients are significant and negative,

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

indicating that the pollution rights system effectively reduces sulfur dioxide emissions and promotes regional emissions reduction. Moreover, the F-statistic, as a test of joint significance, is also significant, indicating the overall effectiveness of the model.

The choice of the year 2007 as the time point for implementing the pollution rights trading system is rationalized because by this time, Zhejiang Province had officially established a pollution rights trading center, and Jiangsu Province had also been actively expanding the scope of pollution rights trading across the province. The trading policy became more institutionalized, and compared to 2002, the scope of policy implementation was broader in 2007, with more trading entities, procedures, and market transparency, effectively establishing a province-wide pollution rights trading system. Therefore, considering these factors, 2007 was selected as the time point for analysis (Lü, 2011)[8].

Furthermore, from Model 1 to Model 5, the inclusion of control variables such as lnPGDP (log of per capita GDP), IND (industrialization level), lnEG (log of total energy consumption), and lnIV (log of completed investment in industrial pollution control) did not render the interaction term coefficients insignificant. This indicates that the explanatory variables in the estimation equation effectively explain the selected dependent variables. The selection of control variables is thus deemed scientifically sound. The empirical results demonstrate that the pollution rights system effectively reduces sulfur dioxide emissions, underscoring the effectiveness of the Chinese government's commitment to and exploration of the pollution rights system.

5.4 Examination of hysteresis effects and robustness testing

5.4.1 Examination of hysteresis effect

The previous empirical tests have demonstrated that the pollution rights system effectively reduces sulfur dioxide emissions and promotes regional emissions reduction. However, since the implementation of pollution policies is an ongoing process, it is plausible that the effectiveness of pollution reduction in pilot areas may differ due to the timing of policy implementation. To validate its effectiveness, it is crucial to continue analyzing the sustainability of the pollution reduction effects of this system, while also focusing on the overall pollution reduction effects. Specific regression results are provided in Table 5.

Table 5: Examination of hysteresis effect

Variable	(6)	(7)	(8)
	lnSO2	lnSO2	lnSO2
L1.treat×T	-0.331***		
	(-3.57)		
L2.treat×T		-0.138**	
		(-2.30)	
L3.treat×T			0.037*
			(1.77)
treat	-0.288***	-0.377***	-0.403***
	(-3.10)	(-3.79)	(-3.88)
lnPGDP	-0.538**	-0.686**	-0.971***
	(-2.48)	(-2.59)	(-3.03)
IND	2.470***	2.928***	3.210***
	(4.15)	(4.39)	(4.52)
lnEG	1.259***	1.477***	1.805**
	(3.21)	(2.87)	(2.54)
lnIV	0.005	0.056	0.121*
	(0.09)	(0.90)	(1.95)
_cons	6.153***	4.818*	3.794
	(2.93)	(1.76)	(1.00)
N	56	52	48
R2	0.629	0.623	0.672
F	17.069***	15.576***	17.577***

Note: The values in parentheses are t-statistics,* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Based on the examination of lagged effects from Table 7, it is evident that the interaction term coefficient is initially significant and negative, but later becomes positive. This suggests that the effectiveness of the pollution rights system in reducing sulfur dioxide emissions gradually diminishes over time. This phenomenon may be attributed to several factors. Firstly, the early initiation of pollution rights trading system pilot programs in certain regions of Zhejiang and Jiangsu provinces may have influenced the effectiveness of the system in reducing sulfur dioxide emissions. Secondly, it indicates the

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

presence of a cumulative dynamic effect of the pollution rights trading system on sulfur dioxide emissions reduction. Therefore, in addition to persistently improving and strengthening the pollution rights trading system to enhance its effectiveness in reducing sulfur dioxide emissions, China should actively explore other policy tools to constrain sulfur dioxide emissions. Only through such measures can the sustainability of environmental development be ensured.

6. Conclusions

The paper presents a theoretical and empirical analysis of the impact of emissions trading policies on pollution reduction in the Yangtze River Delta region using industrial pollutant emissions data, particularly focusing on sulfur dioxide emissions, from 2001 to 2015 across four provinces and municipalities. The findings conclusively demonstrate that emissions trading policies have indeed effectively facilitated emissions reduction in the Yangtze River Delta region. Furthermore, the study verifies two hypotheses: firstly, that emissions trading can effectively reduce industrial pollutant emissions, exemplified by sulfur dioxide; and secondly, that emissions trading has a dynamic impact on the reduction of industrial pollutant emissions represented by sulfur dioxide.

Building upon these conclusions, the paper proposes the following policy recommendations:

Promotion of Emissions Trading System in China: The study advocates for the widespread adoption of emissions trading systems in China. While numerous studies and analyses, including the present study, have evidenced the effectiveness of emissions trading in promoting regional emissions reduction, there exist various impediments to the practical implementation of emissions trading policies (H. Zhang and Liu, 2022)[9]. Therefore, it is suggested that China address three key aspects in the promotion of emissions trading systems. Firstly, China needs to establish a robust and scientifically sound emissions trading market. Presently, China's emissions trading market primarily operates at the primary level, involving transactions between enterprises and government, where the government allocates initial emission quotas to enterprises through methods such as auctions or allocation. However, secondary trading markets, primarily conducted through online auctions, suffer from issues such as information asymmetry and pricing difficulties, potentially resulting in abnormal pricing of emission rights (Marquardt and Wiedman, 1998)[10]. Hence, it is imperative for the government to promote information transparency before trading, minimize intervention during transactions to ensure market resource allocation, and endorse transactions by guaranteeing their completion and subsequent processes, utilizing technologies like blockchain if necessary.

Enhancement of Government Supervision for Emissions Trading: Strengthening government regulation and formulating national laws and regulations are essential for emissions trading. Currently, China lacks comprehensive national laws and regulations pertaining to emissions trading, necessitating clear definition and status of emissions trading at the legal level and reinforcement of existing systems. Crucially, there is insufficient government support for cross-regional emissions trading, which affects enterprises' economic interests due to the imperfect trading and regulatory systems. Therefore, China needs to establish a vertical supervision system from national to provincial and local levels to ensure cross-provincial and cross-municipal transactions are secure and confident. Additionally, China should broaden the scope of emissions trading to include all entities relevant to pollution control, such as those in catering, medical, livestock farming, urban wastewater treatment facilities, and landfill leachate treatment facilities, as these are indispensable components of China's pollution management system. Encouraging transactions among these entities through relevant policies is crucial. Furthermore, China can draw lessons from and emulate the emissions trading system in the United States, such as facilitating nationwide trading of emission rights and transitioning from administrative divisions to watershed-based trading of water pollutants, thereby tailoring emissions trading systems to local contexts.

References

[1] Bell, Ruth Greenspan, and Clifford S. Russell. 2018. "Environmental Policy for Developing Countries." In Routledge eBooks, 239–46. https://doi.org/10.4324/9781315197296-10.
[2] Cooter, Robert D. 1989. "The Coase Theorem." In Palgrave Macmillan UK eBooks, 64–70. https://doi.org/10.1007/978-1-349-20215-7_6.
[3] Zhou, Jia, Jinnan Wang, Hongqiang Jiang, Can Dong, Rensheng Tian, Jun Bi, Jing Zhang, and Xi Cheng. 2019. "A Review of Development and Reform of Emission Permit System in China." Journal of Environmental Management 247 (October): 561–69. https://doi.org/10.1016/j.jenvman.2019.06.104.

ISSN 2616-5902 Vol. 6, Issue 4: 31-38, DOI: 10.25236/AJBM.2024.060406

[4] Zhang, Kunmin, and Zongguo Wen. 2008. "Review and Challenges of Policies of Environmental Protection and Sustainable Development in China." Journal of Environmental Management 88 (4): 1249–61. https://doi.org/10.1016/j.jenvman.2007.06.019.

[5] Wang, Jinnan, Zhanfeng Dong, Qianwei Ying, Qiong Wu, Chazhong Ge, Yueying Wu, and Jianwu Yang. 2021. "Practices of Emission Trading in China: Exploration and Innovation." In Springer eBooks, 39–89. https://doi.org/10.1007/978-981-16-6905-7_2.

[6] Zhang, ZhongXiang. 2015. "Carbon Emissions Trading in China: The Evolution From Pilots to a Nationwide Scheme." Climate Policy 15 (sup1): S104–26. https://doi.org/10. 1080/14693062. 2015. 1096231.

[7] Deng, Xiangzheng, Malin Song, Zhihui Li, Fan Zhang, and Yuexian Liu. 2024. "Environmental Resource Allocation Efficiency and Sustainable Development." In Environmental and Natural Resources Economics, 67–95. https://doi.org/10.1007/978-981-99-9923-1_3.

[8] Lü, Zifeng. 2011. "Emissions Trading in China: Lessons From Taiyuan SO2 Emissions Trading Program." Sustainability Accounting, Management and Policy Journal 2 (1): 27–44. https://doi.org/ 10. 1108/ 20408021111162119.

[9] Zhang, Haoran, and Yu Liu. 2022. "Can The Pilot Emission Trading System Coordinate the Relationship Between Emission Reduction and Economic Development Goals in China?" Journal of Cleaner Production 363 (August): 132629. https://doi.org/10.1016/j.jclepro.2022.132629.

[10] Marquardt, Carol A., and Christine I. Wiedman. 1998. "Voluntary Disclosure, Information Asymmetry, and Insider Selling Through Secondary Equity Offerings." Contemporary Accounting Research 15 (4): 505–37. https://doi.org/10.1111/j.1911-3846.1998.tb00569.x.*