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The Impact of Carbon Emission Trading System on ESG of Agricultural Enterprises: Evidence from 24 Listed Agricultural Companies in China

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Abstract. With China's dual carbon goals of carbon peaking and carbon neutrality, the carbon emission trading system will play a crucial role. In addition, agriculture, which is closely linked to carbon emissions, is a foundational industry in China. It is worth paying attention to how it responds to carbon emission trading policies. This study uses data from agricultural listed enterprises from 2009 to 2022, and employs the Difference-in-Differences (DID) method and the intermediary effect model. The evidence suggests that the the carbon emission trading system will significantly improve the the ESG evaluation of agricultural enterprises. Furthermore, green management innovation, green total factor productivity, and CSR information disclosure quality of enterprises will act as intermediaries. The study calls for the government to accelerate the establishment of a national carbon trading market, improve reward and penalty systems, and evaluation frameworks for green innovation in agricultural enterprises. It also emphasizes the need to strengthen pre-subsidies for small-scale enterprises, encourage environmental literacy training for management personnel in agricultural enterprises, intensify green innovation efforts, and establish relevant department assessments of corporate social responsibility.

Keywords: Carbon Emission Trading System; ESG; Agricultural Enterprises; Green Management Innovation; Green Total Factor Productivity; CSR Information Disclosure Quality.

1. Introduction

In the process of rapid economic development, issues such as environmental pollution and wealth disparity have attracted widespread social attention. On September 22, 2022, General Secretary Xi Jinping, during the 75th United Nations General Assembly, first proposed the "dual carbon goals": China will achieve carbon peak by 2030 and carbon neutrality by 2060. On the road to emission reduction, the carbon emission trading system serves as a crucial safeguard. The development of this system in China has evolved from initial pilot projects in seven provinces and cities to the establishment of a nationwide carbon emission trading market. Taking Shanghai's carbon emission data as an example, the scope 1 carbon dioxide emissions in Shanghai were 194.2 Mt in 2014, decreasing to 192.9 Mt by 2019. Despite this reduction, it remains challenging to achieve the ideal state. Therefore, the establishment, promotion, and improvement of environmental policies such as the Carbon Emission Allowance Trading System are imminent.

In the process of socio-economic development, enterprises, as one of the most active entities, ought to bear more social responsibilities. With the strong advocacy of green development by the central government, the incorporation of the Environmental, Social, and Governance (ESG) evaluation system into corporate management decisions becomes crucial. Among various types of enterprises, agricultural enterprises hold a unique position due to their close association with ecological stability, greenhouse gas emissions, and significant social responsibilities such as food security. Therefore, for agricultural enterprises, the prompt establishment of a sound ESG evaluation system is of great significance.

The establishment of the carbon emission trading system can reduce carbon emissions to a certain extent, and the purpose of implementing the ESG evaluation system is to better ensure that enterprises fulfill their environmental and social responsibilities. The carbon emission trading system can reduce

greenhouse gas emissions, enhance environmental performance, and promote green innovation within enterprises (Shigong Lv et al., 2019; Jingyin Liu et al., 2023). These aspects are closely related to the ESG evaluation of enterprises. Hence, the key focus of this paper is to explore whether the carbon emission trading system can enhance the ESG evaluation of enterprises.

China's carbon emission trading system began as a pilot project in seven provinces and cities in 2011, including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen. It can effectively leverage the market's role in resource allocation, offering a low-cost method to achieve carbon reduction. ESG, encompassing evaluations in the areas of Environment, Social, and Governance, is a comprehensive indicator assessing a company's performance in promoting sustainable economic development and fulfilling social responsibilities (Lijuan Su et al., 2023).

Summarizing existing research findings, they can be broadly categorized into two types: those studying the impact of the carbon emission trading system on specific indicators of different entities, such as enterprises, cities, and provinces, and those exploring the underlying mechanisms through which the carbon emission trading system influences the ability of entities to achieve emissions reduction. Numerous studies indicate positive impacts of the carbon emission trading system, such as boosting green innovation (Xin Zhao et al., 2022; Jingyin Liu et al., 2023), total factor productivity (Junguo Hua et al., 2022; Jun Hu et al., 2023), export earnings (Qi Wei et al., 2022), carbon information disclosure quality (Lina Liu et al., 2023), ESG information disclosure quality (Haijing Cai et al., 2022), operational efficiency (Jie Wen et al., 2021), and reducing urban emission costs (Zhao Wang et al., 2019). However, there are also negative impacts, such as decreasing market power for high-carbon enterprises (Wei Wang et al., 2022). Of particular interest is the study on total factor productivity, where some scholars have found that the carbon emission trading system may inhibit the TFP of pilot cities (Zhijie Jia et al., 2023), which contradicts the conclusions of the aforementioned articles.

Several researches have conducted in-depth analyses of why the carbon emission trading system affects certain indicators and how it achieves the goal of carbon reduction. For instance, research by Shao-Zhou Qi and colleagues indicates that the carbon emission trading system promotes low-carbon innovation in enterprises by effectively alleviating barriers to low-carbon innovation financing (Shao-Zhou Qi et al., 2021). Shigong Lv's study suggests that the carbon emission trading system enhances a company's environmental performance by increasing emission costs and enforcing rigidity, compelling companies to take measures to reduce pollution levels (Shigong Lv et al., 2019). Research by Di Zhou and his colleagues demonstrates that carbon emission trading can reduce carbon intensity in pilot cities as this policy compels cities to adjust industrial structures and pursue energy-saving and emission reduction pathways (Di Zhou et al., 2020). Study by Kaihao Liu and his colleagues indicates that the carbon emission trading system significantly promotes exports for companies. The mechanism behind this impact is attributed to the system's enhancement of green innovation and alleviation of financial constraints on companies (Kaihao Liu et al., 2023). Research by Lijuan Su and her colleagues highlights that the carbon emission trading system improves a company's ESG performance by alleviating financial constraints and increasing investment in research and development (Lijuan Su et al., 2023). Yang Zhang and his colleagues' study reveals that there is an intermediary effect of debt financing costs between carbon emission trading and corporate green innovation. In other words, the carbon emission trading system influences the improvement of corporate green innovation levels by affecting the costs of debt financing for enterprises (Yang Zhang et al., 2022). Additionally, study by Jing Zhang and her colleagues demonstrates that the carbon emission trading system promotes the transformation and upgrading of industrial structures (Jing Zhang et al., 2023). Similarly, research by Xuejie Bai et al. finds that the energy-saving and emission reduction paths resulting from the carbon emission trading system are more attributed to the transformation of energy structures rather than efficiency improvements (Xuejie Bai et al., 2021).

Through the literature review, it is obvious that current research has some shortcomings. Firstly, there is a limited number of articles focusing on agricultural enterprises as the research subject, despite the significant role of agriculture in reducing carbon emissions. Therefore, additional research in this area

is needed. Secondly, there is a scarcity of in-depth studies on the underlying mechanisms of the carbon emission trading system's impact. Many articles empirically demonstrate the system's influence on specific indicators of the research subject but do not clearly explain the mechanisms, hindering subsequent improvements in related behaviors. Thirdly, there is limited research connecting ESG with the carbon emission trading system. Given the current importance of ESG in corporate management, insights on improving ESG evaluations from studies on the carbon emission trading system could be beneficial.

To address these shortcomings, this paper makes three marginal contributions: firstly, setting agricultural enterprises as the research subject and empirically demonstrating the impact of carbon emission trading on the ESG evaluation of agricultural enterprises; secondly, providing a deeper explanation of how the carbon emission trading system influences a company's ESG evaluation through the mediation effect model; thirdly, distinguishing the differential impacts of the carbon emission trading system on large-scale and small-scale agricultural enterprises through heterogeneity analysis, aiming to provide recommendations for further refining relevant institutional development.

2. Hypotheses

Currently, the nationwide construction of the carbon emission trading market is accelerating, and agricultural enterprises, as significant sources of greenhouse gas emissions, naturally should be a target of policy implementation. As the ESG evaluation system gains high attention both domestically and internationally, the establishment of this system is crucial for assisting agricultural enterprises in better fulfilling social and corporate responsibilities, given the unique characteristics of these enterprises.

Currently, a large number of studies have demonstrated that the carbon emission trading system can help improve various aspects of enterprise performance, including the quality of green innovation (Zhao et al., 2022; Liu et al., 2023), total factor productivity (Hua et al., 2022; Jun Hu et al., 2023), operational efficiency (Jie Wen et al., 2021), and ESG information disclosure quality (Haijing Cai et al., 2022). The carbon emission trading system, as a market incentive-based environmental policy, differs from mandatory control policies in its non-coercive nature. It aids companies in lowering environmental costs, and some may even gain additional economic benefits through market trading of permits. Therefore, companies under such incentives should actively engage in environmental actions, optimize their production activities, undertake green innovation to enhance environmental benefits, and consequently improve their ESG evaluations. Thus, the first hypothesis is proposed:

Hypothesis 1: The carbon emission trading system significantly improves the ESG evaluation of agricultural enterprises.

In China, agricultural enterprises encompass a diverse range, including globally recognized Fortune 500 companies like COFCO Group, as well as lesser-known small enterprises in towns. From the perspective of the position in the supply chain, there are enterprises situated at the front end of the supply chain that provide initial production materials such as seeds, pesticides, and fertilizers. There are also enterprises located in the middle of the supply chain that offer technical assistance and guidance to farmers during the production process. Additionally, there are enterprises positioned at the rear end of the supply chain, involved in acquiring agricultural products and processing them to varying degrees. Therefore, agricultural enterprises exhibit diverse classifications based on different criteria and results.

Analyzing rationally, as the carbon emission trading system is bound to affect the production of agricultural enterprises, adjustments made by these enterprises according to policies involve a certain time lag. Large enterprises, facing considerations such as production scale and technology, tend to have a greater time lag effect than small-scale enterprises. In other words, smaller enterprises, due to fewer considerations, can quickly adjust their production to comply with the implementation of the carbon emission trading policy. This aligns with the viewpoint presented by Binbin Lu et al. (2021):

Small and medium-sized enterprises can mobilize organizational flexibility and rapid response capabilities when facing special events, maintaining business stability. Therefore, the second hypothesis is proposed:

Hypothesis 2: Compared to larger-scale agricultural enterprises, the carbon emission trading system has a more significant positive effect on improving ESG evaluations for smaller-scale agricultural enterprises.

The ESG evaluation system comprises three parts: E (Environmental), S (Social Responsibility), and G (Corporate Governance). As the carbon emission trading system is an environmental policy, its relationship with ESG evaluation, particularly the Environmental aspect (E), is closely linked. Hence, the carbon emission trading system is likely to influence the degree of importance companies place on environmental friendliness, subsequently affecting their ESG evaluations. Based on previous research, companies with larger board sizes tend to have higher carbon information disclosure quality (Mohammad Nasih et al., 2019). Higher carbon information disclosure quality implies greater emphasis on environmental protection in production, indicating that the management is more concerned about the company's degree of green development. Consequently, companies may undertake a series of green management innovations to adapt to the implementation of the carbon emission trading system, resulting in higher ESG evaluations. Therefore, the third hypothesis is proposed:

Hypothesis 3: The carbon emission trading system improves a company's ESG evaluation by enhancing green management innovation.

Numerous studies have found that the carbon emission trading system promotes total factor productivity in enterprises (Jun Hu et al., 2023; Hua et al., 2022). Considering the meaning of total factor productivity, its improvement implies the ability to produce more output with fewer resources, contributing to increased economic efficiency. Higher total factor productivity also helps companies reduce production costs, allowing them to better capture market share and achieve improved economic benefits. Both Governance (G) and Social Responsibility (S) in the ESG evaluation system are closely related to economic development. The higher the economic benefits of a company, the more potential that the company may have to promote local economic development and improve the economic situation in the region where it operates. In other words, the company is undertaking more social responsibility. Moreover, higher economic efficiency makes it more probable for companies to focus on employee welfare and hierarchical relationships, contributing to better internal governance. Therefore, the fourth hypothesis is proposed:

Hypothesis 4: The carbon emission trading system improves the ESG evaluation of agricultural enterprises by enhancing green total factor productivity.

In the advent of the new era, companies are expected to transcend the traditional goal of maximizing profits and shift towards more diversified operational objectives, such as increasing awareness of corporate social responsibility. The carbon emission trading system will further enhance a company's awareness of social responsibility, leading companies to actively increase the frequency and quality of their CSR (Corporate Social Responsibility) reports. Consequently, the ESG evaluation of companies will be elevated. As stated by Shi Li et al. (2022): After the early 21st century, influenced by the formulation of international organizational standards, CSR began to focus more on its role in sustainable development and eventually integrated into the realm of ESG. Therefore, the quality of CSR information disclosure is likely to impact a company's ESG evaluation. Hence, the fifth hypothesis is proposed:

Hypothesis 5: The carbon emission trading system improves the ESG evaluation of agricultural enterprises by enhancing the quality of CSR report disclosures.

3. Research Methodology

3.1. Data Source

The data for this study are sourced from the Wind database and CSMAR database. The ESG scores are obtained from Bloomberg's ESG evaluation system for listed companies from 2009 to 2022. As the focus of this study is on agricultural enterprises, all agricultural companies will be filtered from the overall evaluation system. Considering the study period from 2009 to 2022 and potential data gaps, a total of 24 agricultural enterprises are selected as the research subjects for this study. The names and industries of these 24 agricultural enterprises are presented in the table below:

Table 1. Names and Industries of 24 Agricultural Enterprises

Company Name	Industry
Longping High-Tech	Agriculture
Denghai Seeds	Agriculture
Yasheng Group	Agriculture
Wanxiang Dern	Agriculture
Beidahuang	Agriculture
Hainan Rubber	Agriculture
Shunxin Agriculture	Agricultural and Sideline Food Processing Industry
New Hope	Agricultural and Sideline Food Processing Industry
Shuanghui Development	Agricultural and Sideline Food Processing Industry
Tianbang Food	Agricultural and Sideline Food Processing Industry
Zhengbang Technology	Agricultural and Sideline Food Processing Industry
Baolingbao	Agricultural and Sideline Food Processing Industry
Haida Group	Agricultural and Sideline Food Processing Industry
Delisi	Agricultural and Sideline Food Processing Industry
Da Bei Nong	Agricultural and Sideline Food Processing Industry
Jinxin Nong	Agricultural and Sideline Food Processing Industry
Qiaqia Food	Agricultural and Sideline Food Processing Industry
Tang Ren Shen	Agricultural and Sideline Food Processing Industry
Haoxiangji	Agricultural and Sideline Food Processing Industry
Haixin Food	Agricultural and Sideline Food Processing Industry
Guannong Shares	Agricultural and Sideline Food Processing Industry
Tongwei Shares	Agricultural and Sideline Food Processing Industry
COFCO Sugar	Agricultural and Sideline Food Processing Industry
Guotu Zhonglu	Agricultural and Sideline Food Processing Industry

From the table above, it can be seen that the agricultural enterprises referred to in this study encompass all businesses related to pre-production, production, and post-production in agriculture. These can be referred to as agribusinesses or agriculture-related enterprises, representing a vital component of the modern agricultural industry.

The main independent variable in this study is the virtual variable "Carbontrade," which is the product of the policy implementation time and location. Based on Hypotheses 3, 4, and 5, the Green Innovation Index, Green Total Factor Productivity, and CSR Information Disclosure Quality of agricultural listed companies from 2009 to 2022 are selected as intermediate variables. These three intermediate variables are either directly obtained from the database or derived from computational processes applied to the database's data.

It is essential to note that due to some data having minor gaps, linear interpolation has been applied to complete the dataset. After the completion of the interpolation process, the total sample size is 320, all at the enterprise level.

3.2. Variable Settings

The dependent variable of this article is the ESG score of agricultural enterprises, and the data used is Bloomberg's ESG evaluation system for listed companies from 2009 to 2022. Additionally, considering that China's carbon emission trading policy began its trial implementation in seven provinces and cities, including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen, starting from 2011, and based on past research experience, the study's commencement is set in 2009. Moreover, previous research did not extend the research time to after 2021, most of which only stayed in 2019. However, considering that China's carbon emission trading policy started the construction of a nationwide carbon emission trading market for the power generation industry in 2021, this symbolizes that China's carbon emission trading policy is gradually expanding its scope of influence. Although the policy changes in 2021 do not involve the agricultural sector, the signals sent by these changes may also have a certain impact on agricultural enterprises, leading to them taking proactive measures to improve. Therefore, the end of this study is set for 2022.

The primary independent variable in this study is a 0-1 virtual variable named "Carbontrade," resulting from the multiplication of policy implementation time and policy implementation location. Specifically, using the commencement of carbon emission trading as a reference point in 2011 and the seven provinces and cities as the cutoff, entities with a time before 2011 are marked as 0, while those from 2011 onwards are marked as 1. Similarly, entities with headquarters registered in Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen are labeled as 1, and others as 0.

There are three intermediate variables in this study: Green Innovation Index, Green Total Factor Productivity, and CSR Information Disclosure Quality. The Green Innovation Index(Green Innovation) is derived from the research of Longsheng Xi et al. (2022). Green Total Factor Productivity(Green Productivity) is calculated based on the studies by Haihong Guo et al. (2020) and Yufeng Hu et al. (2020). Lastly, CSR Information Disclosure Quality (CSR) is determined by whether a company's CSR report for the year discloses information related to the environment, marked as 1 if yes, and 0 otherwise.

Control variables in this study, referring to established research (Lijuan Su et al., 2023; Xiaojing Li et al., 2022), include the asset-liability ratio, Tobin's Q ratio, enterprise age, and the natural logarithm of total assets. These variables are extracted from the CSMAR database.

3.3. Model Setting

As the primary goal of this study is to investigate whether the implementation of carbon emission trading policies enhances the ESG evaluation of agricultural enterprises, the research employs the Difference-in-Differences (DID) method as the econometric model. The specific model is presented below:

$$\text{ESG}_{it} = a_0 + aCarbontrade_{it} + \beta X_{it} + \text{year}_t + v_i + \mu_{it} \quad (1)$$

The subscript i denotes the enterprise number, the subscript t represents the year, and $Carbontrade_{it}$ is the 0-1 virtual variable obtained by multiplying time and location, as mentioned in the previous text. X_{it} represents control variables, year_t represents the year in which the enterprise is, v_i represents the i-th enterprise, and μ_{it} represents the random error term.

In addition to the fundamental model, this study delves deeper into the impact of carbon emission trading systems on ESG by exploring mediating effects. Therefore, based on hypotheses 3, 4, and 5, we designed the mediation model. First, the green management innovation index is used as the mediating variable, and it is multiplied by $Carbontrade_{it}$ to obtain the interaction term. The specific model is as follows:

$$\text{ESG}_{it} = a_0 + aInnovation_{it} + \beta X_{it} + \text{year}_t + v_i + \mu_{it} \quad (2)$$

$Innovation_{it}$ is the interaction term obtained by multiplying $Carbontrade_{it}$ and $Green\ Innovation_{it}$, and other variables are the same as above.

Next is to use green total factor productivity as the mediating variable, and the model is similar to the one proposed in hypothesis 3, as follows:

$$\text{ESG}_{it} = a_0 + aProductivity_{it} + \beta X_{it} + \text{year}_t + v_i + \mu_{it} \quad (3)$$

$Productivity_{it}$ is the interaction term obtained by multiplying $Carbontrade_{it}$ and $Green\ Productivity_{it}$, and other variable explanations are the same as above.

Finally, using CSR information disclosure quality as the mediating variable, the specific model is as follows:

$$\text{ESG}_{it} = a_0 + aInformation_{it} + \beta X_{it} + \text{year}_t + v_i + \mu_{it} \quad (4)$$

$Information_{it}$ is the interaction term obtained by multiplying $Carbontrade_{it}$ and CSR_{it}, with other variable explanations the same as above.

4. Empirical Analysis

4.1. Regression Results Analysis

This study initially takes ESG as the dependent variable, $Carbontrade$ as the primary independent variable, and includes control variables for panel fixed-effects regression. The regression results of the main independent variable are presented in Table 2:

Table 2. Main Model Regression Results of the Impact of Carbon Emission Trading Policy on ESG

	ESG
Carbontrade	4.652**
	(2.180)
Control	Yes
Time Effect	Yes
Individual Effect	Yes
N	320

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be observed that the coefficient of Carbontrade is 4.652 and is significant at the 5% significance level. This implies that, holding other variables constant, businesses located in areas and time points where the carbon emission trading policy is implemented have ESG scores 4.652 points higher than businesses not in pilot regions. This aligns with Hypothesis 1 mentioned earlier, indicating that the carbon emission trading policy contributes to improving the ESG evaluation of agricultural enterprises, and the effect is significant.

4.2. Heterogeneity Analysis

Hypothesis 2 suggests that compared to larger agricultural enterprises, the impact of the carbon emission trading policy on improving ESG evaluations is more significant for smaller enterprises. Therefore, based on the average number of employees in enterprises as a reference, the sample is classified, and heterogeneity analysis is conducted. The panel fixed-effects are used again for the DID model regression. The following table presents the regression results for both smaller and larger scale enterprises:

Table 3. Regression Results of Carbon Emission Trading Policy on ESG for Different Scale Agricultural Enterprises

	Smaller Scale	Larger Scale
	ESG	
Carbontrade	3.412*	5.771
	(1.731)	(0.927)
Control	Yes	Yes
Time Effect	Yes	Yes
Individual Effect	Yes	Yes
N	235	85

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be seen that the coefficient of Carbontrade for smaller-scale enterprises is 3.412 and is significant at the 10% level. This indicates that, holding other variables constant, smaller-scale enterprises in regions and periods where the carbon emission trading policy is implemented have ESG scores 3.412 points higher than smaller-scale enterprises in non-pilot areas and periods. The coefficient of Carbontrade for larger-scale enterprises is 5.771, which is positive and aligns with Hypothesis 1, suggesting that the carbon emission trading policy contributes to the improvement of ESG. However, the coefficient is not significant, supporting Hypothesis 2, indicating that the positive effect of the carbon emission trading policy on the ESG evaluation of smaller agricultural enterprises is more significant than that of larger agricultural enterprises.

4.3. Mediation Effects

Hypotheses 3, 4, and 5 are all tests of mediation effects. Therefore, regression tests are conducted according to the model setting in the third part. Table 4 shows the regression results of the mediation effects, where columns (1), (2), and (3) correspond to the mediation effects of green management innovation, green total factor productivity, and CSR information disclosure quality of enterprises, respectively. The regression results are as follows in Table 4:

Table 4. Regression Results of Mediation Effects

	(1)	(2)	(3)
	ESG		
Innovation	3.639***		
	(5.800)		
Productivity		7.248***	
		(3.488)	
Information			4.573**
			(2.563)
Control	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes
Individual Effect	Yes	Yes	Yes
N	320	320	320

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

It can be found that the coefficients of the three variables are all positive and significant. First, looking at the coefficient of "Innovation," which is 3.639 and significant at the 1% level. This implies that, holding other variables constant, for every 1-unit increase in the agricultural enterprise's green innovation index, the ESG rating of agricultural enterprises under the carbon emissions trading policy increases by 3.639. The reason for this might be that the carbon emissions trading system compels companies to innovate in green management, recruit new management talents, and provide environmental literacy training to employees. This enables companies to more effectively implement the carbon emissions trading policy, participate more actively in the carbon trading market, assume more social responsibility, improve their production methods and innovation levels, thereby enhancing the ESG rating of the enterprise.

Next is the coefficient of "Productivity," which is 7.248 and significant at the 1% level. This implies that, holding other variables constant, for every 1-unit increase in the agricultural enterprise's green total factor productivity, the ESG rating of agricultural enterprises under the carbon emissions trading policy increases by 7.248. The reason for this might be that after the establishment of the carbon emissions trading system, companies will have to allocate a portion of their profits to purchase carbon emission rights. This results in companies losing some profits, prompting them to seek more efficient and environmentally friendly production methods to reduce this loss in cost. As a result, companies will enhance their green total factor productivity through green innovation, leading to an improvement in the ESG rating of the enterprise.

Finally, the coefficient of "Information" is 4.573 and significant at the 5% level. This implies that, holding other variables constant, for every 1-unit increase in the agricultural enterprise's CSR information disclosure quality, the ESG rating of agricultural enterprises under the carbon emissions trading policy increases by 4.573. The reason for this may be that after the establishment of the carbon emissions trading system, companies will increase their emphasis on environmental protection. Consequently, companies will change their business objectives, no longer pursuing profit maximization as their sole goal but focusing more on social responsibility. This ensures that

companies contribute positively to people, industries, and society. As a result, companies will be more proactive in disclosing their corporate social responsibility reports to the public, improving the quality of CSR information disclosure, and enhancing the corporate image, thereby improving the ESG rating of the enterprise. In summary, Hypotheses 3, 4, and 5 are all supported.

5. Conclusion

This study investigated the impact of the carbon emissions trading system on the ESG of agricultural enterprises. The results show a significant positive effect of the carbon emissions trading system on the ESG of agricultural enterprises. The mediation effect model is applied to reveal that the system influences the ESG evaluation of enterprises through green management innovation, green total factor productivity, and CSR information disclosure quality. The effects of all these factors were positively significant. Specific conclusions and policy recommendations are as follows.

Firstly, the carbon emission trading system has a positive impact on the ESG of agricultural enterprises, which fully demonstrates the necessity of incorporating the agricultural sector into the national carbon trading market. On the road to achieving “carbon peaking” and “carbon neutrality,” carbon emission trading is an important link that cannot be ignored. The first reason is that the carbon emission trading system can fully play the important role of the market in resource allocation and promote carbon reduction in a low-cost way; the second reason is that the introduction of carbon emission trading system can help enterprises solve the problem of net zero carbon emissions, improve the environmental friendliness of enterprise production, and help enterprises achieve the last mile of carbon neutrality. Therefore, it is necessary for the government to further accelerate the construction of a national carbon trading market, increase the importance attached to the agricultural sector, and quickly include the agricultural sector in the national carbon trading market.

Secondly, the carbon emission trading system positively affects the ESG evaluation of agricultural enterprises through green management innovation. The practical significance lies in the need for agricultural enterprises to enhance environmental awareness training for their management teams, elevating their understanding of agricultural carbon reduction and carbon trading. As demonstrated in the research by Nasih and his colleagues (2019), enterprises with larger board sizes are more inclined to improve the quality of carbon information disclosure. Therefore, for agricultural enterprises, strengthening environmental training for management teams is one aspect. Additionally, the recruitment of individuals with high environmental literacy into the enterprise’s management team is an effective way to enhance the scale of the management team. Both approaches aim to elevate green management innovation within enterprises, reinforcing the impact of the carbon emissions trading system. The goal is to ensure that policies are effectively implemented from top to bottom.

Thirdly, the carbon emissions trading system positively influences the ESG evaluation of agricultural enterprises through the enhancement of the green total factor productivity. Drawing on the research by Hua and his colleagues (2022), carbon emissions trading effectively raises the overall productivity of agricultural enterprises, with the intermediary mechanism being the green innovation within the enterprise. Consequently, the following recommendations are proposed: the government should increase compensation incentives for green innovation in agricultural enterprises, bolster their capacity for independent research and collaborative innovation, optimize production structures, prioritize environmental friendliness and innovation in production, and incentivize enterprises to undergo transformative innovation. Additionally, the government should expedite the establishment of reward and penalty systems for green innovation and environmentally friendly production in agricultural enterprises, fully leveraging the motivating effects of such systems. For enterprises, it is crucial to intensify investments in Research and Development (R&D), focusing on high-quality innovation rather than sheer quantity, to avoid superficial innovation and prevent the development of a culture where innovation is merely a response to policies.

Fourthly, the carbon emissions trading system positively influences the ESG evaluation of agricultural enterprises through the quality of CSR information disclosure. In this new era, enterprises

should not only aim to maximize profits but should also focus more on the dimensions of human welfare, industry development, and societal progress, actively taking up their social responsibilities. This is especially critical for agricultural enterprises, foundational industries responsible for food security and livelihoods. Therefore, for the government, there is a need to continually refine evaluation standards and related laws for agricultural enterprises, improve evaluation systems based on the needs of the new era, and conduct more comprehensive and sophisticated monitoring and evaluation of enterprises. Similarly, enterprises should establish dedicated entities responsible for the implementation of corporate social responsibility, set corresponding CSR assessment indicators, cultivate social responsibility awareness among employees, regularly disclose CSR reports to the public, and build a positive corporate image.

Fifthly, the carbon emissions trading system has a more evident positive impact on the ESG evaluation of small-scale agricultural enterprises. Compared to large-scale agricultural enterprises, small-scale enterprises face more intense market competition, higher operational risks, and greater business pressures. Therefore, more flexible and targeted subsidy policies should be implemented for small-scale agricultural enterprises. As small-scale enterprises constitute the primary component of China's current agricultural landscape, the lack of their production would make it challenging to meet the daily consumption needs of the country's residents. Hence, small-scale enterprises bear more social responsibilities and are an indispensable part of China's agricultural production. Additionally, considering that small-scale enterprises inherently lack funds and research personnel for green innovation compared to large-scale enterprises, the implementation of the carbon emissions trading system would prompt them to allocate more resources and funds to meet the demands of the carbon trading market. Consequently, the government should provide more subsidies to small-scale enterprises. According to research by Jiangfeng Hu and his colleagues (2020), it is preferable for the government to offer flexible and targeted upfront subsidies rather than post-event subsidies. Therefore, the government should provide small-scale enterprises with more adaptable and targeted upfront subsidies.

Finally, this study has some limitations: Firstly, the sample size is relatively small due to the inherent scarcity of data on agricultural enterprises, compounded by the specific timeframe set for the research, resulting in a limited sample size. Future research can enhance the sample size through various means to provide a more comprehensive understanding of the impact of the carbon emissions trading system on the agricultural sector. Secondly, the study focuses solely on three aspects of agricultural enterprises (green management innovation, green total factor productivity, and CSR information disclosure quality) to explore the mediating effects of the carbon emissions trading system on ESG evaluations. Other existing influencing mechanisms and pathways still need further identification and exploration. Subsequent research could incorporate additional influencing factors to refine the mediating effects of the carbon emissions trading system on ESG evaluations in the agricultural sector and clarify their respective impact weights. Thirdly, the categorization of agricultural enterprises in this study is relatively simplistic, and the current diversification of agricultural enterprises warrants a more detailed classification in future research. This approach would allow for a nuanced investigation into the impact mechanisms of the carbon emissions trading system on different types of agricultural enterprises, contributing to the specificity and effectiveness of policies.

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