

The Impact of Carbon Trading Pilot Market on the Enterprises' Technology Innovation in China

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Abstract. This paper mainly studies the positive incentive effect of China's carbon trade pilot market on the technological innovation capabilities of enterprises. This paper will analyze the actual effects of the carbon trade pilot market since its implementation from the perspective of micro-enterprises. Previous studies were mainly based on the macro carbon market perspective, and the main analysis focused on the carbon reduction effect of the carbon market. Therefore, this paper will be an effective supplement to the existing research on the carbon trade pilot market. This paper will discuss the actual policy effects of the carbon trade pilot market from the two aspects of traditional enterprise technological innovation capabilities and green innovation capabilities, and further explore how carbon market policies play a positive role in technological innovation incentives for enterprises. In addition, this paper will supplement the relevant research on the impact of government behavior and corporate decision-making on the effects of the carbon market, which is lacking in previous studies. Then, combined with the above comprehensive analysis, relevant policy recommendations are put forward.

Keywords: Carbon Trade Pilot Market, Enterprises' Innovation Capability, ESG, Financial Performance.

1. Introduction

Greenhouse gas emissions, especially carbon dioxide emissions, are an important responsibility and mission for China's ecological civilization construction and as a world power. Since China officially became a member of the Paris Agreement in 2015, China has been committed to exploring emission reduction solutions with countries around the world. At the same time, in 2009, China pledged at the 2009 Copenhagen Climate Change Conference that by 2020, the national carbon intensity will be reduced by 40% to 45% compared with 2005. In 2015, before the 21st Conference of the Parties (COP) in Paris, Chinese leaders announced that by 2030, China's carbon intensity will be reduced by 60% to 65% compared with 2005, and carbon peak will be achieved by 2030 at the latest. At the same time, climate and ecological problems caused by global warming have attracted widespread attention from the people. Therefore, in order to improve the living environment of the people and achieve national goals, in 2011, the National Development and Reform Commission of China issued the "Notice on Carrying out Carbon Emission Rights Pilot Work", and then seven pilot carbon emission rights trading markets in Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen were officially implemented. The mechanism design and actual operation of these carbon trade pilot markets provide theoretical and practical basis for the institutional design and construction of the formal national carbon market, and also provide a new development direction for China, which is in the process of high-quality economic development. In the past, some industries in China, especially heavy industry, were seriously polluting and had poor export sophistication performance. The implementation of the carbon trade pilot market gives enterprises positive incentives, enhances their enthusiasm and ability for innovation, and effectively improves the high-pollution, low-value-added production and export model from a structural perspective [1].

The main trading model of the carbon trade pilot market is to issue a fixed quota for free, and then auction the available carbon emission quota for enterprises. In addition, there are also national certified emission reductions (CCERs) as a supplement to market vitality. Can these really effectively increase the investment in scientific and technological innovation of enterprises? Whether enterprises

will decide to reduce their own costs by improving resource utilization and reducing carbon emission rates through scientific and technological innovation depends on the comparison between the cost of scientific and technological innovation and the marginal emission cost of enterprises. Therefore, this paper will analyze from the perspective of micro-enterprises whether enterprises will improve their own scientific and technological innovation capabilities after the implementation of the carbon trade pilot market policy through empirical analysis. Many previous studies have focused more on the macro impact of carbon trading policies, such as the effect on overall carbon emission reduction. This paper will be an effective supplement to the micro-direct impact of China's carbon trade pilot market trading policy. In addition, it is worth mentioning that different carbon market trading mechanism designs have different incentives for corporate technological innovation. This paper also explains it as a part, and combines it with other contents to put forward some policy opinions on the institutional design and development of China's carbon market.

In general, this paper believes that the implementation of China's carbon trade pilot market has a significant positive impact on the comprehensive technological innovation capabilities of enterprises, and its impact mechanism is diverse. Therefore, this paper will combine the existing literature to prove the argument from the two parts of corporate technological innovation capabilities and green technological innovation capabilities, and use total factor productivity and the number of corporate green patent applications to represent the two capabilities. In addition, this paper will also analyze the intermediary factors separately, that is, what factors other than direct impacts can be used to improve corporate technological innovation capabilities, so as to provide targeted suggestions for policy and market model design.

2. Impact on the Enterprises' Common Technology Innovation

Regarding the impact of environmental regulation on the technological innovation capability of enterprises, there are usually two views: positive impact and negative impact. The positive impact is mainly represented by the "Porter hypothesis", which believes that environmental regulation can produce an "innovation compensation" effect, that is, although the cost of enterprises to meet environmental protection requirements increases, enterprises can improve their own production efficiency through technological innovation and even obtain additional benefits [2]. In contrast, the negative impact emphasizes that environmental regulation strategies such as carbon markets cannot promote enterprises to improve their technological innovation capabilities, but will instead cause enterprises to reduce their production scale.

Therefore, the primary assumption of the relevant research literature is that the pilot carbon trading market has a promoting effect on the technological innovation capabilities of enterprises. Total factor productivity (TFP) is used as the explained variable to represent the level of enterprise technological innovation capabilities. TFP is a comprehensive evaluation indicator of the efficiency of enterprises in utilizing production factors such as labor, capital, and technology, and has a significant direct correlation with enterprise technological innovation [3]. Huang's research first directly mentioned the research on the impact of the pilot carbon trading market on the total factor productivity of enterprises. He emphasized the contradiction between previous studies, that is, there was no clear definition of whether the carbon trade pilot market, an incentive-based environmental regulation, had a positive or negative impact on enterprises. Most of the research was basically a supplement and proof of the conclusions of the "Porter hypothesis". Therefore, Huang et al. used the financial data of Shanghai and Shenzhen A-share listed companies from 2010 to 2020, from the implementation of the carbon trade pilot market to the official release of the carbon market, as the object of empirical analysis, and directly verified the significant positive impact of the carbon trading pilot policy on the total factor productivity of enterprises, and also proved that this positive impact was more significant in areas with low carbon prices [4]. In essence, the proposal of the carbon trade pilot market is to promote high-carbon industries to achieve efficient resource utilization and carbon emission reduction through technological innovation. Therefore, when the carbon trade pilot market in various

regions can continue to operate and maintain its annual expansion, it means that this goal is gradually being achieved. Since previous studies targeted the entire market, in order to further analyze the effect of this policy, some scholars later narrowed the research target scope to enterprises in high-pollution and high-carbon industries. Ye Yu chose to study the impact of environmental regulation on the total factor productivity of heavily polluting enterprises from a more micro perspective. He screened listed companies between 2010 and 2020, defined heavily polluting enterprises using the China Securities Regulatory Commission's statement, and selected enterprises in 14 heavily polluting industries as the experimental group, while other industries were the control group. Through regression analysis, the current environmental regulation method has a significant positive impact on the total factor productivity of heavily polluting industries, especially for non-state-owned enterprises in China and enterprises with higher ESG ratings [3]. In the study of Liu et al., the impact of carbon trading strategies on the total factor productivity of high-carbon enterprises was studied more clearly, and "green total factor productivity" was innovatively introduced to explain the green technology innovation capabilities of enterprises. The article proved through empirical research that carbon trading policies, as positive policy incentives, have a positive impact on enterprises to increase investment in scientific and technological innovation and improve resource utilization efficiency [5].

3. Impact on the Enterprises' Green Technology Innovation

The previous section explained that the carbon trade pilot market has a significant positive impact on the traditional technological innovation capabilities of enterprises. However, the traditional concept of enterprise technological innovation covers many aspects, including technological innovation for the development of new products, technological innovation for expanding sales channels, etc. However, the implementation of the carbon trading market policy is essentially to promote enterprises to improve their green technological innovation capabilities, that is, to improve the utilization rate of resources and reduce environmental pollution through technological innovation. Therefore, the traditional technological innovation capability indicators cannot well describe and analyze the policy effect. Therefore, in order to further verify the implementation effect of China's carbon trade pilot market trading policy, Li et al. proposed that it should emphasize its role in the green production and green technological innovation of enterprises, and use the number of green technology patent applications of enterprises as a representative of green technological innovation capabilities as an explanatory variable and conduct regression analysis. Regression analysis confirms that the carbon trading policy has a significant impact on the green innovation capabilities of heavily polluting enterprises [2]. In addition, this literature also studies the impact of corporate decision-making and government behavior on the green innovation incentive effect of the carbon trading market. For example, as mentioned in Part 2, when facing policy-based environmental regulatory pressure, enterprises will have the choice of avoiding innovation costs and accepting innovation incentives. This depends on the trade-off between different enterprises and factors such as cost and sustainable development. Government behavior as external pressure has a direct relationship with corporate decision-making and the effective performance of the carbon market. In theory, the stricter the implementation of government policies, such as reducing the allocation of free carbon emission quotas and adopting a more stringent and restrictive quota method, the greater the pressure on enterprises to meet policy needs, making it easier for enterprises to increase their investment in green technology innovation to achieve sustainable development plans. In this study, empirical analysis confirmed that carbon trading policies directly encourage enterprises to choose active innovation strategies, and the carbon market in regions with greater external pressure has a more significant effect on improving the green innovation capabilities of enterprises. In summary, the carbon trade pilot market as an incentive-type environmental regulation policy has a significant impact on corporate decision-making preferences. This impact was further analyzed in the study of Shen et al. He defined the process of enterprises weighing the "compliance costs" required for green innovation and the benefits of innovation as "corporate risk-bearing capacity", and used regression analysis to

illustrate that the trial operation of the carbon market can effectively improve the risk-bearing capacity of enterprises and enhance the choice of enterprises to increase innovation investment [6]. In addition, the literature further illustrates that government subsidies have a significant positive impact on the effect of carbon market operation, that is, the funds or policy assistance provided by the government for corporate environmental innovation investment can effectively improve the green technology innovation capabilities of enterprises and the operating efficiency of the carbon market. The role of government behavior in the carbon trade pilot market is further emphasized, indicating that in addition to strict environmental regulatory policies, the government must also take into account policy support such as subsidies to achieve the goal of using carbon quotas and carbon emission rights trading to enhance green innovation capabilities. The above materials have deepened the analysis of the actual effectiveness of the carbon trade pilot market policy in relevant research, and well demonstrated that the carbon market has a positive green innovation incentive effect on the enterprises directly facing it. However, in fact, through industrial chain and inter-enterprise cooperation, policy regulation often forms a significant spillover effect through the inter-enterprise relationship network. Therefore, the impact of the carbon trade pilot market on the green technology innovation capabilities of non-controlled emission enterprises can more comprehensively reflect whether the carbon market has a significant impact on the entire market. In the research of Jiang and Ma, it is also clearly proved that the carbon trading policy has a significant spillover effect between industrial chains. The quantity and quality of green innovation of non-controlled emission partners associated with controlled emission enterprises have been significantly improved after the policy was implemented. This further illustrates the positive effect of the carbon trade pilot market policy, which is not only reflected in the enterprises participating in the market, but almost all enterprises and industries associated with controlled emission enterprises will receive positive green innovation incentives [7]. In addition, in addition to its own spillover green technology innovation incentive effect on non-controlled enterprises, the carbon market also has a synergistic effect with other environmental regulatory policies. Multiple environmental regulations have enhanced the incentive effect of the carbon trade pilot market on corporate green innovation [8]. Although the number of corporate green innovations has increased significantly under the incentive effect, many companies have ignored the quality of their green innovation in order to obtain government funds and tax subsidies. Whether this phenomenon is prevalent also needs to be further studied through empirical analysis to verify whether the carbon market trading policy can meet China's needs for green and high-quality development in corporate technology development and export structure, and to test whether there are obvious problems in the current policy design. In this regard, Li analyzed the green innovation incentive quality of the carbon emission trading policy in his research, and found through regression analysis that the implementation of the carbon trade pilot market has a significant positive incentive effect on high-quality green technology innovation, but has no significant effect on low-quality green technology innovation [9]. So, in general, the operation effect of the carbon trade pilot market in various places is in line with the original design expectations and purposes, and the policy has a significant positive guiding and incentive effect on the overall green technology innovation capabilities of Chinese enterprises. However, the study also found that the policy has different effects on enterprises of different types and regions and different carbon market mechanism designs. Therefore, further research and analysis is needed on the mechanism and policy design of China's carbon trade pilot market so as to improve and enhance it based on its mechanism and give full play to its role in stimulating technological innovation for enterprises, especially emission-controlled enterprises.

4. The Variables Affecting the Motivational Effect of CTPM on Enterprises' Capacity Regarding Technological Innovation

This section will analyze the mechanism that affects the intensity of the carbon trade pilot market's effect on the technological innovation capabilities of enterprises from the perspective of different

variables, comprehensively analyze the mediating variable and moderating variable that affect the incentive process, and analyze the shortcomings of the current carbon trade pilot market based on the impact of each variable and put forward corresponding policy recommendations.

4.1. Mediating Variable

4.1.1. ESG

Environment, Social, Government (ESG) reflects a company's ability to operate and cope with risks in the long term, as well as the social responsibilities it undertakes. Good ESG will enhance the company's reputation and attractiveness to investors. Companies participating in the carbon market often disclose their carbon emission information to the public. Carbon emission information, as an important data that constitutes ESG, is an important evaluation indicator of the company's external image. Therefore, while participating in carbon market transactions, companies will increase their investment in green technology innovation due to the social responsibilities they need to bear and the pressure of considering their external image, thereby improving their ESG performance. In theory, after the ESG is improved, it will be easier for companies to raise funds externally, and their products will receive better positive feedback in the market, so that companies will have a stronger ability to increase their investment in green technology innovation. Based on the mechanism assumptions of the above theory, many new studies have made up for the past deficiencies in the relationship between carbon market policies and ESG and between ESG and green technology innovation capabilities. Some studies have shown that the launch of the carbon trade pilot market has a significant positive improvement on the ESG performance of companies [10]. In addition, studies have confirmed that excellent ESG performance can significantly reduce the difficulty of obtaining funds and the cost of innovation for enterprises, thereby effectively improving the risk resistance of enterprises' green innovation investment, enhancing their willingness to innovate and increasing their investment in innovation [11]. In addition, the above studies have found that the incentive effect of ESG is more efficient in state-owned enterprises and large enterprises. Therefore, in order to improve the policy effect of the carbon market based on this mechanism, in addition to encouraging enterprises to disclose ESG-related information, it is also necessary to strengthen financing assistance for small and medium-sized enterprises, especially for small and medium-sized enterprises with good ESG performance, and non-state-owned enterprises should be given more resources.

4.1.2. Financial performance

Based on the "Porter hypothesis", an effective carbon market will generate effective positive innovation investment incentives for related enterprises, that is, through carbon emission quota restrictions and the cost of excess emissions, enterprises can be effectively forced to improve their resource utilization efficiency and carbon emission reduction effects, and can effectively help enterprises generate innovation benefits through carbon emission rights trading. At the same time, this behavior will also enhance the corporate image, and then its products will also have better performance and competitiveness in the market, thereby improving corporate financial performance and prompting enterprises to continue to invest in green technology innovation. This mechanism has been effectively demonstrated in the empirical analysis of Zhou Chang and his team. The team's research has proved that carbon emission rights trading has a significant effect on improving corporate performance and corporate value. However, this study also shows that the current carbon trade pilot market research cannot directly show that carbon trading policies can promote enterprises to strengthen innovation investment by improving corporate financial performance. This may be because the current carbon trade pilot market is only at the stage of inter-enterprise transactions. In the future, the design and implementation of green carbon financial products directly related to green technology innovation should be strengthened to enhance the actual effect of this theoretical mechanism [12].

4.2. Moderating Variable: Intensity of Environmental Regulation

According to the analysis in Part 3, the intensity of pressure exerted by environmental regulation is the main factor that directly affects the effect of carbon trade pilot market on the green technology innovation capability of enterprises. In fact, existing studies have verified that the greater the pressure of government environmental regulation, the more difficult it is for enterprises to implement technology innovation transformation strategies. In regions with stronger environmental regulation, carbon trade pilot market policies can more effectively encourage heavily polluting enterprises to carry out green technology innovation. The stronger the environmental regulation, the stronger the synergy with the internal environmental protection investment motivation of enterprises for green technology innovation. In Cai and Xu's research, the mechanism of this synergy is also comprehensively analyzed, mainly through external pressure to accelerate the response of enterprises to social public relations, environmental governance and production and manufacturing costs, and effectively change the preference of enterprises to choose green innovation strategies through changes in regulatory intensity [13]. Therefore, in the process of promoting the carbon market, it is necessary to dynamically adjust the intensity of policy implementation, so that enterprises are more willing to improve their own green technology innovation capabilities without making them bear too much burden.

5. Conclusion

This paper systematically discusses that the carbon trade pilot markets in various regions of China have effectively improved the scientific and technological innovation capabilities of enterprises. This positive policy effect is more significant in regions with lower carbon prices in China. For enterprises, the positive innovation incentive effect is more significant for non-state-owned enterprises and heavily polluting enterprises. In terms of the carbon market operation model, first of all, for the problem of the method of allocating carbon emission quotas for enterprises, empirical analysis shows that the using of benchmarking method is more conducive than historic method to function motivational effect of carbon trade pilot market. Secondly, for the financial derivatives of carbon trading market, the current carbon financial products in China's carbon market are not mature, and the overall carbon market service is limited to transactions between enterprises. Therefore, further development is needed to give full play to the innovation incentive effect of carbon market. Finally, for the effective implementation of efficient carbon market in the country in the future, in terms of policy, the government needs to pay attention to some additional factors. For ESG performance, the government can motivate enterprises to improve their ESG performance by increasing rewards and subsidies for enterprises with good ESG performance, and in the process improve their own green technology innovation capabilities. As for the intensity of carbon quota regulation, it is also necessary to improve the accuracy of its intensity design based on data and market performance more rigorously to ensure its mandatory incentive effect on green innovation of enterprises.

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