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A Comparative Review of the Role Mechanisms of Carbon Emissions Trading and Carbon Tax

-- Based on the Carbon Emission Reduction Perspective

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Abstract

This paper starts from the perspective of carbon emission reduction, through the content analysis of the theoretical sources of carbon trading and carbon tax, the role of carbon emission reduction mechanism, as well as the research literature on the effect of carbon emissions of the two to systematically sort out and review, on this basis, on the future of China should be how to effectively utilize the two emission reduction policies, that is, the two synergistic integration mechanism to build up some suggestions.

Keywords

Carbon Trading; Carbon Tax; Comparative Review; Emission Reduction Effect.

1. Introduction

The Paris Agreement was adopted on December 12, 2015 at the 21st United Nations Climate Change Conference (Paris Climate Conference), which requires parties to specify the amount of each country's autonomous contribution to the mitigation of climate change, to ensure that carbon emissions peak as early as possible, and to zero out the net increase in carbon emissions by mid-century.At present, the total amount of greenhouse gases emitted into the atmosphere by countries around the globe is about 51 billion tons per year, which is far beyond what the ecosystem can withstand, so in order to avoid a climate disaster and further deterioration of the ecological environment, human beings need to stop emitting greenhouse gases into the atmosphere. Most developed countries have clearly defined the timetable for carbon neutrality after the realization of peak carbon emissions, such as Finland, which confirmed that it would achieve net-zero emissions by 2035, and Sweden, Austria, Iceland and other countries, which will achieve net-zero emissions by 2045; and the European Union, the United Kingdom, Norway, Canada, Japan and other countries, which have pledged to achieve carbon neutrality by 2050.On September 22, 2020 at the 75th United Nations General Assembly, China officially proposed a "dual carbon" goal. The "dual-carbon" goal refers to China's commitment to achieve carbon peaking by 2030 and carbon neutrality by 2060. The "dual-carbon" goal has a profound domestic and international development background, and is a Chinese commitment based on the development situation of the international community. In terms of domestic development, China has achieved full industrialization over the past decade, and the goal for the next period is to achieve a green transformation of the economic and social development model.The report of the Twentieth Party Congress points out that carbon peaking and carbon neutrality should be actively and steadily promoted. The realization of carbon peaking and carbon neutrality is a broad and profound economic and social systemic change; it is also important to accelerate the green transformation of the development mode. From this, we can see that achieving the "dual-carbon" goal is the key to realizing the green transformation of the development mode, and plays an important role in realizing Chinese-style modernization. Therefore, achieving the "dual-carbon" goal will not only have a far-reaching impact on the global economy and society,

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but also be of great significance to the strategic overall situation of promoting China's high-quality development and comprehensive modernization.

And to realize the carbon emission reduction target, there are two main tools of carbon emission reduction policy, i.e. carbon trading and carbon tax. As two important measures for carbon emission reduction, carbon trading based on total control and carbon tax based on price orientation have their own comparative advantages in terms of emission reduction targets, scope of regulatory coverage, certainty of emission reduction costs and management costs, etc. (Chen Xiangyang, 2022). The question of which of these two policy tools is more effective for carbon emission reduction remains a controversial topic both internationally and domestically. Some scholars believe that a carbon tax is the most effective mechanism for carbon emission reduction, while many countries, including the EU countries, have committed to or are proposing to set a cap on carbon emissions and conduct carbon trading of quotas (He Sha et al., 2023). From the viewpoint of domestic policy implementation, the current carbon emission reduction mechanism in China is more inclined to build a carbon trading market, and the implementation of carbon tax policy has been neglected. China has selected seven provinces and municipalities and regions to start the carbon trading pilot work since 2013, and by 2021, China's unified carbon trading market will be officially launched.In seven years, China's unified carbon market has been successfully built and started to operate, but the mechanism and system of the market and so on are still to be perfected, and the ability to promote reasonable carbon pricing is still to be improved; and in terms of carbon tax, China has not yet begun to implement the carbon tax mechanism.

In this paper, we will analyze the carbon emission reduction effects of carbon pricing policies of carbon trading and carbon tax from the three aspects of theoretical sources, functioning mechanisms and comparison of the two systems.

2. Theoretical Sources

2.1. Theoretical Sources of Carbon Trading

Carbon trading refers to the act of trading the right to emit carbon dioxide as a commodity, the core meaning of which is to "cost" the external environment (Peng Xiaojie et al., 2021). From an economic point of view, the problem of carbon emissions, like other environmental pollution problems, has its origins in the Tragedy of the Commons and Externality (Zhang Xiliang et al., 2021). The Rational Man Hypothesis in economics states that everyone who engages in economic activity is self-interested and seeks to maximize benefits at minimal economic cost (Western economics, 2019). Rational producers in the early market, in order to maximize their own interests, emit greenhouse gases into the environment uncontrollably during the production process and do not have to pay any price, which makes the ecological environment seriously deteriorate and generates negative "externalities". The way to internalize the external diseconomies is to clarify the property rights of resources and use the market to solve the problem of externalities. Based on the Coase Theorem proposed by Coase in 1960 (Coase, R. H., 1960), Dales introduced the idea of property rights in 1968, and proposed the concept of emissions trading for the first time. The concept refers to the following: in carbon trading, let the government fix the pollution emission rights in the market, and then assign the defined property rights to the market participants, that is, the enterprises, and allow them to trade and transfer the power under the market rules, so as to achieve the purpose of using the market optimization to realize the better allocation of resources.

2.2. Theoretical Sources of Carbon Tax

Another way to internalize external diseconomies is to introduce policy interventions that make individual marginal costs equal to social marginal costs through policy instruments such

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as taxes and subsidies (Zhang Xiliang et al., 2021). "Carbon tax", a tax imposed to reduce or control the emission of carbon-containing fuels or carbon dioxide (Tian Guanfeng et al., 2023), is targeted at companies that have used carbon-containing fuels to collect the tax. The theoretical basis for this is derived from the Pigou tax (Pigou, A. C., 1920), which was proposed by the welfare economist Pigou (1920). The Pigou tax argues that emitters should be taxed according to the degree of harm caused by pollution, and that the tax should be used to bridge the gap between the private and social costs of production by emitters. Carbon tax can be said to be the specific practice of Peguy's tax, carbon tax relies on the authority of the government, to play the function of government intervention to mandatory urge enterprises to reduce carbon emissions.

3. Mechanisms for Carbon Trading and Carbon Taxes

The problem of carbon emissions is rooted in "externalities", and carbon market and carbon tax are both market-based carbon emission reduction mechanisms to address the externalities of public goods (carbon emissions) (Xia Fan et al., 2023), and both are effective means for the government to achieve carbon emission reduction through intervention in the market (Chen Xiangyang, 2022). The two have different mechanisms of action in promoting carbon emission reduction.

3.1. Mechanism of Carbon Trading for Carbon Emission Reduction

Carbon trading market is the carbon quota as a commodity in the carbon trading market between the participating subjects. The main participant of the carbon trading market is the enterprise whose annual energy consumption reaches a certain amount, for example, China stipulates that the annual emission of about 26,000 tons is the standard value for enterprises to enter the carbon trading system (Peng Xiaojie, 2021). In the carbon trading market, the government, as the initial allocator of carbon quotas, determines the total amount of carbon quotas in the carbon market and the reasonable amount of carbon quotas to be received by each participant according to the top-down approach, which is the initial amount of carbon emission quotas for the participant. On the basis of the initial amount of carbon allowances, each participating entity starts normal production and operation, using the initial amount of carbon allowances as the upper limit for carbon emissions. In the market, some enterprises have adopted advanced green production technology or improved energy utilization rate, etc., so that before the next carbon quota issuance cycle begins, there is still a surplus of quota; on the contrary, some enterprises are engaged in the industry of particularly large consumption of energy, or energy utilization rate is not high, the level of production technology is low, etc., which produces carbon emissions in excess of the carbon quota, so that the transaction is between the enterprises with a surplus and those with emissions exceeding the limit, and the enterprises with a surplus and those with emissions exceeding the limit. The transaction is then made between the enterprise with a balance and the enterprise with emissions exceeding the standard. Such trading ensures the effective utilization of carbon allowances. Carbon trading market can increase the market price, to encourage the main body of enterprises involved in the transaction to continue to innovate, and actively research and development of clean energy technology and energy efficient use of technology, so as to achieve the goal of carbon emission reduction. Therefore, in the carbon trading market, if the transaction price is lowered under the situation of relying only on the market, the government should adopt some policies to raise the price in a timely manner to ensure that the role of the mechanism is effectively played to ensure the effective realization of carbon emission reduction targets.

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3.2. The Mechanism of Carbon Tax for Carbon Emission Reduction

Carbon tax is a mandatory policy document required by the government to tax fuel products with high carbon content according to the proportion, that is, as long as the enterprise uses the fuel that meets the tax conditions, it needs to pay the tax according to the amount of use. For example, Sweden's carbon tax rate fluctuates within the range of $133-140 per ton of carbon dioxide equivalent, and only drops to $126.78 per ton of carbon dioxide equivalent in 2019 (Bai Wenjun, 2023). The carbon tax was introduced in the hope of reducing carbon dioxide emissions by increasing the cost of fuel use (Tian, Champion, 2023). The basic principle of the functioning of the carbon tax mechanism lies in the fact that the reduction of fossil fuel consumption and carbon dioxide emissions is achieved by taxing fossil fuel products such as gasoline, aviation fuel, and natural gas downstream of coal and oil combustion in proportion to their carbon content. Make the tax equal to the actual external cost of the production activities of enterprises, thus forcing enterprises to consider all economic costs, including environmental pollution, and realize the equilibrium in which the marginal social cost is equal to the marginal social benefit. When enterprises find that the cost of emission reduction is lower than the tax payable, they will choose to reduce emissions spontaneously; when the cost of emission reduction is higher than the tax, paying tax will maximize profits and minimize costs for enterprises, and at this time the tax paid by enterprises can be equal to the marginal cost of emission reduction. In either case, carbon tax can be conducive to the effective realization of carbon emission reduction targets.

4. Comparison of Carbon Trading and Carbon Tax

4.1. Practical Development of Carbon Trading and Carbon Tax

Dales has put forward the concept of carbon trading in 1968, and the theory really put into practice can be traced back to the United Nations Framework Convention on Climate Change (UNFCCC) adopted by the United Nations Environment Assembly in June 1992, which is the official source document for the emergence of the carbon trading market. 1997, the United Nations drew up the Kyoto Protocol on the basis of the United Nations Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol established three flexible cooperation mechanisms aimed at reducing greenhouse gases - the international emissions trading mechanism (ET), the joint implementation mechanism (JI), and the carbon tax. The Kyoto Protocol established three flexible cooperation mechanisms aimed at reducing greenhouse gas emissions - the International Emissions Trading (ET) mechanism, the Joint Implementation (JI) mechanism, and the Clean Development Mechanism (CDM) (Introduction to the Kyoto Protocol NPCIC: 2009). 2004 saw the successful registration of the world's first CDM project, and since then, many countries have begun to use CDM projects to generate income from carbon trading. Many countries began to use the Certified Emission Reductions (CERs) generated by CDM projects to offset the carbon quota surrender, which in fact creates cross-border trading of carbon emission rights. (Chen, 2022) In 2005, the European Union established the first real sense of regional carbon emissions trading system (European Union Emissions Trading System, or EU-ETS), which adopts the "on-line-trading" model under the control of total carbon emissions, and allows countries to trade carbon emissions on a cross-border basis. "Up to now, there are 32 carbon emissions trading systems in the world, including 9 carbon emissions trading systems at the national level, 1 carbon emissions trading system at the regional level, and 22 carbon emissions trading systems at the level of national administrative divisions (Peng Yun et al., 2022). There are five relatively mature carbon markets in the world, namely the European Union Emissions Trading System (EU-ETS), the New Zealand Carbon Market (NZ-ETS), the Regional Greenhouse Gas Emission Reduction Initiative (RGGI), the U.S. California Cap-and-Trade Mechanism, and the South Korean Carbon Market (K-ETS).Since the

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development of the market in 2005, the carbon market system has been developed in a relatively mature manner, with the EU Carbon Taking the EU carbon emissions trading system as an example, its development has gone through a gradual process of "test-construction-improvement-normalization", and after the test phase, it has gradually stepped into the development phase of system construction and system reform, and has gradually matured. It has provided reference for countries around the world to build carbon trading markets, and has also provided a system and institutional basis for the construction and operation of the global carbon trading system.

The history of "carbon tax" is only more than 30 years, and the Nordic countries are the earliest practitioners of carbon tax system (Tian, 2023). 1990, Finland imposed carbon tax for the first time in the world, and then Norway and Sweden quickly introduced it, and Denmark followed the pace of the successful implementation of "carbon tax" in 1992, followed by Switzerland and other European countries. Denmark followed suit and successfully implemented the "carbon tax" in 1992, and then Switzerland and other European countries introduced the tax one after another. With the advancement of international agreements and the achievement of international consensus, not only developed countries, but also some developing countries have joined the ranks of the introduction of carbon tax. 2019 June, after years of multi-party coordination, South Africa's "Carbon Tax Act" successfully entered into force, which makes South Africa the first country in Africa to introduce a carbon tax; Singapore will also levy a carbon tax from 2019, becoming the first country in Southeast Asia to introduce a carbon tax. Singapore is also the first country in Southeast Asia to introduce a carbon tax from 2019. As of May 2021, there are 35 carbon tax regimes implemented globally, and the collection programs involve 27 countries and 8 regions across Europe, North America, Africa and Asia (Chen Xudong et al., 2022). Moreover, most of the countries that have introduced carbon tax have adopted carbon tax as an independent tax. Although the development practice of carbon tax is relatively short, in some countries (such as Sweden, Norway and other Nordic countries) has developed a complete set of carbon tax system that integrates well with other mechanisms.

The carbon tax mechanism has not yet begun to be implemented in China, but there are already many scholars who have conducted research on whether and when to start the carbon tax in China (Hu Yuan, Yang Yutao; Wang Qin, 2023; Wen Zhichao, 2020; Fu Zhihua, 2018), as well as how China should start the carbon tax mechanism (Wang Xi, 2023; Xiao Qiang, 2023), and these studies have provided some useful theoretical framework foundations for China's future introduction of carbon tax provides some useful theoretical framework foundations.

4.2. Emission Reduction Effect Literature Organizing Research

Scholars at home and abroad have conducted a large number of studies on how the implementation of carbon trading policies will affect carbon emission reduction efforts. (Calel et al., 2016) found that the European Emissions Trading System (EU-ETS) can effectively promote low-carbon technological innovation in pilot enterprises, thereby promoting the realization of carbon emission reduction targets. (Zhu J M. 2019) and other scholars proposed that the carbon emissions trading mechanism reduces the carbon emissions of different industries, and the regulated industries in the pilot areas reduce carbon emissions by 15.5% and energy consumption by 22. 8% compared with non-pilot areas (HU.Y.C, 2020). (ZHANG.W et al., 2020) found that the carbon emissions trading mechanism can increase the total industrial output value by 13.6% and significantly reduce the industrial carbon emissions by 24.2%. (GAO.Y.N et al., 2020), based on the input-output tables of 28 industries in 30 provinces, also concluded that the carbon emissions trading mechanism is conducive to the emission reduction of pilot regions and industries, and that the effect of carbon emission reduction based on the production side is better than that based on the consumption side.(Lu Min et al., 2022) concluded that the carbon emissions trading mechanism reduced the emissions of carbon

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dioxide and environmental pollutants in the pilot provinces. (Zhang Caijiang et al., 2021) found that the implementation of the carbon emissions trading policy in the pilot areas has obvious carbon emissions mitigation effects; (Fan Qiufang, 2021) pointed out that the implementation of the carbon emissions trading policy is conducive to accelerating the achievement of carbon emission reduction targets, and the longer the policy is implemented, the more prominent the emission reduction effect. (Ye Fangyu et al., 2022) argued that the carbon emissions trading policy significantly reduces CO2 emissions and the concentration of air pollutants, showing the phenomenon of synergistic development of pollution reduction and carbon reduction, mainly through the promotion of enterprises to carry out green technological innovation and the transfer of polluting industries to complete the carbon emissions reduction, and that the carbon emissions reduction effect of the carbon emissions trading policy is more obvious in the high level of industrialized industries and large-scale cities.The implementation of carbon emissions trading policies can effectively promote end-of-pipe, clean production and energy-saving green technology innovation in manufacturing enterprises. Wang Yong and Zhao Han (2019) found that the establishment of carbon market has an enhancing effect on carbon emission efficiency. (Liu Chuanming et al., 2019) used the synthetic control method to study the emission reduction effect of the policy from the national level, and found that the carbon trading policy brings obvious carbon emission reduction effect, but there are regional differences. (Lu Min et al., 2018) used trend analysis and gray prediction modeling to find that the carbon trading mechanism can effectively reduce the indirect carbon emission intensity of the industrial sector in Shanghai, but the impact on direct carbon emissions is small. (Xue Fei, 2021) confirmed the existence of carbon emission reduction effect and synergistic emission reduction effect of carbon trading market scale, the expansion of carbon trading market scale is not only conducive to reducing carbon emissions in the pilot area, and in realizing carbon emission reduction at the same time can play a synergistic emission reduction effect to reduce sulfur dioxide emissions. In summary, the carbon emissions trading system can accelerate the realization of carbon emission reduction goals, mainly through the carbon emission reduction effect and synergistic emission reduction effect, to promote the participation of carbon market trading enterprises to carry out green technological innovation and the transfer of polluting industries to complete the carbon emission reduction, carbon trading through the promotion of industrial low-carbon transformation, and improve the energy structure of the realization of carbon emission reduction, but the role of the improvement of energy efficiency is limited.

In the study of the effect of carbon tax on carbon emission reduction, (Nordhaus, 2006) systematically constructed a computable general equilibrium model (CGE model) with the United States as an example, and confirmed that the negative impacts of carbon tax and emission reduction policies on the overall macro-economy and the industry level are weaker than the emission reduction policies of the carbon trading market to varying degrees. Compared with carbon trading, carbon tax also has the advantages of tax neutrality and welfare effects, and the realization of the goal of "double dividend". (Pearce, 1991) formally put forward the concept of "double dividend" of carbon tax for the first time. (Goulder, 1995) distinguished between "weak double dividend" and "strong double dividend". The imposition of carbon tax can not only reduce the demand for energy products from the perspective of product price increase, but also promote the research and development and use of low-carbon clean energy, with a double emission reduction effect (Liu Lei, 2019). (Lu et al.2010) studied the impact of the introduction of carbon tax on China's environment and economy using the CGE dynamic model, and found that the introduction of carbon tax can play a huge role in emission reduction, while the negative impact on the economy is relatively small. (Lee et al. 2018) studied the "efficiency dividend" of Japan's carbon tax in various paths from the perspective of "tax neutrality", and the results show that, under the condition of maintaining a certain amount of fiscal revenue, the carbon tax replaces part of the consumption tax, which can increase the

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income of residents and households, and is conducive to stimulating economic growth, and is a good way to realize the goal of achieving economic growth. The results show that, under the condition of maintaining a certain amount of fiscal revenue, the carbon tax replacing part of the consumption tax can increase residents' household income, which is conducive to stimulating economic growth and the best way to realize the "efficiency dividend". Some scholars have explored the effect of carbon tax on energy saving and emission reduction in different countries or industries and its influence on enterprises' decision-making on emission reduction (Arcila, 2022; Hou et al., 2022).(Shuwei Zhang, 2011) By constructing a general equilibrium CSGM model, the simulation scenario shows that carbon tax has little impact on economic growth, but can effectively improve the energy structure of the power sector. (Liu, Haiying, 2023) argues that the carbon emission reduction mechanism of carbon trading and carbon tax is different. Carbon trading policy can reduce carbon emissions through low-carbon transformation of industrial structure and improvement of energy consumption structure, but it does not play a significant role in promoting the improvement of energy efficiency. Carbon tax is to achieve carbon emission reduction by improving energy structure and energy efficiency, and it has no obvious role in promoting the transformation of industrial low-carbonization. In the early and middle stages of realizing the goal of "double carbon", carbon tax is a very good tax source, which not only has low cost but also can raise funds well, can promote the progress of carbon reduction technology, realize marginal cost carbon emission reduction, and has the natural advantages of realizing the goal of "double carbon" (Zhang Li et al. Some scholars believe that there are many negative impacts of the carbon tax system, such as (Gao Pengfei, 2002) found that the carbon tax will lead to a large loss of gross domestic product (GDP); there is a tax rate that has the best emission reduction effect. (Linqing et al., 2010) believe that under the low-carbon international order, carbon tax and other will make carbon benefits outflow, leading to deterioration of the terms of trade, and bring substantial damage to economic development. (Zhao, 2011) argues that if OECD member countries impose carbon tax, it will prevent carbon-intensive industries from participating in international competition and cause economic losses. (Zhou Hai, 2018) argues that the introduction of a carbon tax will make the residents' income, employment, consumption and savings are on a downward trend, which in turn affects the distribution of income, leading to the widening of the income gap, and the overall trauma to the economy is relatively large. In summary, the tax neutrality and double benefits of the carbon tax can reduce the difficulty of the implementation of the carbon tax system in the early stage to a certain extent, and the carbon tax can improve the structure of energy consumption and energy efficiency by promoting the development of low-carbon production technology and low-carbon energy technology, so as to effectively achieve the goal of carbon emission reduction. Although the carbon tax also has related disadvantages, but overall the advantages outweigh the disadvantages.

Comparative research on the effectiveness of the two policy instruments has also been done by many previous researchers, (Chen Xiangyang, 2023) there are differences in terms of emission reduction effect, cost and fairness, etc. Strand (2013) takes the actual trading situation of the carbon market as the background, compares the carbon emissions trading policy and the carbon tax of fossil energy importing countries, and finds that the two policies have an emission reduction effect and will form a special offsetting mechanism. (Qiu Lei 2013) conducts a normative study on carbon tax and carbon emissions trading mechanism based on economic efficiency, and compares the incentive effects of the two carbon emission reduction policies on the basis of analyzing the role mechanisms of the two policies, concluding that the carbon emissions trading mechanism is superior to the carbon tax system from the perspective of incentive effects alone. (Wang Jingan 2013) analyzes and compares the costs, effects, feasibility and incentives of the carbon market and carbon tax, and concludes that the carbon market has a greater effect on emission reduction. (Liu Shuangliu et al. 2022) argues that the carbon

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emissions trading system has relatively clear emission reduction effects and relatively small implementation resistance, while the carbon tax has relatively low implementation costs and is relatively more fair, while the carbon tax revenue has a double dividend effect.

5. Conclusion and Recommendations

Carbon emissions trading and carbon tax have different theoretical foundations and mechanisms. Carbon tax is based on the "polluter pays principle" advocated by the theory of environmental economics, which is a government-led redistributive "indirect" emission reduction mechanism, while carbon emissions trading is based on the "beneficiary pays principle" advocated by the theory of ecological economics, which is a mechanism to promote emission reduction through positive incentives. "Carbon emissions trading is based on the "beneficiary pays principle" advocated by the theory of ecological economics, which is a mechanism to promote emissions reduction through positive incentives. Comprehensive previous research shows that although carbon trading system and carbon tax system have their own advantages and disadvantages, both of them can effectively promote the realization of carbon emission reduction target.

As to how to improve the carbon trading mechanism and carbon tax mechanism in the future, previous researchers have made some research results. For example, (Liu Yuan,2023) believes that diversified carbon emissions trading policies should be implemented to promote green technological innovation of manufacturing enterprises. (Shi Xueying, 2018; Wang Shijin and Yang Lin, 2023) analyzed the penalty mechanism of default in carbon trading market, and believed that a "combined" penalty model should be implemented to strictly enforce the default liability in carbon emissions trading. (Chen, 2022) puts forward five suggestions for the development of China's carbon market: accelerating the construction of the carbon emissions data system, promoting the introduction of rules for non-compliant organizations and individuals, introducing carbon financial derivatives, introducing a stabilization mechanism for the national carbon market, and researching cross-border connectivity solutions for the carbon market. (Liu Kui et al., 2022) believe that it is necessary to further expand the coverage of carbon emissions trading system by industry and the scope of trading subjects, so as to give full play to the emission reduction effect of carbon trading policy, thus promoting the smooth realization of the "dual carbon" goal. There are still a lot of controversies. (Zhang Bao, 2023) analyzes the theoretical basis for the introduction of carbon tax in terms of whether the tax is an independent tax or an integrated tax, and whether the carbon tax is positioned as a general tax or a specific-purpose tax. (Hu Yuan, 2023) proposes that carbon dioxide should be included in the scope of environmental protection tax, and clarifies the elements of carbon tax system based on the three basic principles of tax law, tax fairness and tax efficiency. (Xiao Qiang et al., 2023) summarizes the inspiration of foreign practical experience to China, combines with China's actuality and puts forward the path of carbon tax in China, which should follow the principles of gradual and differentiation, and scientifically design the elements of carbon tax system.

There are also many scholars who believe that China should adopt a combination of carbon trading mechanism and carbon tax mechanism to formulate and implement policies in the future. (Zhang Zet al.2017) evaluated and analyzed the implementation effect of single carbon tax and combined carbon emission reduction policy by constructing a global CGE model, and found that the emission reduction effect of combined carbon emission reduction policy is better. (Xia Fan,2023) Drawing on the experience of coordinated linkage of the international carbon market and carbon tax, it puts forward the design ideas and institutional arrangements for the coordinated development of China's carbon market and carbon tax. (Chen Xiangyang, 2022) points out that carbon trading and carbon tax are not two parallel lines, they can be integrated

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and used, coordinated with each other, and the complementary role of the two can better achieve the goal of carbon emission reduction, and the integration mechanism of carbon tax and carbon trading mechanism is constructed. (Liu Shuangliu et al., 2022) argues that carbon tax and carbon trading, as two important means of carbon emission reduction policy, are not simple substitutes, but can complement each other, taking into account the fairness and efficiency of emission reduction. And it puts forward suggestions for synergistic application of carbon tax and carbon emissions trading system in terms of establishing a perfect coordination mechanism between the systems, adapting the implementation of the system to the economic and social development, dealing with the relationship between carbon tax and other taxes, and improving the method of allocation of quotas and coverage of the carbon market. (Fu et al., 2018) Based on the reality of the national situation and the actual needs of carbon emission reduction, it is believed that at the present stage and in the coming period, the parallel and comprehensive application of the two policy instruments of carbon trading and carbon tax should be considered in an integrated manner, and a carbon tax should be introduced at an opportune time while carbon trading is further improved.

This paper argues that in the future, China should try to establish a perfect coordination mechanism between the systems; and strengthen the convergence of the regulatory scope and intensity of the carbon tax and carbon emissions trading. (1) Different carbon emission reduction systems can be applied according to the carbon emission reduction potential of enterprises, with the carbon emission trading system mainly applied to large carbon emitters and the carbon tax system mainly applied to small and micro enterprises. In order to avoid the phenomenon of "double taxation", consideration can be given to setting up a mechanism for the mutual conversion of carbon tax and carbon emission right trading, allowing enterprises to convert carbon emission right trading fees into carbon tax in accordance with the prescribed proportion, and the carbon tax borne by enterprises can also be converted into carbon emission right trading fees in accordance with the prescribed proportion. (2) Consideration can be given to levying a carbon tax on all enterprises, with a lower tax rate for enterprises participating in the carbon emissions trading system. The carbon trading price formed in the carbon market is volatile, and there may also be a carbon market failure, i.e., the carbon trading price in the carbon market is too low to play a regulating role, for which China can learn from the practice of developed countries such as the United Kingdom and stabilize the carbon trading price through carbon tax.

China's carbon trading market is in the early stage of establishment, although the national unified carbon market has been established in 2021, but there are large research gaps in the top-level design and micro level of the unified market; and China has not yet begun to implement the carbon tax system, so the practice of the carbon tax system in China and how to effectively integrate it with the carbon trading system will be the focus of future research.

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