

Research on the Theory and Development of Carbon Emissions Trading Market under the Background of 'Double Carbon'

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Abstract—In recent years, China's carbon trading market has achieved good emission reduction results but it is not yet perfect. Carbon trading mechanisms are facing huge challenges. Through the analysis of the current industry carbon trading market, the problems existing affecting the process of the carbon emission trading market are deeply discussed, providing a methodology for the regional carbon trading mechanism and the implementation of the national macro carbon emission reduction targets. It puts forward three challenges to carbon trading market cognition, carbon trading subject and carbon emission reduction technology, to contribute to achieving carbon peak, carbon neutralization.

1. INTRODUCTION

The greenhouse effect has become a hot topic of global concern. In order to achieve the goal of global temperature control, the carbon trading market came into being. The carbon marketed mechanism controls the carbon emission capacity of various industries by quotas of the industry. At the same time, companies can trade their excess carbon emissions by reducing emissions, increase low-carbon investment, and reduce social emission reduction costs. In September 2020, China proposed a plan to achieve carbon peak by 2030 and achieve carbon neutrality by 2060. China's economy has developed rapidly, among which electricity has a wide coverage and high utilization rate. As the main industry of China's carbon market, it covers 1700 enterprises, and carbon emissions account for 1 / 3 of the country. As a key industry of carbon emission from China, the power industry plays an important role in the carbon emission trading market. The power generation industry will be the first included in China's carbon emission trading pilot, take power as a breakthrough point, expand market entities, improve the trading system, enrich the trading varieties and trading methods, and make contributions to the realization of the great vision of double carbon.

2. CARBON EMISSION TRADING SYSTEM

The main process of the carbon trading mechanism are that the government first determines the total amount of carbon emission rights required by each subject. After that, each subject can trade excess carbon emission rights through emission reduction, thus promoting greenhouse gas emission reduction [1]. Carbon emission trading can effectively push the flow of carbon emission rights

among the main bodies, so that the main bodies with lower emission reduction costs give priority to emission reduction and increase carbon technology investment, reduce the cost of achieving the dual carbon target and increase the power of emission reduction. This paper will analyze the existing carbon trading mechanism from the sett of total carbon emissions, industry scope and the allocation of initial carbon emissions.

2.1 Setting of the total amount of carbon emission rights

The sett of the total amount of carbon emission rights is not only an important part of the carbon trading mechanism, but also the first step to achieve global temperature rises control [2]. van et al. [3] simulated the relationship between greenhouse gas concentration and global average temperature rise by constructing a transient climate response model TCR (Transient Climate Response), thus providing ideas for sett the total amount of carbon emission right. But due to the variety of greenhouse gases and the large differences between regions, the generalization of the model is low. The ' Paris Agreement ' sets long-term global temperature control targets, and its ' bottom-up ' nationally owned NDCs targets improve the implementation of global temperature control targets [4]. However, due to the different specific conditions of each country and the different types of targets proposed, there are huge differences in many aspects of emission reduction [5]. Therefore, regional differences and emission reduction targets make the accounting and sett of total carbon emissions uncertain [6].

Economic development is another important factor of sett the total amount of carbon emissions [7] , for example, China 's commitment to reach the carbon peak in 2023 ; carbon emission intensity decreased by about 65 % compared with 2005. Based on this goal, the study found

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that carbon emissions are affected by China 's economy [8]. At present, China 's total carbon emissions are not clear, so the economy will become one of the important factors affecting China 's total carbon emissions.

2.2Determination of the industry coverage scope

The industry scope is the main body participating in the carbon emission trading market, and the determination of the industry coverage has a great impact on China's carbon trading market. The pilot carbon emission trading projects in our provinces are shown in Table 1. How to improve the efficiency of carbon trading mechanism by defining the scope of carbon trading industry, so as to improve the efficiency of carbon trading mechanism,

balance its system and trading costs, has become an important link [9] in formation of carbon trading market. Gradually expanding the industry scope of the carbon trading market is the main way to achieve the goal of "double carbon". Expand the industry scope and enrich the trading varieties and methods of the industry, but its transaction costs will also increase, triggering the contradiction between carbon trading costs and interests. Integrating all industries in the carbon emission trading market will produce a waste of resources. How to choose the scope of the carbon emission trading industry is closely related to the effect of emission reduction. Energy-intensive industries are the primary industries in carbon emission trading, such as power, coal, combustion, steel and other industries.

TABLE I. SCOPE OF PILOT REGIONAL CARBON EMISSION TRADING INDUSTRIES

region	start time	Major industries
Beijing	On November 28th, 2013	Thermal power generation, thermal production, cement, petrochemical, etc
Shanghai	On November 26th, 2013	Electric power, iron and steel, petrochemical, chemical industry, non-ferrous metals, building materials, textile, rubber, chemical fiber, etc
Tianjin	On December 26th, 2013	Electric power, heat, petrochemical, steel, chemical industry, oil and gas exploitation
Shenzhen	On June 18th, 2013	Electric power, large public buildings, public institutions, state government construction, industrial enterprises, public transportation
Guangdong	On December 19th, 2013	The first batch of electric power, chemical fiber, medicine, paper making and other enterprises
Hubei	On April 2nd, 2014	Electric power, metallurgy, chemical industry, building materials, food and beverage, petroleum, automobile, chemical fiber, medicine, paper making, etc
Chongqing	On June 19th, 2014	Electric power, steel, non-ferrous metal smelting, building materials, chemical industry, aviation industry, etc
Fujian	On December 22nd, 2016	Electric power, petrochemical, building materials, steel, non-ferrous, paper, aviation, ceramic industry

Industry coverage according to the scale of carbon emissions or industry carbon reduction strength, but industry coverage is limited, some restricted by the carbon trading market industry will be transferred to unrestricted industry production, makes the effectiveness of carbon trading reduced [10], therefore, need to develop risk mechanism in advance, industry trade intensity is one of the important indicators of carbon leakage, the stronger the trade intensity, the higher the foreign dependence. Therefore, On the basis of the establishment of the carbon trading market, we should both limit the scope of the industry and minimize the cost of carbon emission reduction [11], because the carbon emission and emission reduction cost are different in all walks of life, in order to achieve the dual carbon target as soon as possible, Starting from the cost of carbon reduction and takes the marginal contribution of industry carbon reduction cost as the standard that provides new ideas for dividing carbon emission trading industries.

2.3Distribution of the initial carbon emission rights

The sett of the initial carbon emission right is not only an important link to promote carbon emission reduction, but also an effective means related to the future economic development of [12]. There are many questions about how

to determine the distribution of regional and industrial carbon emissions rights. The existing schemes are based on both current regional emissions levels and historical emissions allocation schemes, such as grandfather allocation schemes, historical responsibility schemes, payment capacity schemes and population size schemes. The grandfather allocation scheme is also known as the historical emission scheme, and its allocation principle is a new round of carbon emission right allocation based on the proportion of historical emissions from the region. The grandfather distribution scheme can effectively maintain the production and economic development of the region, but the long-term use of the program will reduce the carbon emission reduction power in the region and restrict the economic development. The historical responsibility scheme is based on historical cumulative carbon emissions. The regions with high historical cumulative carbon emissions will obtain less carbon emission rights, which provides a new idea for the regional and regional distribution of carbon emission rights from economic and social development opportunities, but ignores the actual carbon emission demand [13] of current production and operation activities. The ability to pay to approach prioritizes economically developed regions to lead carbon reduction plans, but the cost is relatively high. The population scale schemes to distributes the initial carbon emission rights based on the proportion of the population

of the region, which reflects the per capital carbon emission rights, but does not consider the technological and economic scale [14] between regions. In general, using different ways of distribution will reduce the benefits of some regions, how to balance the regional carbon emission right to promote international carbon reduction as a key [15], in general, on the basis of different distribution scheme, considering the advantages of each scheme, establish a comprehensive index of regional carbon emission distribution, can be more comprehensive consideration between the regional economy, resources and environment, to avoid the disadvantages of single carbon emission distribution, thus improve the feasibility of carbon emission right distribution [16]. In addition, how to determine the quota of carbon emission right is also a difficulty in carbon emission right. Fang Kai et al. [17] distributes carbon emission weights through information entropy value distribution and statistical methods. The regional allocation index of information entropy method is related to the weight coefficient of the distribution index, so the weight coefficient is high. Although the information entropy method is a relatively objective weight allocation method, but the considerations are single. The grandfather distribution scheme based on historical carbon emissions has become an important method of carbon emission rights distribution. [18]. This scheme aims to distribute carbon emission rights through the proportion of carbon emissions in the industry over the years, but the method ignores the sustainable development of the economy and reduces the deep emission reduction.

In order to more effective use of limited carbon emissions, Hjalsted [19] using industry total output valued carbon emission distribution, but to economic output distribution carbon emissions will make the economic output of high industry get more carbon emissions mismatch, carbon emission reduction efficiency is reduced, therefore, on the basis of economic output value need to consider the structure of production factors of industry. In order to solve the problem of carbon emission mismatch and improve the effectiveness of carbon emission righted distribution, the benchmarking method [21] has formulated the inter-industry carbon emission intensity standard on the basis of the economic output value of the industry. Reasonable distribution of carbon emission rights is one of the important ways to achieve carbon emission reduction. A scientific and reasonable carbon emission rights distribution scheme can not only achieve regional carbon emission reduction, but also promote regional economic development. At present, the research of carbon trading mechanism in various ranges and industries still needs further research.

3. CURRENT STATUS OF CARBON TRADING MARKET SIMULATION

Through the simulation study of carbon trading market, the applicability of carbon emission trading mechanism to each subject can be tested. After each subject obtains the initial carbon emission rights, the remaining carbon emission right can be traded with each subject, so as to

encourage the carbon emission reduction cost among each subject. Marginal carbon reduction cost estimation will become an important part of the carbon trading simulation market.

3.1 Marginal carbon reduction cost estimate

Marginal carbon reduction cost valuation determines the effectiveness of carbon emission reduction, and is an important evaluation indicator of the carbon trading market. The marginal carbon reduction cost estimation reflects the difficulty of carbon reduction, but it is negatively related to its historical carbon reduction actions. The higher the marginal cost of carbon reduction, the less the potential of carbon reduction. The difference in marginal carbon reduction costs between trading entities will affect the effectiveness of the carbon trading mechanism, [22]. Its methods mainly include emission reduction emission technical expert evaluation method, production theory estimation method, energy model estimation method and proxy index method [23]. The expert evaluation method core is to use technology to evaluate the carbon emission reduction and operating costs of different emission reduction technologies, and rank the emission reduction cost according to drawing the marginal emission reduction curve [24] of the trading subject. This method can briefly represent the relationship between marginal emission reduction cost and carbon emissions, but this method independently evaluates different carbon emission reduction technologies, ignores the correlation between various technologies, and may appear the repeated calculation of carbon emission reduction cost, making the estimation results not accurate enough.

Based on the energy model estimation method, it analyzes the impact of the physical production and operation activities on the whole macro economy, which includes the computable general equilibrium model and the comprehensive evaluation model. It is a calculation method [25,26] that can be used for analysis and simulation. Compared with the evaluation method of carbon emission reduction technical experts, the energy evaluation model has the advantage of considering different carbon emission reduction technologies as a whole, and solves the problem of weak cost calculation of carbon emission reduction. In addition, the energy models estimation method can capture the impact of external factors on carbon emission reduction costs by connecting different aspects, such as society, economy, and resources. However, due to its assessment perspective scope is larger, it is relatively difficult to refine between different carbon emission reduction technologies, cannot determine the law between carbon emissions and the cost of [27], and based on the computable general equilibrium and comprehensive evaluation model need to assume the many parameters, so greatly reduces the accuracy of the estimation [28].

The typical method of production theory estimation method is the output distance function method, by calculating the distance function value to estimate the emission reduction cost, its advantage is that the method

of data requirements is relatively low [29], because the method will be expected output and unexpected output are considered in the model, so can through the not expected output "shadow price" researched carbon emissions performance. Among them, the Shepherd distance function method can change the total output value in the process and carbon emissions in the adjustment process, while the directional distance function method introduces the directional vector. Although the distance function method can estimate the cost of subject marginal carbon reduction from a macro perspective, the method method has quite different results from the reality because it ignores the impact of market conditions on the results [30].

Compared with other methods, the cost estimation process of the proxy index method is simple. Zhou et al. [31] takes the operating cost of carbon reduction of each subject as the proxy index of its marginal carbon reduction. The related investments and operations of Clean Development (CDM) can be used as important indicators of cost estimation by proxy index method. However, in recent years, the transaction price of CDM has been reduced. If CDM is continuously used as an indicator, it may cause the accuracy of carbon reduction cost to reduce, and the "top-down" construction method has high requirements on the basic data of the subject. Fang Kai et al. [32] estimating the marginal cost by the potential economic loss of carbon emission reduction can effectively solve the shortage of basic data.

3.2 Simulation method of carbon trading market

The carbon trading market is gradually becoming mature, and the existing carbon trading simulation methods are mainly the computable general equilibrium model (CGE) and the planning model. The CGE model describes the coordinated interaction mechanism, describes the combined influence of policy intervention and market price, introduces the alternative possibility and non-linear relationship, and the calculation and processing are relatively simple. This method is one of the main methods of the existing carbon trading market simulation in China, and Yu et al. [33] explored the total regional carbon emission from the CGE model. Qian et al. [34] used the CGE model to develop an inter-regional initial carbon emission righted allocation plan. However, the CGE model is very sensitive to the initial conditions. If the data is missing, it will limit the application of the CGE model. If the long-term application to the carbon trading market, it will cause inaccurate results.

The planning model method constrains the carbon emission trading through the local equilibrium method, targeting the minimum regional carbon emission cost, and restricting the total carbon emission of the region. Zhou et al. [35] analyzed the planning model for using the relationship between the initial carbon emission righted allocation scheme and carbon emission reduction among Chinese provinces during the 11th Five-Year Plan period. The [36] of Chang et al. estimated the control of the total carbon emission rights in the region using a planning model. Cui et al. [37] was also determined by planning the scope of the model carbon emission trading industry. It

can be seen that compared with the CEG model, the planning model focuses on the trading subject, carbon emission reduction and trading strategy, which has low data requirements and is relatively simple.

4. CONCLUSIONS

In order to achieve the "double carbon" goal as soon as possible, promote the high emission industry to achieve low carbon. Advocating a green and low-carbon lifestyle, China also faces many challenges in the future. First of all, most enterprises lack of understanding of carbon trading market, lack of knowledge, and the policy orientation is not clear, market prospects not open carbon green industrial structure and energy consumption prospects, enterprise participation is insufficient, carbon trading activity is low, unable to form an effective carbon trading price, low carbon trading price is not conducive to regional low carbon technology investment and energy structure transformation, will lead to lower carbon reduction efficiency, affect the "double carbon" target. Secondly, there are few main participants in carbon trading in China and the domestic pilot carbon market is single. Due to the limitation of theory and practice, the industry coverage of carbon trading mechanism is far from its original design intention, and the development is not balanced. China also needs to actively study and organize the carbon trading market, increase the proportion of non-carbon energy sources, and make it become an important driving force for national rejuvenation. Finally, China's carbon emission reduction technology is not yet perfect, which needs to rely on technological innovation to support the energy supply system of the new power system.

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