Progress and Prospect of Personal Carbon Trading

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Keywords: Personal carbon trading, Research status, Private car, Internet of things.

Abstract. With the improvement of living standards, the influence of the consumption of carbon emissions is increasingly obvious. In the industrial upgrading and transformation of the developed countries, the household consumption has become the main source of carbon emissions. Simply studying on carbon trading from the upstream areas of production can’t meet the requirements of future carbon emission reduction. It is necessary to study PCT. This paper introduces carbon trading research status of upstream production area, emphatically discusses the concept, feasibility and mechanism of PCT, and proposes to estimate and trade carbon emissions on private car sources, which occupies a larger proportion of the household consumption, based on the technology of the internet of things. In short, the research on PCT is a trend in the future, with some theoretical and application value.

Introduction

With the global warming and energy depletion, the world has reached a consensus to establish the development of low-carbon economy strategy. China, as carbon emissions country and signed developing countries in the Framework Convention, also actively develop low-carbon economy, and strive to reduce carbon dioxide emissions. In 2009, on the eve of United Nations Climate Conference, Chinese government has announced the reduction of its carbon emissions per unit of GDP by 40-45% from the 2005 levels by 2020. Response to global emission reduction pressure and practical needs of national development, as one of the important means, carbon trading is part of the efforts to promote the development of carbon emission reduction for China in the future, which is imperative.

The concept of carbon emissions trading originated from the UNFCCC and the Kyoto Protocol. As the new path of the greenhouse gas emissions reduction with carbon dioxide as its representative, market mechanism treated the carbon dioxide emissions as a kind of commodity by the Kyoto Protocol in 1997, resulting in the formation of the carbon dioxide emissions trading, referred to as carbon trading. Subsequently carbon trading market has grown hugely. According to the analysis of 2014 global carbon trading market development report, the total trade volume of global carbon market transactions was about 104.2 million tons, with the total amount about 54.9 billion dollars. The political economy of carbon market is positive, which has enabled the formation of a political coalition and businesses to ‘profit’ model in response to climate change; a cycle of investments, profits and growth centered on the market that may help processes of decarbonization can be imagined for investors (Matthew Paterson, 2012)[1]. In a word, as a result of the interests of political and commercial investment, carbon market as a means of policy will be more flourished, and have a certain positive effect to the reduction of greenhouse gas emissions.

Carbon Trading of Upstream Production Area

With the change of economic development mode and adjustment of industrial pattern, the pattern of carbon emissions from different fields is also constantly adjusted. From the beginning of the design to
the implementation of carbon trading, the world and the organization has focused on the upstream production areas, researched how to discharge, and achieved certain results. Specific content includes the following 3 parts.

System Aspects

First of all, the research focus on the system aspects, that is the origin, status quo and characteristics of carbon trading system. At present, there are many studies on the EU system, the American system and the Japanese system, while the other systems are less. The content of the research is mostly consistent, which the majority is about the summary of the characteristics, and the less is about the analysis of the defects. On the deficiency, the EU-ETS is not perfect at the operational level[2]. Free distribution formed low efficiency in a large degree. In the actual operation of the EU-ETS, due to the excessive quota, the imbalanced relation to quota between the supply and demand in market suppressed the price, thus, it completely failed to limit emissions of the mind. Secondly, the EU-ETS does not include other greenhouse gases except carbon dioxide. The greenhouse effect such as methane and nitrous oxide are more obvious. The Chicago Climate Exchange (CCX) exists in name only, while the Regional Greenhouse Gas Initiative (RGGI) has dispersion and poor integrity[3].

Elements

Secondly, the research focus on the elements, involving the emission’s distribution, the transaction’s price and the legal mechanism. The main distribution methods include the free distribution of grandfather method (EU-ETS), auction law (RGGI), to buy at a fixed price (Australia) and hybrid method (New Zealand). There are no the optimal allocation method suitable for any place due to the difference of each methods. Liu Guanchen (2012) combed the carbon emissions trading price in Europe and the United State according to the three developing periods[4]. He Ying (2012) believed that China’s current carbon trading regulation policy should be changed to policy based canonical form, determine the basic framework of the legal regulation of carbon emissions trading, fit the voluntary transactions into the object of regulation in the mandatory legislation form, improve the relevant supporting policies and legal system, and promote the development of the carbon trading[5].

Function of Marketization

Thirdly, the research focus on how to commercialize. The development of the State Council made a clear recommendation of the carbon market system. Pang Jinju (2012) pointed out that the pricing mechanism of the carbon trading market needed to implement the effect of the combination of the market mechanism and the role of government. Carbon finance orientation not only refered to a variety of financial transactions on greenhouse gas emissions reduction targets, but also included investment and financing of low carbon development project, financial support of carbon emission reduction technology, the green credit banks and other related financial activities[6]. He Mengshu (2011) carried on research based on the financial perspective of China's carbon emissions initial distribution and pricing, and proposed the introduction of the option to the initial allocation[7]. In addition, the domestic scholars derived from the new concept—carbon trading volume documents, based on the analysis of the foreign carbon trading, such as Chen Demin (2012) proposed carbon ticket concept in carbon trading market construction of Chongqing City[8].

Overall, the current research on the global trading system focus on the summary of historical induction, and fewer people make comprehensive comparison of various trading system, rarely concerning about actual operation effect and the failure reason of the transaction system. However, with the improvement of living standards, the impact of household carbon emissions is becoming increasingly apparent. In the industrial upgrading and transformation of the developed countries, household carbon emissions has become the main source of carbon emissions. Thus, the research of the carbon trading gradually derives from the perspective, that is, from the perspective of downstream consumer areas - who discharges, and conducts research about personal carbon trading (PCT).
**Personal Carbon Trading**

**Concept**

PCT is a broad concept that contains a range of specific policy objectives. Its main characteristic is: everyone can obtain free distribution to carbon emissions quota, main sources of carbon emissions from household energy use and private car traffic, the carbon quota can be exchanged, and the amount of carbon emissions can be in the yearly progressive decrease with the national carbon emissions reduction. The individual distribution of carbon allowances can achieve large-scale emission reduction. In addition, there are other similar concepts such as personal carbon allowance (PCA), tradable energy quotas (TEQs), cap and share (C&S) programs etc.

**Feasibility**

Whether personal carbon trading is feasible, from the government level, the main consideration is social acceptance and the cost of implementation. Due to the fairness and efficiency, from the concept of PCT and policy basis, the public will be more willing to accept carbon trading, in line with the experimental results. Due to the complexity of its problem and the docking with the existing policy, its operating costs are undoubtedly huge to realize PCT. Lane (2008) estimated the PCT costs of implementation, and the results showed that the costs were much larger than other policies. However, PCT was still at the beginning stage, so the cost was very uncertain. Bird (2009) analyzed the research of Lane, and found that the results of the study were much more moisture, and the cost was much lower[9]. Anyhow, no matter the real cost, compared to other major policy instruments, the PCT cost is still relatively high. Therefore, it is necessary to offer a new technique in the realization of PCT, to reduce the costs of implementation.

**Mechanism**

To build a trading mechanism, we must consider transactions mode, platform, accounting system, etc.. When PTA, DTQs, PCA was proposed, it had been involved in the transaction mechanism of PCT, with the right to trade or discharge by who or the amount. The carbon quota can be traded like merchandise to consumers in the carbon market. Low emission consumers can sell excess carbon quotas to increase income, while high emission consumers can pay for additional emissions to compensate for the lack of carbon credits. Li Jian (2014) designed three aspects of the carbon trading framework from the carbon budget, the transaction scope and control project, and carbon quota initial distribution, and proposed carbon currency model[10]. Yang Liping (2011) analyzed the reasons of the carbon consumption externalities through establishment of the utility model of carbon consumption, and discussed two optional governance methods[11]. Zhang Yuhua (2013) quantified the initial personal carbon emissions right by the inverse analysis method, and defined the personal carbon credit as well as its financial and commercial value. On the basis of the concept of ‘carbon credits’ and ‘carbon sink’, ‘silver carbon’ concept was designed, binding the RMB and carbon silver. The policy and recommendations on building a national carbon credit trading system such as internationalization of RMB-denominated process were further promoted[12].

Anyway, PCT is a carbon trading mechanism based on energy demand side management, which is the extension to downstream consumer level from ‘cap and trade’ mechanism, and a complement to the carbon trading mechanism of upstream producers. Moreover, the consumer has a larger choice of carbon emissions, so as to be more conducive to the maximization of the personal utility. And current mitigation mechanism is mainly for the upstream manufacturer perspective to solve the the problem of ‘how to discharge’, in the lack of solution to the problem of ‘who can discharge’ from the downstream consumer perspective, resulting in the lack of consumer emission reduction power. But through PCT, fitting carbon emissions, namely the environmental costs of consumption activities into the economic accounting system, and establishing the mechanisms for emission reduction at the source, can be incentive means of effective strategies for the personal carbon emissions reduction in theory.
Carbon Emissions Trading of Private Cars

At present, the research of PCT mainly focuses on the theoretical exploration stage, with less empirical experience. If the PCT is implemented, the amount of carbon emissions should be effectively measured as a basis, laying the foundation for the demonstration. At present, personal carbon emissions are mainly composed of households’ and private cars’, with bigger part of private car emissions. Due to the mature monitoring equipment of water, electricity and other household energy based on the internet of things, collect its consumption directly, so as to calculate its carbon emissions. But no carbon emissions measurement equipment for private cars can be found in the current market. At the same time, taking the haze problem into account seriously, private car ownership is one of the reasons for its formation. In particular, some well-off families have more than 2 private cars. These families generally have a long mileage, and have more carbon emissions, but the limited license and other compulsory measures have no effect on this kind of situation, and there is no means to limit its carbon emissions. Therefore, it will be difficult in realizing the carbon emissions trading all at present. But install a real-time monitoring in personal private car OBD interface through the internet of things technology, collect real-time information of private car about fuel consumption and location, upload monitoring center, calculate the carbon emissions per person according to the carbon emissions calculation method, thus provide private car carbon emissions data for PCT. As can be known, the carbon emissions trading of private cars has a certain executable. This method can change the behavior of human consumption, let the human improve the way to get along with nature from the heart, so as to achieve low-carbon economy.

Key Issues

How to calculate the carbon emissions of the vehicle: the choice of carbon emissions calculation method, and how to build a precise algorithm according to per vehicle carbon emissions data from DC.

How to construct the vehicle carbon emissions trading mechanism. Study the initial carbon emissions quota for each vehicle. Analyse the traders (the buyer is the individuals or units with vehicles, while the seller is the management mechanism issued ‘carbon credits’, the market maker and individuals or units with excess ‘carbon credits’), study the carbon trading process of market mechanism, that is, seven step transaction specific detailed rules as follows, determine the seller to submit their applications, audit, the buyer to submit an application to sell the quota, make the settlement of transaction, supervise, and implement punishment with inspection. Thus the carbon emissions of the vehicle can be reduced, without influence of people’s normal life.

How to achieve the real transaction. Study on carbon emissions and carbon currency conversion mode, the RMB currency and carbon trading price, how to implement the exchange, settlement and all require further development.

Outlook

From the operational feasibility of the method, the measurement can be selected:

Discharge coefficient method: the carbon emissions of private cars can be calculated according to the actual consumption of fossil fuels and the corresponding CO$_2$ emission coefficients:

$$E_{\text{personal travel}} = \sum_m (\text{Fuel}_m \times \text{CO}_2\text{Coefficient}_m)$$

where, $E_{\text{personal travel}}$ represents annual carbon emissions of private cars (tCO$_2$); Fuel$_m$ represents annual consumption of the M fossil fuel (t); CO$_2$Coefficient$_m$ represents CO$_2$ emission coefficient of the M fossil fuel; m represents fossil fuels (gasoline, diesel, natural gas). The combination of emission coefficient and carbon footprint model is estimated by empirical calculation.

Development of carbon emissions trading system for private cars. Based on internet of things technology, collect vehicle information of OBD interface in the private car through each sensor, design wireless data transmission mechanism and host computer software, achieve the rapid
exchange of vehicle data, return the private car consumption of real-time transmission back to the server, and transform into CO\textsubscript{2} emissions through calculating formula, laying the foundation for the realization of the private car carbon trading.

**Conclusion**

With the world climate issues, the development of low-carbon economy has become the consensus of the world, and carbon emissions trading is the only way to lead low-carbon economy development. This paper summarizes the research status of carbon trading from the perspective of ‘how to discharge’ and ‘who discharge’. In the process of combing, it’s discovered that PCT is still in the theoretical discussion stage, and the implementation of real PCT requires a long period of time, with the challenges and problems still need more experts and scholars to study. In short, control carbon emissions from the downstream consumer level and achieve the long-term development of low-carbon economy, that is, PCT is also very important.

**Acknowledgement**

This research was financially supported by the Zhejiang provincial public welfare technology application and research project of China under grant 2016C33038.

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