



# A STUDY ON INDIVIDUAL CARBON TRADING MECHANISM BASED ON CARBON REDUCTION BONUS IN THE CONTEXT OF CHINA'S MOTOR VEHICLE RESTRICTION POLICY

## Environmental Science

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## ABSTRACT

In the context of the development of China's carbon emissions trading market, research into individual-based carbon trading markets is gradually gaining momentum. But due to the diversity of individual carbon emissions and the difficulty of quantifying them, there are many challenges to realising a personal carbon trading market, and China has yet to develop a complete personal carbon trading system. Therefore, based on Beijing's tail number restriction policy, this paper designs a personal carbon trading market mechanism based on the carbon emissions generated by car use as a commodity, with a focus on trading mechanisms, and supported by incentive systems, regulatory systems and compensation systems. With the help of the "carbon reduction red envelope" trading platform to achieve the participation of two main bodies, multi-benefit. The changes in carbon emissions under different scenarios are also analysed, and some of the conditions for the operation of the personal carbon trading mechanism proposed in this paper are calculated. The individual carbon trading mechanism proposed in this paper, solves the inconvenience caused by the license plate restriction policy to Chinese people, promotes the flexible and systematic development of urban management, and provides ideas for the development of China's individual carbon trading market.

## KEYWORDS

mechanism research, number restriction policy, personal carbon trading market.

## INTRODUCTION

As the global air pollution situation becomes more and more severe, different countries are experiencing different degrees of pollution. In China, the explosive growth in the number of private cars has brought the problem of traffic pollution to the fore. In order to reduce pollutant emissions from motor vehicles, some Chinese provinces and cities have implemented traffic management measures to restrict tail numbers one after another. The policy has to some extent alleviated vehicle exhaust pollution and achieved a certain level of emission reduction, but the many inconveniences caused to the public may become a source of stimulation for people to buy non-first vehicles, thus allowing the emission reduction effect to rebound, among other things, contrary to the concept of green development in China. Figure 1 Personal Carbon Trading Process. Among the measures taken by countries to tackle the pollution problem, the emergence of the carbon trading market has attracted particular attention. 16 July 2021 saw the opening of China's carbon emissions trading market, marking the further development of China in terms of carbon emissions trading, but there are still problems such as an uneven level of development and a single development sector, and a complete trading system has not yet been formed for individual carbon trading. Many domestic scholars have also tried to study the construction of personal carbon trading market from different angles, including personal carbon trading for private cars, carbon tax policy, household carbon budget, carbon coin model, etc.

Based on the above, this paper designs a personal carbon trading mechanism based on Beijing's motor vehicle tail number restriction policy to alleviate the inconvenience caused by the restriction policy to the public while ensuring the same emission reduction effect, promote the development of flexible and systematic urban management, and provide ideas for the development of China's carbon market in terms of personal trading.

## MECHANISTIC ANALYSIS

In this paper, in the background of Beijing's tail number restriction policy, combined with Beijing's "I voluntarily drive less one day a week" campaign, under the supervision of relevant government departments, the owners of vehicles with restricted numbers and unlimited numbers are treated as trading subjects, the carbon reduction generated by parking as a trading commodity, and the provision of a regulatory platform to assist in trading, establishing a two-object trading and multi-party benefit road traffic personal carbon trading in the context of the three major. The basic structure of the market mechanism is shown in Figure.

During the effective period of the management measures related to the tail number restriction in Beijing, the owner of a car with a restricted number can voluntarily drive for one day less and become a seller, selling the right to drive for that day to the platform to receive a reward (red packet A); the owner of a car with a restricted number who wants to drive can check the relevant information on the platform, and if there is a spare driving right, he can become a buyer and buy the driving right from the platform with a red packet to drive without penalty. Once the transaction is successful, there are three main destinations for the red packets paid by the buyer. Of these, Red Packet 1 is used as a reward for the transaction, i.e. Red Packet B received by the seller; Red Packet 2 is stored as the platform's reward fund for the seller's reward for selling driving rights, i.e. Red Packet A received by the seller; and Red Packet 3 is donated to public welfare organisations as public welfare savings.

The platform is a multi-functional trading venue based on the Traffic Management 12123 APP developed by the Institute of Traffic Management Science of the Ministry of Public Security, and is envisaged to be an auxiliary applet of the Traffic Management 12123 APP. The platform will be able to display "commodity" information (i.e. the right to drive) and combine it with the functions of the Traffic Management 12123 App, such as recording information on violations, to achieve the new function of exempting penalties for successful transactions. The Beijing government's transport department is responsible for overseeing the entire carbon trading market process.

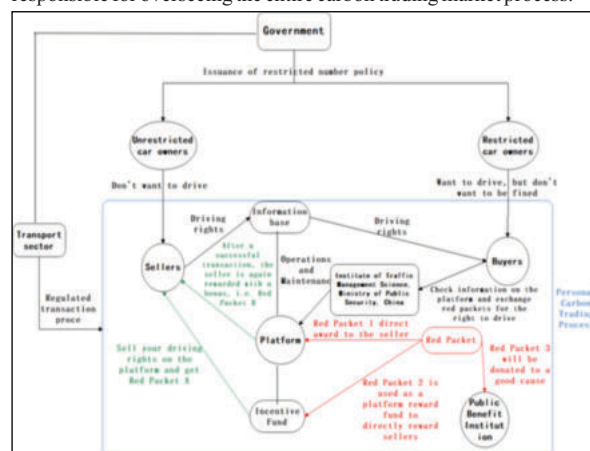


Figure 1: Personal Carbon Trading Process

## MECHANISM DESIGN

According to the mechanism and the actual situation, the main part of the mechanism is designed in this paper with the trading system as the focus and the incentive system, supervision system and compensation system as the supporting system.

### • Trading System

#### 1. The main body of the transaction

The traffic control department mainly acts as the supervisor of the transaction mechanism, responsible for supervising the whole transaction process, etc. All vehicle owners can act as the two sides of the transaction for reasonable transactions.

#### 2. Platform function elaboration

The trading platform is embedded in the "Traffic Control 12123" APP in the form of a small program, which realises the trading function, supervision function and information query function. The information enquiry function is used to inquire about the information of power release, etc.; the transaction function is used for the payment and reward of red packets by opening relevant payment and collection windows. The supervision function includes the supervision of non-restricted car owners' trading objects, and the revocation of the violation information of restricted car owners with successful transactions.

#### 3. Transaction rules

The main constraints are imposed on the behaviour of multiple parties in the transaction process. Supply and demand are regulated through rules such as setting the number of releases, trading caps and reasonable trading prices to avoid a rebound in overall carbon emissions. Secondly, the problem of different types of cars having different times due to the restriction is solved by taking the intersection time period through the driving time. By imposing penalties for non-compliance, the binding force and feasibility of the system is improved. The seller of the transaction is determined by random lottery and no personal information of the parties to the transaction is revealed.

### • Incentive system

The formation of driving rights in the trading mechanism is based on the carbon reduction resulting from voluntary parking by non-restricted vehicle owners. As voluntary parking is uncertain and spontaneous, a series of incentives are needed to effectively stimulate voluntary parking by non-restricted vehicle owners to ensure the supply of driving rights.

The incentive system takes non-restricted car owners as the main incentive target, and the government and relevant transportation departments as the incentive provider, with the aim of reducing carbon emissions and benefiting the public. The incentive form is mainly in the form of red packet rewards, supplemented by intangible incentives such as honorary titles and point accumulation.

### • Regulatory System

In order to ensure fair and equitable trading, a sound regulatory system is needed to supervise to manage the carbon trading process and to ensure that the operating results of the trading mechanism can meet the expected objectives.

The traffic control department as the main supervisor, will use the trading platform to supervise the wrong operation, uploading false information and other irregularities in the trading process, and at the same time combine with offline daily patrols to investigate the irregular driving behaviour of the supervised party.

### • Compensation System

As a public welfare project, this mechanism rewards emission reduction in the form of red packets, which requires a certain amount of financial guarantee. Therefore, the development of a compensation system for the carbon reduction bonus reduces the risk of trading due to the lack of funds to a certain extent.

The compensation is mainly aimed at owners of vehicles with unlimited numbers. As the regulator of the trading process, the Beijing Traffic Management Department is also the responsible party for the compensation system, responsible for implementing the compensation system, communicating and negotiating with all parties, etc. The compensation mechanism is mainly funded by a draw on the

transaction amount, support from relevant national policies, corporate donations, etc.

## KEY POINTS OF IMPLEMENTATION

The operation of the mechanism requires special attention to the following aspects. The first is the consultation with the government and other departments. The first is consultation across government. Seeking authorisation from Traffic Management Research Institute of the Ministry of Public Security and Beijing Municipal Commission of Development and Reform regarding the copyright of the platform design is a difficult point for the smooth implementation of the mechanism. The second is to seek cooperation with domestic public welfare projects to ensure that the route of the buyer's red packet donations for public welfare projects is achieved. The third is to design a reasonable and effective program to promote the personal carbon trading market. The fourth is the maintenance and upgrading of the platform and the improvement of the regulatory system.

## ANALYSIS OF DEMAND SCENARIOS

The implementation of the personal carbon trading market needs to be in line with the requirements of the current national energy saving and emission reduction policies. In order to ensure that overall carbon emissions do not increase after implementation, the market mechanism is analysed in three scenarios based on other policy activities such as Beijing's traffic restrictions.

### Scenario 1: No restriction on the number of vehicles.

For reference, the one-way commuting time in Beijing is about 47 minutes, the number of motor vehicles is 6.57 million, and the weekday trip rate is about 70%, i.e. 4.599 million mobile commuting motor vehicles on weekdays, of which about 3.4818 million are private vehicles. It is known that one hour of motor vehicle travel emits 2.33kg of carbon, so assuming that the number of weekday commuter private car trips is 2 per day. in 100 days, the carbon emissions from motor vehicles in Beijing are approximately

$$C1=100*459.9*2*47/60*2.33*10000=1678788.3 \text{ (ton)}$$

Without the implementation of the restriction policy, Beijing's motor vehicle carbon emissions are large and tend to cause pollution to the environment. In addition, the high number of motor vehicles in Beijing also tends to cause traffic congestion.

### Scenario 2: Implementation of a number restriction policy.

With the implementation of the number restriction policy, approximately 20% of vehicles are restricted, i.e. approximately 3,679,200 weekday commuting vehicles. in 100 days, Beijing's motor vehicle carbon emissions are

$$C2=100*367.92*2*47/60*2.33*10000=1343030.64 \text{ (ton)}$$

$$\Delta C=C1-C2=335757.66 \text{ (ton)}$$

$$\text{Carbon emission reduction rate} = 335757.66/1678788.3 = 20.00\%$$

The above calculation shows that the implementation of the restriction policy has resulted in a significant reduction in overall carbon emissions. However, the test restriction policy will also cause a lot of inconvenience to the public.

### Scenario 3: Individual carbon trading market mechanism based on the restricted number policy.

In order to implement the principles of the carbon trading market in depth and to implement the requirements of the dual carbon target, the personal carbon trading mechanism proposed in this paper needs to ensure that overall carbon emissions do not rise after implementation. In the trading process, assume that the number of driving rights generated by non-restricted car owners is  $m1$ , the number of driving rights sold by non-restricted car owners is  $m2$ , and the actual number of rights released in the market is  $m2 = m1/a$  (one)

Imagine that the number of car owners who want to buy driving rights is  $t$ .

If supply is greater than demand, i.e.  $m2 > t$ , carbon emissions are:

$$C4=C2-2*47/60*2.33*(m1-t)$$

When supply equals demand, i.e.  $m2=t$ , carbon emissions are:

$$C4=C2-2*47/60*2.33*(m1-m2)$$

$$=C2-2*47/60*2.33*m1*(1-a).$$

Therefore, to ensure that overall carbon emissions do not rise after the implementation of individual carbon trading markets, i.e.  $C_4 \leq C_2$ , when supply is greater than demand:

$$C_2 - 2 \cdot 47 / 60 \cdot 2.33 \cdot (m_1 - t) \leq C_2, \text{ solving for } m_1 \geq t.$$

When supply is less than demand:

$$C_2 - 2 \cdot 47 / 60 \cdot 2.33 \cdot m_1 \cdot (1 - a) \leq C_2, \text{ solving for } a \leq 1.$$

Combined with the rules of Beijing's carbon reduction bonus campaign, the number of non-restricted car owners participating in the personal carbon trading market within 100 days of the number restriction is about 6,300, and the amount of carbon emission reduction generated is about 1,800 tons, then it can be roughly estimated that the driving rights generated by non-restricted car owners are about:  $m_1 = 1800 \cdot 1000 / 2.33 / 24 = 3.22$  (million)

According to Beijing's restricted number policy, approximately 1,134,000 cars are restricted during the restricted number dates, and based on a 70% travel rate, it can be estimated that approximately 919,800 car owners are travel demanders. Further considering the effect of the release ratio  $a \leq 1$  on the actual number of releases, it can be seen that the demand for driving rights in the carbon trading market is very large.

In summary, ensuring that overall carbon emissions do not rise is a prerequisite for the introduction of personal carbon trading, and the main factor affecting the good functioning of the personal trading market is the number of non-restricted car owners participating. Therefore, the key to the establishment of the mechanism is to increase the participation of non-restricted vehicle owners and to call on the general public to join the cause of energy saving and emission reduction.

## CONCLUSION

The study of personal carbon trading mechanisms has become a topic of concern for many scholars, and it is particularly important to choose the entry point for the construction of the mechanism. In this paper, we have chosen a very representative transportation consumption sector in China as the entry point, and combined it with Beijing's tail number restriction policy to build a personal carbon trading mechanism with vehicle exercise rights as the core, which is important for solving the inconvenience of personal car use under the number restriction policy, controlling the increase of vehicle ownership, regulating urban traffic management, accelerating the integration of green low-carbon and digital information, and reducing carbon emissions. However, the operational mechanism discussed in the paper has certain limitations, and the related pricing design needs further research.

## Acknowledgment

This research was supported by the Fundamental Research Funds for the Central Universities 2018MS092

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