Analysis on Externality of Traffic Jams in Beijing--Based on Supply-demand Equilibrium

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Abstract: Since entering the 21st century, the problem of traffic congestion in Beijing is increasingly outstanding. It is subject to a greater impact of people's daily life, and the resulting social loss. Recently, it carry out a large number of measures of traffic congestion in Beijng, but the current traffic situation is still not optimistic. At first, this paper analyzes the status of traffic congestion in the city of Beijing, the Beijing Municipal Bureau of Transportation Statistics introduced general situation of the Beijing municipal traffic and was aware of the grim situation of congestion, and then we analysis to explore the negative externality of traffic congestion from the ecological effects, social effects, and let you more intuitive see traffic congestion bringing negative impact through a series of analysis, causing the reader enough attention. And then, the paper puts forward some suggestions on the following two aspects: supply and demand.

1 Introduction

Traffic congestion is the most outstanding performance of the negative externalities of urban road traffic, which is characterized by the negative effects of time delay, energy waste, air pollution and emotional impact. These will have a bad impact on the entire market economy. Beijing, in recent years, has taken the increase of road supply, new parking facilities and encryption of traffic line layout control measures, but the effect is not obvious, urban traffic congestion is increasingly serious. Therefore, it is necessary for us to conduct in-depth analysis of the root cause of Beijing traffic congestion, also seek the reason and harm of traffic congestion in theory and practice. Base on supply and demand, we seek to eliminate the negative externality of traffic congestion.

2 theoretical analysis of the causes of the negative externality of traffic congestion

2.1 basic theoretical analysis of traffic congestion. Supply and demand are the basic theory in western economics, the supply and demand imbalance will cause social resources idle or excessive use. And for the traffic congestion phenomenon, produced the most basic reason is traffic market between supply and demand imbalance. Here we analyze the phenomenon of the fundamental.
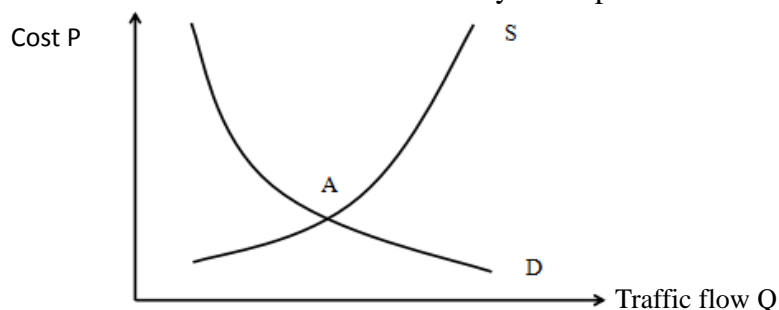

Fig. 1 traffic supply and demand equilibrium point

In the equilibrium point A, supply and demand balance, at this time whether the supplier or the demand side has reached the most appropriate point in this condition, so as to achieve the maximization of social benefits. When the road is lower than the price of the road, the traffic demand will be more than the supply, that is, the phenomenon of insufficient supply result in traffic congestion. When the road is higher than the price of the point, there will be an excess supply resulting in a waste of social resources [1].

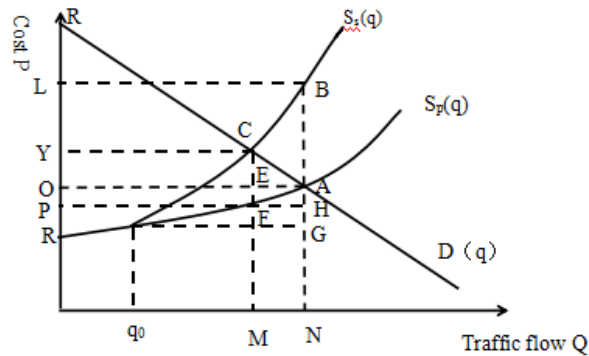## 2.2 from the demand side analysis of the reasons for the formation of traffic congestion

Fig. 2 the loss of social welfare caused by traffic congestion

D (q) represents the demand curve of the drivers on the road, the horizontal axis represents the road usage, the vertical axis represents the each driving road 1 km journey would be willing to pay price. In reality, the road usage can be measured in terms of car kilometers, and the price of the road refers to the maximum price of the driver on the actual fuel consumption costs and time costs are willing to pay [2]. It is assumed that the demand function is linear:

$D(q) = a - bq$

(1)Based on the theme of this paper, we should consider two aspects of supply and demand aside. S_p (q) represent individual consumers to use the road private cost curve. It can satisfy the requirement of the following conditions: when q is fewer vehicles on the road, when the road traffic volume is less than the threshold value of Q_0, so driving speed of the driver is very fast, there is no congestion.

Assume that S_s (q) represents the social cost function of a large number of consumers using the road. When the road usage is low for Q_0, the social cost curve is coincident with the private cost curve. Obviously, from the chart above, when the drivers consider the cost of the whole society and their own needs, the best use of private roads will be more than the whole society to use the optimal amount of road, the road congestion is inevitable.

3 quantitative analysis of the negative externalities of traffic congestion

This chapter is the focus of this paper, how much negative impact of traffic congestion of the capital in the end? What is the reason that is affected the residents to travel and to be late for work? From the ecological environment, economic losses, this chapter further quantify the impact of traffic congestion in Beijing.

3.1 harmful gas pollution costs. Motor vehicle emission pollution has become one of the main sources of air pollution in Beijing, in the air of Beijing motor vehicle emissions is CO_2, NO_x , PM10, PM2.5. In 2015, the carbon dioxide emissions in Beijing is 71200 tons, NO_x emissions is 137600 tons, the amount is very hugeIn this paper, we use the protection expenditure evaluation method to estimate the ecological value loss caused by the pollution and congestion:

Daily harmful gas pollution loss = traffic congestion at the time of the additional emissions of harmful gases x unit harmful gas transaction costs

Meanwhile, harmful gas unit cost on the basis of the existing transaction price is determined as follows: nitrogen oxides treatment cost 6000 yuan per ton (refer to Shanxi Province for the first time in nitrogen oxide emissions trading auction Starting price), dust clean-up costs 150 yuan per ton (refer to the forest ecosystem service function evaluation of social public data table), sulfur dioxide governance cost 2500 yuan per ton[3] (2010 June 5, Shanxi Province of emission rights trading center of emission rights auction Starting price).

Fig. 3 location distribution of traffic pollution monitoring point

Five traffic pollution detection point in Beijing, as shown in the figure, traffic pollution monitoring point results show that traffic environment the annual average concentration of PM2.5 was 90.5 mg / cubic meters and higher than the city average of 12.3%；annual average nitrogen dioxide concentration was 75.3 mg / cubic meters and higher than the city average of 50.6%. The distribution of inhaled particles in Beijing is shown below.
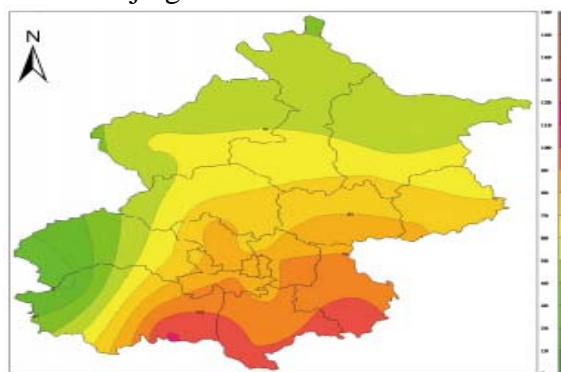

Fig .4 the spatial distribution of fine particles (PM2.5) in air

It can be seen from the figure, Beijing is more serious of being inhaled particle pollution, of the above shown in Beijing, near the suburbs of atmospheric PM10 and PM2.5 source apportionment show that containing road dust, the dust pollution source is the main pollution source of the atmospheric PMl0 and PM2.5, PM10 emissions accounted for 39.5%. In the proportion of dust concentration, the proportion of traffic dust accounted for 65%. In short, motor vehicle emissions related air pollution index of nitrogen dioxide and respirable particulate are beyond the national standard in Beijing.

3.2 noise pollution. Traffic congestion can also lead to noise pollution, in the congestion, drivers will be more frequent on the horn or restart the car, increasing noise in the area of congestion. There are a large number of residential areas near the traffic trunk, which greatly affects the daily rest and daily life of residents, resulting in a more intense reaction. Road traffic noise in the city's built-up area is 69.2 dB (a). The number of road traffic noise in the built-up area of the district is from 63.5 to 72 dB (a). Among them, the average of road traffic noise of six districts of the city built area was 69.9 decibel(a), the noise average of outer suburb district built area of road traffic was 67.2 dB (a). According to the management of noise pollution in China, the above dB are more than the suitable range of human body.

4 traffic congestion management countermeasures

4.1 based on the relationship between supply and demand of the slow blocking strategy. From the perspective of economics, the main reasons of traffic jams is traffic demand and road resources of unreasonable use, therefore, we can develop easing traffic congestion strategy from the two aspects of traffic supply and traffic demand. Specially, management staff, strengthen management, and maximum efficiency using existing road traffic resources can reduce traffic congestion.
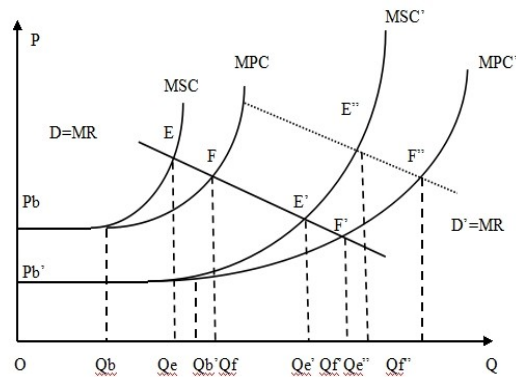
Fig. 5 supply demand of traffic resources

4.1.1 the supply management of easing traffic congestion. New expansion, reconstruction of the road car park and other facilities are the main means of transportation supply management, included the construction of urban light rail and subway. In order to meet the increasing traffic demand and ease traffic congestion, we are detailed in Figure 5. MR is the marginal revenue curve of traffic demand during the peak period, MSC is marginal cost curve when the road is not expanded, and the capacity is Qb. After the expansion, the traffic capacity of the road network has greatly improved, traffic capacity of the road expanded from Qb to Qb '. According to the change of MC, an optimal traffic flow rose from the Qe to Qe '. Obviously, increasing traffic supply can alleviate the pressure of traffic jam effectively. We can also try to change the supply mode of transport to supply more efficient. In order to improve the traffic supply capacity, we can change the mode of traffic supply. There is carrying on the market reform in all area in China, the way of supply is no exception, only though the market reform, it can be more efficient.

4.1.2 the demand management of easing traffic congestion. The new road, or the increase in the supply of roads, can not change the situation of traffic congestion. Because the new road will form a smooth flow of the phenomenon, which will attract people to increase demand. In this way, after a period of time, the new road traffic congestion levels will return to the situation before. As shown in the figure, Qf increases to Qf '. And the practice also proved that only increasing the traffic supply is unable to alleviate the traffic jam radically, we must analyze from two aspects of supply and demand. If you start from the traffic demand, you can use the way to charge a congestion fee to link traffic congestion.

4.2 measures to alleviate traffic congestion on the basis of supply

4.2.1 ITS technical means to solve the congestion problem. Intelligent transportation systems (Intelligent Transportation System (ITS) is the lack of a comprehensive utilization of electronic, information, sensor and other means of science and technology and the development of information, intelligence socialization new traffic management system. Traffic signal control system, 110 alarm the police system, traffic electronic toll collection system, dynamic link query subsystem and so on, the application of the system can reduce the number of traffic congestion in large extent. For example, the electronic toll system (Toll Collection Electronic, referred to as ETC) collect fees on the high-speed moving vehicles and do not have to stop the car. Currently, China's high-speed ETC system has basically achieved the national network, covering 29 provinces. It is estimated that China's ETC fuel savings of about 65 million liters and saving benefits of about 430 million yuan. Though dynamic link query system, the traffic control department implement the effective management scheme, travelers can choose the optimal travel route, effectively slowing the traffic congestion[5].

4.2.2 to speed up the construction of urban infrastructure and to improve the road network structure. In recent years, Beijing city has invested a lot of energy to improve the infrastructure of transportation, and cost a lot of manpower, material resources and financial resources. Good results have been achieved. But the intensity of infrastructure construction is not very good to ease traffic congestion and is still the cause of the increase in the number of motor vehicles, but also with the Beijing road network structure is not perfect. We should further rationalize the institutional mechanisms to strengthen overall planning, improving the road network structure and enhancing the

overall level of transportation infrastructure. So we are concerned about the construction of infrastructure, but also to improve the structure of the road network in Beijing, to make it more suitable for the division of urban functional areas of Beijing, and the specific needs of people travel. Only using two pronged approach, we can solve the traffic congestion problem.

4.3 measures to alleviate traffic congestion on the basis of demand. Public goods are not exclusive and not competitive characteristics, each individual hope of public goods is used to maximize their own interests. At this time for the whole society will not be able to achieve maximum benefits, as above analysis, will cause the loss of part of the society. And this part of the way can solve the specific property rights and charges.

And for the transportation, the construction and use of any road traffic are to pay a huge cost, but road traffic or often only consider using their own road gasoline, car consumption and time cost, this negative impact caused by the whole society to ignore. Then the congestion charge is one of the effective ways to solve this problem.

Congestion pricing is aimed at the most congested areas through the fee or tax and other economic levers, so as to achieve transportation efficiency and environmentally friendly low carbon target. In accordance with this goal, it is the specific analysis according to the specific circumstances in Beijing. We can combine with the morning and evening peak congestion in the area to determine the area of congestion charges.
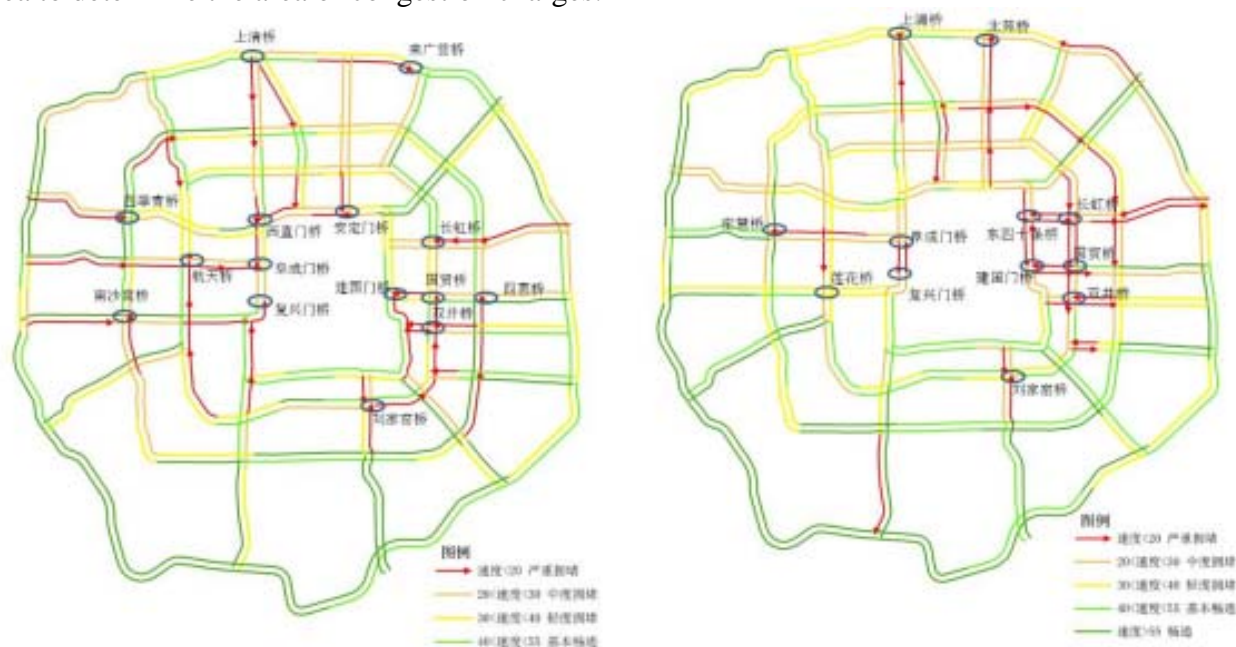

Fig. 6 congestion charging area

According to the above, we can develop a plan that levied change to sailed into congestion areas of private cars, buses and taxis in the morning and evening rush hours sailed into congestion areas of private cars, buses and taxis charge, given different levels of subsidies to bus and taxi. For residents living in the toll area, we can give tax incentives, and for residents who do not affect the road conditions, can be exempted from congestion charges[6]. About the way of congestion pricing, we can combine the above mentioned electronic toll collection technology. In this way, we ensure that the time cost is low and the credibility of the collection and coverage, while it also provides convenience to the collection of regulation. Payment methods can be used in advance of delivery and the day to pay.

5 Conclusions

Nowadays, traffic congestion problem is the concern of all sectors of the community in Beijing. Residents' quality of life, health status, psychological status, as well as the economic development, the air environment in Beijing have received the impact of traffic congestion. As soon as possible to get rid of the first block has been an urgent requirement. But traffic congestion problem by the

population, the excessive growth of motor vehicle ownership, urban transportation planning are not reasonable. We need to use economic leverage, technical means, reasonable policies and regulations to be able to curb the multi pronged. It ease traffic congestion from the travel structure and urban layout in Beijing. From the two aspects of supply and demand to proceed, we analysis of the formation of traffic congestion and external cost. It is proposed to solve problems of traffic congestion externalities in Beijing.

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