



# Can urban rail transit curb automobile energy consumption?



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## ABSTRACT

With the rapid development of China's economy and the speed of urbanization, China's automobile sector has experienced rapid development. The rapid development of the automobile sector has increased energy consumption. According to the results of this paper, automobile energy consumption accounted for about 10.73% of total energy consumption in China in 2015, about 3.6 times the proportion a decade ago. With the deterioration of urban traffic conditions, relying on expanding the amount of vehicles and city road network cannot solve the problem. Urban rail transit is energy-saving and less-polluting, uses less space, has large capacity, and secure. Urban rail transit, according to the principle of sustainable development, is a green transportation system and should be especially adopted for large and medium-sized cities. The paper uses the binary choice model (Probit and Logit) to analyze the main factors influencing the development of rail transit in Chinese cities, and whether automobile energy consumption is the reason for the construction of urban rail transit. Secondly, we analyze the influence of urban rail transit on automobile energy consumption using DID model. The results indicate that the construction of urban rail traffic can restrain automobile energy consumption significantly, with continuous impact in the second year.

## 1. Introduction

### 1.1. The development of automobile transportation

Transportation is an important link between production and consumption, supporting social and economic activities. The transport sector consumes lots of primary and secondary energy sources such as coal, gasoline, diesel, fuel oil, natural gas, heat, and electricity. According to 2008 data compiled by the International Energy Agency (IEA), the energy consumption of the global transport sector accounted for 29.6% of total energy consumption, and the proportion of the sector's energy consumption in 25-nation European region is about 29%. While the proportion is about 27% for Japan, it is more than 35% in all 34 OECD countries. In the U.S., the proportion is even over 40%, and this is expected to increase with the development of the national economy (Geng et al., 2009). According to the IEA, oil consumption in the transport sector accounts for 50% of the world's total oil consumption. On the other hand, high energy consumption in the transportation sector means high pollution and emissions (Lin and Xie, 2014). According to the IEA, the transportation sector accounts for nearly one-third of the world's carbon emission caused by energy consumption, and this will exceed 50% by 2030. At present, it is a top priority

for the Chinese government to develop effective climate policies to curb domestic carbon dioxide emissions (Zhang et al., 2017).

The automobile sector is an important part of the transportation industry (Lin and Xie, 2013). With the rapid development of China's economy and the speed of urbanization, the automobile sector has experienced rapid development. China's automobile market in 2015 still maintained rapid development. China's total annual vehicle production and sales are about 24.5 million and 24.6 million units in 2015, an increase of 3.3% and 4.7% respectively. Its production and sales have also ranked first in the world for seven consecutive years. The number of automobiles in China reached 172 million by the end of 2015, and the ratio of automobiles to motor vehicles increased rapidly from 47.06% to 61.82% over the past five years. There are 40 cities in China with over 1 million vehicles each and there are 11 cities with more than 2 million vehicles each including Beijing, Chengdu, Shenzhen, Shanghai, Chongqing, Tianjin, Suzhou, Zhengzhou, Hangzhou, Guangzhou and Xi'an. In 2015, the number of small passenger cars reached 136 million, and private cars reached 124 million, accounting for 91.53% of small passenger cars. Compared with 2014, private cars increased by 18.77 million, which is an increase by 17.77%.

The rapid development of the automobile sector has increased

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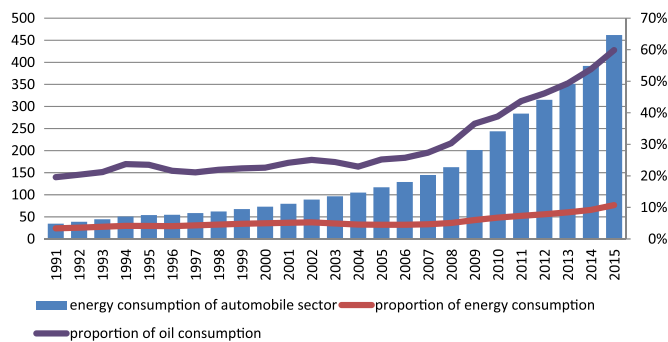


Fig. 1. Energy consumption of automobile sector and the proportion of energy consumption (million TCE).

energy consumption. Building on Lin and Du (2015)'s estimation method for the energy consumption of the automobile sector, we evaluate the energy consumption of the automobile sector in each province of China. According to the results of this paper, the energy consumption of the automobile sector accounted for about 10.73% of total energy consumption in China, about 3.6 times the proportion a decade ago. The share of the oil consumption of the automobile sector in total oil use is also increasing rapidly, especially in recent years. Oil consumption by the automobile sector accounted for about 60% of total oil use in 2015. With further development of the Chinese economy in the future, car ownership will maintain rapid growth rate, and the energy consumption of the automobile sector will continue to increase.

According to the estimation of this paper, energy consumption of the automobile sector in China is shown in Fig. 1.

As can be seen from the figure, energy consumption in the automobile sector increased year by year from 1991 to 2015, and the growth accelerated in recent years. From 2013 to 2015, the total energy consumption of the automobile sector was 351.21, 391.77 and 461.60 million tons of standard coal, respectively, accounting for 8.42%, 9.20% and 10.73% respectively of the national energy consumption. On the other hand, the proportion of the energy consumption of the automobile sector in oil consumption is also increasing rapidly at about 60%.

### 1.2. The significance of restraining automobile energy consumption

The significance of restraining the energy consumption of the automobile sector lies in easing the trend of expanding dependence on foreign oil and ensuring oil security. As shown in Fig. 2, since 1993, China has become a net petroleum importer, after which oil imports continue to increase and the dependence on foreign oil also increased. By 2015, China's oil consumption was 543 million tons, with imports of 328 million tons, and dependence on foreign oil of more than 60% for the first time. With the gradual increase in China's oil consumption demand, the dependence on foreign oil will continue to rise. As the

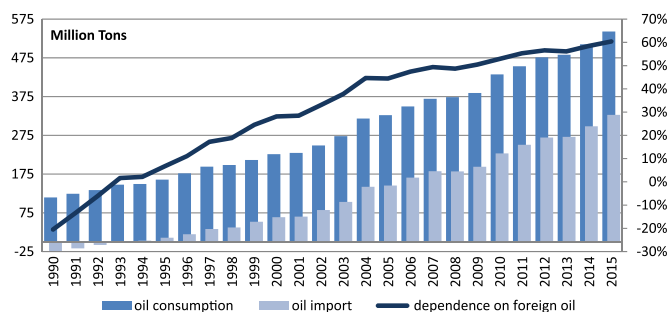


Fig. 2. China's oil consumption, oil import and dependence on foreign oil (million tons).

most important factor in oil consumption, automobile energy use will directly determine China's oil security strategy. Therefore, restraining the growth of car units and automobile energy consumption can ease the trend of expanding dependence on foreign oil and safeguard national petroleum security.

Second, curbing the growth of automobile energy consumption is an important measure for improving the air quality. In recent years, China's ecological environment has become increasingly worsened and Beijing-Tianjin-Hebei region, Yangtze River Delta region, Henan and other places were frequently shrouded in pollution haze.

Since 2001, the concentration of particulate matter pollution exceeded  $30 \mu\text{g}/\text{m}^3$ , and almost reached  $37 \mu\text{g}/\text{m}^3$  in 2007, which is significantly above the average level in (China (Ma and Zhang, 2014). Moreover, the spillover effects of sulfur dioxide, soot and other air pollutants in China's provinces are very obvious, which also brings greater difficulty for environmental governance (Poon Jessie et al., 2006). Vehicles emit hydrocarbons, nitrogen oxides, carbon monoxide, sulfur dioxide, lead compounds and other pollutants. Therefore, it can be concluded that the emissions exhausted by automobiles is a major cause of hazy weather. According to the Ministry of Public Security Traffic Management Bureau statistics, the number of new energy vehicles in China in 2015 was 583,200, an increase of 169.48% compared to 2014, of which 332,000 were electric vehicles. Even if the growth rate is faster, new energy vehicles still account for only 0.34% of the total car units. In the future, petroleum will continue to be the main vehicle fuel. Therefore, the restriction of automobile energy consumption will play an important role in improving air quality and easing haze and pollution.

### 1.3. Urban rail transit development in China

With China's economic development and population growth, urban traffic conditions has deteriorated. Relying on expanding the amount of vehicles and road network cannot solve this major problem. Therefore, it is urgent to study urban rail transit system which is economical and practical based on China's national conditions. Rail transit is an important component of urban public transport.

Indeed, rail transit is energy-saving and less polluting, uses less space, has large capacity, and secure. Urban rail transit, according to the principle of sustainable development, is a green transportation system and should be especially adopted for large and medium-sized cities. As one of the modes of urban public transport, urban rail transit can be divided into multiple categories, such as subway, light rail, monorail, tramway, maglev rail and so on. By the end of 2015, there were 26 cities in China that had completed the construction of 116 urban rail lines (as shown in the Appendix table) with a total length of 3612 km, including 2658 km of subways. There are 15 cities in China with more than 10 million people, so in the long term, urban rail transit is necessary to solve the traffic congestion and environmental problems in large and medium-sized cities.

The development of urban rail transit has provided a creative and more effective mode of transportation, but whether the construction of urban rail transit will effectively curb the growth of car ownership and restrain the energy consumption of automobiles is yet to be known. This is an important issue that needs to be clarified in the context of the rapid development of urban rail transit in order to provide evidence to support the future development of rail transit. Based on the above considerations, this paper aims at empirically evaluating the inhibitory effect of China's urban rail transit on automobile energy consumption.

### 1.4. Literature review

From the perspective of rail transit and environment, the construction of rail transit is considered to be an effective measure to solve the current urban traffic congestion and air pollution. But traditional research is often undermined by estimation error caused

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