Study on the Effect of Freight Structure Change on Air Pollution

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Abstract. Cargo transportation is the derivative demand of economic and social development and the real logistics of goods. The change of freight structure is directly related to the direction of national infrastructure construction. Chinese freight transportation is mainly based on land transportation, railway and road transportation are parallel and there is a substitution relationship between them. The mode of freight transportation in China has gradually changed from the railway-dominated to the highway-dominated, which also causes the gradual increase of vehicle pollutant emissions. The most notable is that heavy trucks share 68% of the particulate matter, which has seriously affected the air environment. The structure of freight transportation needs to be improved urgently and road transport to rail transport is a must-have road.

1. Introduction
Since 2008, the number of motor vehicles in China has been growing rapidly and the number of trucks has reached the peak of growth. The freight turnover of highways has exceeded that of railways for the first time. At the same time, human beings also face serious air pollution problems, especially the "haze weather" in winter, which seriously endangers people's health. According to real-time monitoring by The Ministry of Ecology and Environment, it is know that particulate matter is the primary pollutant in all regions in winter. To get rid of the harm of "haze", it is necessary to take appropriate measures. The Ministry of Ecology and Environment pointed out in its annual report that the particulate matter emitted by trucks accounts for 80% of the total number of motor vehicles and its proportion of total social discharge is also rising. The freight structure has already played a significant role in air pollution.

2. Analysis of the change and status quo of Chinese freight transport structure

2.1. The change of Chinese freight transport structure
Since the reform and opening-up policy, Chinese freight volume has increased rapidly. Because china is a country with a wide geographical area, low water transport accessibility, underdeveloped air transport and passenger transport as the main goal, China has formed a mode of transport dominated by railways and highways. From the perspective of land freight, Chinese freight structure change can be divided into three stages. The first stage: in the early stage of opening up, the economy developed rapidly but transportation lagged behind, so the economy is constrained by traffic. At this time, the main freight lines are too busy to meet the needs of economic growth. Therefore, the railway had to give up the short-distance transportation which was not advantageous and had low income, which
stimulated the development space of road transportation. The second stage (1980-2008): from the 1980s, a large number of highways were built. With the support of national policies and the advantages of high flexibility, high accessibility, short construction period and relatively low investment, highways were developing rapidly, which made the proportion of highway transportation rapidly rising and became the most important mode of freight transport. According to figure 1, the proportion of highway freight traffic in the total freight traffic has been increasing continuously since 1980, while the proportion of railway freight traffic has shown a steady decline trend despite the slight increase in the number.

Figure 1. Freight structure change chart.

The third stage refers to the period after 2008. Not only is the volume of goods transported by road increasing, but the turnover of goods also exceeds that of railways. Before 2008, railway transportation was the preferred mode of transportation for medium and long distance transportation. In terms of freight volume road transportation far exceeded rail transportation, while in terms of turnover railway transportation was still much higher than road transportation. This showed the bulk of the long and medium distance cargo transport mainly depends on railways. After 2008, the freight turnover of highways increased by 189% and maintained a stable high growth trend. Highway freight turnover surpassed railway freight turnover to become the first. It was not until 2014 that China adhered to the strategy of sustainable development, the economy began to slow down and shift gears from the extensive economic growth mode to the green and environment-friendly high-quality growth. Therefore, highway freight volume and turnover remained basically stable, while railway freight turnover showed a slight decline.

Combined with the figure 1 and figure 2, this paper attempts to construct the average distance between railway freight and highway freight according to the next formula:

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\text{Average distance} = \frac{\text{Cargo turnover}}{\text{Cargo weight}}
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(1)

According to the data in table 1, The average distance of railways is relatively stable, while the average distance of highways increased from 69 km to 171 km in 2008. This shows that a large number of short and medium distance goods cargo transport from the railway to the road, which make highway carriage usher in new development climax.
Figure 2. Comparison chart of the change trend of highway freight turnover and railway freight turnover (Unit: billion tons and kilometers)

Table 1. Change in average distance between road freight and rail freight

| Year | Railway(km) | Highway(km) |
|------|-------------|-------------|
| 2006 | 761.71      | 66.52       |
| 2007 | 757.29      | 69.26       |
| 2008 | 759.98      | 171.48      |
| 2009 | 757.14      | 174.77      |
| 2010 | 758.89      | 177.24      |
| 2011 | 749.26      | 182.17      |
| 2012 | 747.55      | 186.72      |
| 2013 | 735.42      | 181.16      |
| 2014 | 721.94      | 183.08      |
| 2015 | 707.39      | 183.99      |
| 2016 | 714.08      | 182.81      |
| 2017 | 730.68      | 181.44      |

2.2. Analysis of the status quo of truck development

According to the development trend of land freight, road freight has become the most important mode of transportation, which has led to a rapid increase in the number of trucks in China. As can be seen from the figure, after 2008 the number of freight cars increased steadily. From 2008 to 2011 the proportion of heavy trucks increased rapidly, which shows that during this period the demand for heavy trucks increased based on the growth of highway freight volume. After 2011 the proportion of heavy trucks in trucks was basically stable with a slight upward trend.

Heavy-duty trucks are one of the most important ways of medium and long-distance freight transportation. With the increase of railway freight prices, a large number of cargo transportation is transferred from railway transportation to road transportation, resulting in an increase in the average transportation distance of highways, which also brings air pollution problems.
3. Analysis of the effect of trucks on air pollution and countermeasures

3.1. Analysis of the effect of trucks on air pollution

According to the annual report of motor vehicle environmental quality issued by the ministry of ecological environment, the quality of air pollutants discharged by motor vehicles has reached 30% of the total social emissions in 2017, becoming one of the main sources of air pollution. In big cities such as Beijing, Shanghai, Hangzhou, Guangzhou and Shenzhen, motor vehicles account for 45% of the pollutant emissions, making them the primary source of air pollution in megacities. Therefore, the motor vehicle pollutant emission control work is more and more urgent. Pollutants emitted by motor vehicles mainly include carbon monoxide, hydrocarbons, particulate matter and nitrogen oxides. Motor vehicles include passenger cars, lorries, low-speed cars and motorcycles. Each type of vehicle emits a different proportion of pollutants. After scientific calculation, the ministry of ecology and environment of China has concluded that pollutants from motor vehicles mainly come from passenger cars and trucks. Buses emit a higher proportion of carbon monoxide and hydrocarbons, while trucks emit a higher proportion of particulate matter and nitrogen oxides.

To analyze the effect of freight on air pollution, the article compares the proportion of pollutants discharged by trucks in cars. As shown in figure 4, trucks that only account for 10% of the number of cars emit 30%, 40%, 70% and 80% of carbon monoxide, hydrocarbon, nitrogen oxide and particulate matter respectively.
According to real-time detection by the Ministry of Ecology and Environment, monthly data since the beginning of winter showed that particulate matter was the primary pollutant in 236 prefectural cities with poor air quality. Trucks emit 80 percent of the particulate matter. Goods vehicles can be divided into minivans, light trucks, medium trucks and heavy trucks. Heavy trucks are the main source of particulate matter. Heavy trucks, which account for 2 percent of the vehicles, emit nearly 60 percent of the particles. Therefore, the focus of haze control is heavy trucks, paying attention to the adjustment of bulk cargo transport structure, especially the adjustment of long-distance freight mode.

### 3.2. Analysis of countermeasures against freight pollution

Since 2010, the Ministry of Ecology and Environment has conducted a systematic study on air pollution of motor vehicles. According to the scientific calculation, the influence of motor vehicles on the atmospheric environment is monitored, and the prevention and control measures are carried out accordingly. Since the beginning of 2017, when relevant departments started to transfer bulk cargo from road transportation to railway transportation at port around Bohai sea, the adjustment of freight structure has achieved initial results. In October 2018, the general office of the state council issued the three-year action plan for promoting the structural adjustment of transportation (2018-2020). The document clearly requires that the transport structure of goods nationwide be significantly optimized by 2020. The volume of bulk cargo transport undertaken by railways and waterways has been significantly increased. Port and railway transport volume and container multi-modal transport volume has increased significantly; Breakthroughs has been made in adjusting the transport structure in key regions. The Beijing-Tianjin-Hebei region and surrounding areas has been built into a national transport restructuring demonstration zone. Compared with the situation in 2017, railway freight volume increased by 1.1 billion tons and the increase rate is 30%, while road transport of bulk goods by coastal ports decreased by 440 million tons.

It is roughly estimated that the transport of 440 million tons of bulk goods can emit 7907.6 tons of particulate matter, 72,157 tons of nitrogen oxides, 184,643 tons of carbon monoxide and 26,491 tons of hydrocarbons, totaling 291,200 tons.

According to the scientific calculation of the Ministry of Ecology and Environment, the pollutant discharge of cargo unit turnover is only 8% of road transport and the consumption is 15%1.

If the policy adopts a laissez-faire attitude, according to the law of historical data growth, the railway freight volume will be basically stable and the road freight volume will further expand. If 1.1 billion tons of rail transport will be completed by road transport, 1,1956.5 tons of particulate matter, 18,932.4 tons of nitrogen oxides, 36,451.6 tons of carbon monoxide and 4,787 tons of hydrocarbons, totaling 85,107.5 tons will be emitted.

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1. Wen Zhang ”Long-distance transportation: railways have environmental advantages over highways” Industry Overview 2018; 10-12
108,505 tons of nitrogen oxides, 279,483.7 tons of carbon monoxide and 40,353 tons of hydrocarbons will be emitted, totaling 440,000 tons.

4. Conclusion

According to the above estimates, the freight transport volume in the three-year plan of action for moving goods from roads to railways can reduce the emission of pollutants by 700,000 tons. At the same time, the relevant departments have also taken further measures. By 2020, the proportion of railway transportation by large industrial and mining enterprises with special railway lines will be more than 80%, the over-limit and over-loading of expressways will be basically eliminated, and the proportion of new and clean energy vehicles in urban distribution vehicles will be increased and upgraded to 80%. It is worth believing that in the near future China will win the battle of blue sky protection and achieve the strategic goal of sustainable development of green water and green mountains.

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