

UNDERLYING FACTORS ANALYSIS OF PASSENGER TRANSPORT CO₂ EMISSIONS INCREASE IN SHANGHAI CITY, CHINA

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1 Introduction

Transport activity accounts for 23% of world energy-related GHG emissions (IEA, 2006b) and is one of the sectors where emissions are still growing. Rapid urbanization and economic growth in developing countries have resulted in a rapid increase in urban transport services and associated energy demand. As one of the most rapidly growing countries and the second largest CO₂ emitter in the world, China is now experiencing rapid growth in economy and motorized mobility, and transport-related energy consumption and pollution problems are poised to soar further.

Shanghai, as the most dramatic urbanization areas of China in the past 10 years, is experiencing rapid urban sprawl, the environmental pressure from transport activity increases a lot. The share of CO₂ emission from transport sector in Shanghai increased from 11% in 2000 to 19% in 2007 (Chen, 2009). With rising disposable incomes, private car ownership in Shanghai has also been rapidly increasing in recent years. The rapid growth of private car ownership has been one of the major causes of CO₂ emissions increasing from transport sector.

Taking the urban passenger transport of Shanghai city as a case, this paper aims to evaluate the transport CO₂ emission growth from 2002 to 2009 and discusses the relationship between transport CO₂ emission increase and the driving factors.

2 Data and Methodology

2.1 Data

The data used in this study come from “Shanghai Statistical Yearbook” (2003-2010) and “Shanghai Comprehensive Transportation Annual Report 2010”. Data include annual mileage, passengers and vehicle ownership by three main modes (metro, public bus, and taxi), as well as the private car data and some socio-economic data such as GDP and population.

2.2 CO₂ emission estimation model

Eq. (1) is used for estimating CO₂ emissions based on the guide lines for national GHG inventories provided by the International Panel on Climate Change. Subscripts i, j and t refer to fuel type (e.g., electricity, diesel and gasoline), transport mode (e.g., bus, metro, taxi and private car) and year respectively. EM is CO₂ emissions from urban passenger transport; EC is energy consumption; σ is net calorific value; θ is the effective CO₂ emission factor.

$$CO2_t = \sum_{ij} CO2_{ijt} = \sum_{ij} (EC_{ijt} \times \sigma_i \times \theta_i \times \varphi) \quad (1)$$

2.3 Methodology to determine factors affecting CO₂ emission increase

In order to decompose the emission to the potential factors affecting it, Eq. (1) can be expressed as Eq. (2) and (3).

$$CO2_t = \sum_{ij} \frac{CO2_{jt}}{PC_{jt}} \times \frac{PC_{jt}}{PC_t} \times \frac{PC_t}{FC_t} \times \frac{FC_t}{GDP_t} \times \frac{GDP_t}{POP_t} \times POP_t \quad (2) \quad CO2_t = \sum_{ij} CP_{jt} \times MS_{jt} \times FE_{jt} \times EI_t \times EC_t \times POP_t \quad (3)$$

Where CP is CO₂ emissions per passenger (i.e., CO₂/PC), MS refers to modal share (i.e., share of passengers carried in a transport mode of the total), FE represents fuel efficiency (i.e., passengers carried per unit fuel consumption); EI the transport energy intensity (i.e., FC/GDP), EA is economic activity as captured by per capita GDP and POP is population.

Using LMDI (the Logarithmic Mean Divisia Index) techniques (Ang, 2005), the decomposition of the CO₂ emission change in passenger transport sector from year $t-1$ to t is expressed as Eq. (4):

$$CO2_t - CO2_{t-1} = \sum_{ij} \tilde{w}_{ij} \ln \frac{CP_{jt}}{CP_{jt-1}} + \sum_{ij} \tilde{w}_{ij} \ln \frac{MS_{jt}}{MS_{jt-1}} + \sum_{ij} \tilde{w}_{ij} \ln \frac{FE_{jt}}{FE_{jt-1}} + \sum_{ij} \tilde{w}_{ij} \ln \frac{EI_t}{EI_{t-1}} + \sum_{ij} \tilde{w}_{ij} \ln \frac{EA_{jt}}{EA_{jt-1}} + \sum_{ij} \tilde{w}_{ij} \ln \frac{POP_t}{POP_{t-1}} \quad (4)$$

3 Results

3.1 Total CO₂ emission change

In terms of the annual total amount, the CO₂ emission increased year by year, the annual growth rate ranged from 8% to 15%, and reached 7 million ton in 2009, which was more than two times of the amount in 2002 (Figure 1). Among each mode, the CO₂ emission from all modes increased. And the highest CO₂ emission mode in 2002 was taxi which accounted for 53% of the total CO₂ emission, and it decreased to 30% in 2009, at the same time, the share of private car reached 51% in 2009 from 12% in 2002. The lowest CO₂ emission was from metro which was accounted for 1% of the total emission in 2009 although the emissions increased more than 5 times with the network expansion and the increased passenger carried per year. The CO₂ emissions from bus also increased but the share of bus decreased to 18% in 2009.

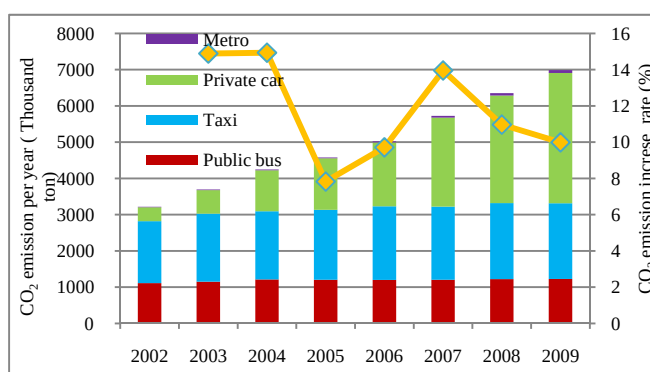


Figure 1 Annual CO₂ emission and growth rate from passenger transport modes

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3.2 CO₂ emission increasing mechanism in Shanghai from 2002 to 2009

As can be seen from figure 2, economic activity and modal share change are the critical factors in the increasing of passenger transport sector CO₂ emissions. Population growth and CO₂ emissions per passenger are also found to contribute to emissions increase. While the fuel efficiency and the transport energy intensity contributed directly to the emission decreasing.

From 2002 to 2009, the total CO₂ emission from passenger transport sector increased 3.8 million ton. The rapid economic growth accounted for 61% of the total CO₂ emissions increasing, other factors such as modal share, population growth and CO₂ emissions per passenger contribute to 16%, 13% and 10% respectively. While the inhibitory effect of CO₂ emission mitigation are 67% from the fuel efficiency and 33% from the transport energy intensity changes (Figure 3).

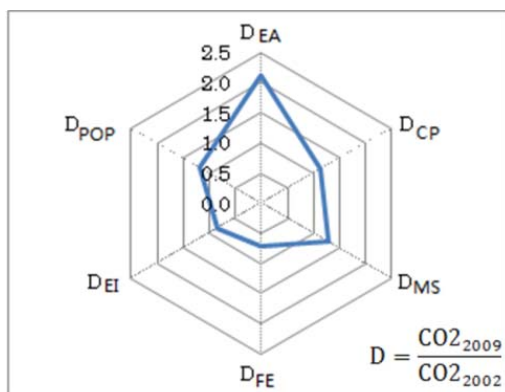


Figure 2 Decomposition of the factor effect

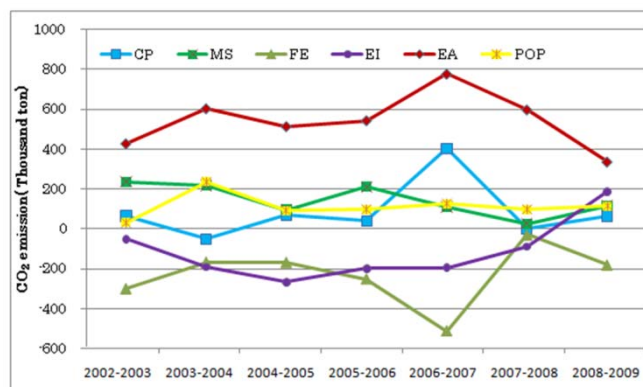


Figure 3 Decomposition of CO₂ emission increase

4. Conclusion

Decomposition analysis showed that the major positive contributor of the total effect was the economic growth; other contributors to the increasing are CO₂ emissions per passenger, modal share change and population growth. By contrast, the fuel efficiency and energy intensity were found to negatively contribute to the total effect.

References

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