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Chinese transport: achievements and challenges of transport policies

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Over the past 30 years, the Chinese economy has experienced unprecedented growth. China is now the second largest world economy, after the US. The growth in the Chinese transport sector has even outpaced that of the economy as a whole: the total number of Chinese motor vehicles has increased from 1.8 million in 1980 to 126.7 million in 2013, and vehicle ownership has grown from 1.8 per 1000 people in 1980 to 93 in 2013 (National Bureau of Statistics of China 2014). China has become the world's largest car market, with annual sales in 2014 at over 18 million passenger vehicles (Chinese Association of Automobile Manufacturers 2015). Together with the fast expansion of air transport and high-speed rail, motor vehicle growth has helped boost personal mobility in China, creating great accessibility to economic and social benefits for people from the entire population spectrum. Also, the auto sector has become a key pillar of the Chinese economy.

But these economic and social benefits have come with severe energy, environmental, and social costs. From a net oil-exporting country in the 1980s, China has become a large oil-importing country, with more than 60 % of its oil now imported (Wang and Jin 2014). This trend can have grave geopolitical consequences. Air pollution in China is now a top concern across the population, and the health consequences of air pollution currently include over a million premature deaths per year (Yang et al. 2013). For many Chinese, a blue sky has become a distant memory. Motor vehicles are a major contributor to urban air pollution problems such as ozone and particulate matter (eg, PM2.5) in China (Yao et al. 2012). And of course, the single-minded urban development of the past 30 years, with urban sprawl and land-use patterns that encourage auto use, has caused road congestion and traffic jams that are becoming a real plague (The Economist 2015).

Indeed, the very success of China's automobile market growth has created a set of deep and serious problems. For example, the biggest complaints of Beijing residents are routinely air

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pollution and traffic congestion. This series of papers examines the problems and solutions. The papers are written by academic experts who also have deep experience in policy and whose work is grounded in real-world solutions.

Public transport is now considered to be the backbone of the urban transport system (The State Council 2013). And because of congestion, many cities have even begun to restrict personal vehicle purchase and use. Vehicle energy efficiency and emissions standards do not relieve traffic jams, but they have become effective policy measures to reduce transport energy consumption and air pollution and to help the Chinese auto sector become more technologically sophisticated. Since the adoption of the first Chinese vehicle fuel consumption standard in 2003, China has regularly strengthened fuel consumption standards across all motor vehicle classes (Wang and Jin 2014). Chinese vehicle emission standards, together with fuel quality standards, are fast approaching the stringency levels in Europe and the US (Pei 2014). In addition, electric drive technologies, such as battery electric vehicles and fuel cell vehicles, and alternative fuels are being promoted for energy security and environmental benefits (The State Council 2012). One manifestation of this policy, missed by many analysts, has been the deployment of over 150 million electric bicycles (Xinhua News 2014), which expand the range over which people will travel by bike.

Recognizing the problems of the Chinese transport sector, key Chinese policymakers and transport researchers have been re-examining the patterns of Chinese urban and transport development and have studied other cities and countries for strategies to alleviate congestion. This special issue on Chinese transport collects 11 articles on urban development, transport planning, vehicle fuel efficiency standards, vehicle emission standards, and electric drive technology in China. The authors of these articles are from a variety of organizations, and some are deeply involved in Chinese transport policy design and execution.

Lyu and his co-authors at the China Automotive Energy Research Center of Tsinghua University have been examining trends in vehicle technologies and transport fuels in China. They show that automotive energy use has become a core energy and environmental issue for China. Future energy demand and supply for the Chinese transport sector will have a substantial impact on global energy markets, global carbon dioxide (CO_2) emissions, and the local environment. Lyu et al. model the interactions of economics, technology, and policy in the transport sector with two transport energy scenarios—a business-as-usual and an integrated policy scenario. They reveal important implications of technology innovation and policy intervention for a sustainable Chinese automotive energy sector.

Guo et al. of the Beijing Transportation Research Center have been addressing urban transport challenges over the past 20 years for the city of Beijing, where urbanization and motorization have caused severe traffic problems. They review the unique characteristics of each urban development stage in Beijing over the past 65 years and summarize Beijing's recent congestion mitigation measures. They identify uncoordinated transport and urban development, low-quality public transportation services, and weak travel demand management measures as causes of the present transport problems in Beijing. They maintain that comprehensive transport planning, development of public transport systems, control of private vehicles, and promotion of non-motorized transportation are needed to solve Beijing's transport problems.

He and Wang of the China Sustainable Urban Transportation Center of Energy Foundation China have been working with Chinese central government agencies, provincial governments, and cities for more than 10 years to promote sustainable urban planning and transport planning. They argue that urban sprawl, traffic congestion, air pollution, and single-minded

city layouts have already caused a decline in the standard of living and a rise in social inequities. They present a few pilot projects demonstrating best practices for sustainable urban development, which are being built on to develop local and national guidelines and policies.

Wang of the China Sustainable Transportation Center has worked with different cities to design sustainable urban transportation systems and presents the new trend of transforming superblocks and giant road networks to new urban forms with human-scale blocks and fine-grain grid road networks. Important questions still remain for the transformation of transportation systems: how will it impact road network capacity? Will the changes significantly reduce transportation CO_2 emissions? How will cities deal with the rearranged cost structure among the different stakeholders in road construction, maintenance, and management? Wang presents a case study in the city of Kunming to address these important issues.

Jiang et al. of the School of Architecture of Tsinghua University have been working with cities to design and evaluate sustainable neighborhood development. They quantify the high transport energy intensity of the automobile-oriented superblock housing developments that have dominated Chinese urban expansion and construction for the past 30 years. Their analysis suggests that policymakers should pursue alternatives to superblock developments and focus on strategic infill urban development.

Huo and co-authors from Tsinghua University have been examining motor vehicle emission trends and urban air pollution. They conclude that vehicle emission standards adopted between 2000 and 2010 in China have resulted in 80 to 90 % reductions in emission rates per distance driven for new passenger vehicles and more than 60 % for new heavy-duty diesel vehicles. Their modeling shows that stringent vehicle emission standards are important for lowering future vehicle emissions.

Jin and colleagues from the China Automotive Technology and Research Center have been developing fuel consumption standards for Chinese vehicles since 2001. Chinese vehicle fuel consumption standards cover passenger cars, light-duty commercial vehicles, and heavy-duty commercial vehicles. Jin and co-authors identify problems in implementing standards and make recommendations to improve the regulation system for Chinese vehicle fuel consumption. In particular, they recommend that the central government clearly define the jurisdictional authority for vehicle energy conservation by clarifying responsibilities of different ministries; develop a long-term vision and middle-term targets to guide policy and technology development; and strengthen policy enforcement, monitoring, and evaluation.

Kodjak et al. of the International Council for Clean Transportation have been working with governments in North America, Europe, Asia, and the Middle East for more than 10 years to develop vehicle fuel consumption standards. They provide an overview of heavy-duty vehicle fuel consumption policies in the European Union, China, Japan, the US, and Canada. Their study identifies several common elements under development for the next round of heavy-duty vehicle fuel consumption standards. These elements include (1) how to incorporate trailer manufacturers into existing regulatory structures, (2) how to add new test procedures to fully account for potential benefits from hybrids and advanced transmissions, and (3) how to address the tension between separate test procedures for fuel economy and conventional air pollutants.

Plug-in electric vehicles (PEVs) have been promoted for energy security and environmental benefits. Sales of PEVs have grown rapidly in the US, China, and several European countries. Zhou and her co-authors at Argonne National Laboratory have been tracking PEV sales and policies in major countries. The PEV market trends in several countries show that national and regional PEV incentives have played an important role in jump-starting the PEV market.

Zhang et al. of the Society of Automotive Engineers-China have been assisting the Chinese central government in designing and evaluating PEV policies. With electric buses as a focus for PEV implementation in China, they evaluate the performance of hybrid electric buses in actual fleet operations with on-road driving tests, daily collection of operation data, and questionnaire surveys in eight Chinese cities. These buses were evaluated for their reliability, energy consumption, and emissions. The evaluation provides a basis for modifying Chinese hybrid electric bus demonstration policies.

Wang et al. of the Automotive Engineering Department of Tsinghua University have been conducting vehicle surveys with Global Positioning System data loggers to understand the driving patterns of private cars in large Chinese cities. Their study covers the daily driving distance, number of trips a day, and parking time of vehicles. Their results provide insights for deployment of electric vehicles and establishment of recharge stations.

These eleven articles present the authors' insights into transport policies in China. The ensemble is an especially sophisticated and informed view of one of the largest problems—and opportunities—facing the most populous nation on earth. We hope that these articles serve as important reference points for China's pursuit of sustainable urban and transport development.

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