A Policy Brief

Evaluation of Subway Expansions on Traffic Congestion and Air Quality in Beijing, China

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During the past decade, nearly 200 million people in China have migrated from rural to urban areas, making it the largest migration in human history. Rapid urbanization brings improvement in the standard of living and opportunities for economic growth along with huge environmental and societal challenges. The growing urban population and unprecedented increase in vehicle ownership has led to severe traffic congestion and air pollution in virtually all major urban areas in China, a common challenge faced by other emerging economies such as Brazil and India.

To address these challenges, central and local governments in China are undertaking huge investment in transportation infrastructure. China's total investment in transportation infrastructure in 2014 amounted to nearly 4% of its GDP. Subway systems are being developed and expanded in all major cities: China's 12th national five-year plan (2011-2015) outlined 69 new subway lines to be constructed with a total length of 2,100 kilometer and spending of RMB 800 billion (USD 130 billion).

What are the social and economic impacts of these rapid and large-scale investments in transportation infrastructure? To what extent can they address traffic congestion and air pollution problems? Do the benefits from these investments justify their costs? Understanding these questions is important not only for government policies in China but for other emerging economies as well.

We recently concluded an assessment of the impacts of the rapid expansion on traffic congestion and air quality. This study has resulted in three published papers. The first paper, titled "The Effect of Subway Expansions on Vehicle Congestion: Evidence from Beijing", is published at the *Journal of Environmental Economics and Management*. It examines the effect of six subway openings on short-run congestion in Beijing between 2009 and 2015. It finds that vehicle congestion drops sharply after new subway openings and that road delay time decreases by 15% on average across the city of Beijing.

The second paper, titled "The Marginal Cost of Traffic Congestion and Road Pricing: Evidence from a Natural Experiment in Beijing", is published at *American Economic Journal: Economic Policy*. It provides the first causal estimate of the relationship between traffic density and speed and optimal congestion charges using real-time fine-scale traffic data in Beijing. The results suggest that optimal congestion charges range from 5 to 39 cents per km depending on time and location. Road pricing would increase traffic speed by 11 percent within the city center and lead to an annual welfare gain of 1.5 billion Yuan from reduced congestion and revenue of 10.5 billion Yuan.

The third paper, titled "Does Subway Expansion Improve Air Quality?", is published at the *Journal of Environmental Economics and Management*. It quantifies the impact of subway expansion on

air quality by leveraging fine-scale air quality data and the rapid build-out of 14 new subway lines and 252 stations in Beijing from 2008 to 2016. The analysis shows that an increase in subway density by one standard deviation improves air quality by two percent. The cost-benefit analysis shows that the total discounted health benefit during a 20-year period from reduced mortality and morbidity as a result of 14 new subway lines amounts to $1.0-3.1 billion, or only 1.4-4.4 percent of the total construction and operating cost.

To sum up, we find that subway expansions in Beijing significantly improved air quality, reduced traffic congestion, and affected travel modes and housing prices. Cost-benefit analysis suggests that most of the cost from subway expansion needs to be justified from traffic congestion relief and other economy-wide impacts, rather than improved air quality. We also show that road pricing can also reduce traffic congestion and increase social welfare.

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