

# Did the metro help reduce air pollution in Delhi?

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Articles

*The Delhi metro has been operational for over a decade now. Has it helped reduce the high levels of air pollution? This column presents initial findings from research that suggests that the metro has encouraged people to switch from private to public mode of travel, resulting in positive effects on air quality in the city.*

The Delhi Metro (DM), an intra-city electric rail system serving the National Capital Region (NCR) of India, has been operational since December 2002. By March 2012, the DM had an operational route length of 167 km<sup>1</sup>.

While a key motivation behind building a mass transit system in Delhi was to ease traffic congestion in the city, it is not hard to imagine that it may have a considerable impact on air quality as well. An improvement in air quality would presumably occur mainly due to the 'traffic persion effect'. This refers to the possibility that commuters who were earlier using private modes of transport such as cars and two-wheelers switch to the DM leading to net reduction in the level of vehicular emissions.

Investigating whether this actually happened becomes particularly important for Delhi because the city is infamous for its high levels of air pollution. On most days between 2004 and 2006, the average levels of nitrogen dioxide and carbon monoxide exceeded the permissible standards set by the Central Pollution Control Board (CPCB)<sup>2</sup>. Such high levels of pollution raise health concerns for the city's inhabitants. The adverse effects of air pollution on health outcomes such as damage to the central nervous system, worsening of asthma and an increase in infant mortality rates, are well documented (Block et al 2012; Currie and Walker 2011; Moretti and Neidell 2011). Studies conducted by the CPCB find that high pollution levels in Delhi are positively associated with lung function deficits and with respiratory ailments (CPCB 2008). Guttikunda and Apte (2009) found that about 10,900 premature deaths every year in Delhi occur due to ambient particulate matter pollution. In light of these facts, it is important to examine whether there has been any significant impact on air pollution in Delhi due to the operation of the metro.

### **Traffic persion versus traffic creation**

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Based on transport economics theories, it is not possible to predict whether the net effect of the DM on air quality will be positive or negative (Vickery 1969; Mohring 1972). The main argument is that along with the traffic persion effect, there could be a traffic creation effect due to introduction of a new mode of transportation. The latter refers to new demand for travel generated by a faster and arguably more comfortable mode of transport such as the DM. For example, new demand for travel could arise if, facilitated by the DM, people decide to relocate to the outskirts of the city to possibly benefit from cheaper real estate prices, and then commute longer distances to work. If part of the increased distance is covered using pollution intensive modes of transport (such as private cars), then this could negate any traffic persion effect and could lead to an increase in overall level of pollution.

An added dimension that needs to be considered while studying the net effect is the presence of two coal-based power plants within the city limits that were operational during our study period (2004-2006). If operation of the DM resulted in increased capacity utilisation of these plants in order to supply electricity for running it, then this could also contribute to higher overall emissions in the city.

### **Analysing the link between the metro and air quality**

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In our study, we examine the effect of the DM on air quality using data obtained from the CPCB on four pollutants<sup>3</sup> – nitrogen dioxide, carbon monoxide, ozone and sulfur dioxide, between 2004 and 2006 (Goel and Gupta 2013). This data is collected at two locations in Delhi - ITO, a major traffic intersection in central Delhi, and Siri Fort, a residential locality in South Delhi. We obtained hourly data on temperature, rainfall, wind speed and relative humidity for Delhi from the India

### **Meteorological Department.**

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In order to establish a causal link between the DM and air quality it is important to compare pollution *actually observed* in the period after the DM became operational with its correct '*counterfactual*'. This counterfactual refers to the level of pollution in the hypothetical scenario where all other factors that affect pollution remain the same as in the post-metro period, and the only difference is that the metro does not exist in the counterfactual. Any difference between the observed pollution in the post-metro period and the pollution in the counterfactual can then be attributed to the DM. To do this, we estimate the trend (pattern over time) in pollution using hourly pollution data over a reasonably long time period which includes the date of extension of the DM. If we detect a sudden change in the level of pollution at the date of extension of the DM, then we attribute this change to the extension of the DM<sup>4</sup>.

Between 2004 and 2006 there were six extensions of the DM rail network. At each extension, we examine the time trend for each pollutant separately. We identify the localised, short term effect on pollution that can be attributed to each extension of the DM by conducting this analysis separately for pollution data from ITO and Siri Fort. Our preliminary analysis shows a reduction in the levels of nitrogen dioxide and carbon monoxide at both locations. This reduction varies between 24 to 29% for nitrogen dioxide and between 26 to 69% for carbon monoxide. For sulphur dioxide, we find an increase of 90% at ITO, and a decrease ranging between 35 to 89% for Siri Fort. For ozone, we do not find a uni-directional effect even across extensions at a particular location<sup>5</sup>.

## Conclusions and caveats

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To summarise, preliminary evidence points toward a reduction in the levels of nitrogen dioxide and carbon monoxide. Given that both nitrogen dioxide and carbon monoxide are important vehicular emissions, our initial findings suggest that the DM has encouraged people to switch from private to public mode of travel resulting in positive effects on air quality in the city. In the light of our findings and given the existing evidence on the adverse health effects of air pollution, these indirect health benefits should be taken into account when urban policy makers contemplate setting up large scale intra-city transportation systems. We provide a rationale for subsidising these mass transit systems, such as the metro or dedicated bus routes, even when the direct costs do not show a net profit. These public transport systems should be considered seriously for other cities that face similar challenges in terms of vehicular congestion and health costs due to pollution.

Two caveats should be kept in mind while interpreting and understanding these results. First, the large number of missing observations in the pollution data makes this analysis particularly challenging. Further examination is needed to ensure that our results are not being driven by the pattern of missing observations. Second, for a few extensions, the magnitudes of change in carbon monoxide and sulphur dioxide are very large to be driven solely by a traffic person effect. Also, ozone is created in the presence of sunlight and nitrogen dioxide through a complicated non-linear process. The results for ozone do not

show a consistent pattern in our analysis. In the light of these facts, further investigation is needed to rule out the possibility that our findings are not being driven by chance or poorly measured pollution data.

*Notes:*

1. Delhi Metro Rail Corporation (DMRC) Annual Report 2011-2012.
2. Based on the authors' calculations of CPCB hourly pollution data.
3. The four pollutants studied here are known as 'criteria air pollutants', which are air pollutants that are being regulated within a country and are used as indicators of air quality.
4. This technique is called Regression Discontinuity Design (RDD). We are assuming that in the absence of the extension of the DM, pollution would exhibit a smooth time trend and therefore any discontinuity in the time trend at the date of the DM extension is the effect of the DM. Our main RDD specification is to regress (logarithm of) hourly pollutant measure on a dummy variable (0/1 variable) that marks the time periods after the extension, a third order polynomial in time and various other controls such as hour of the day effects and weather conditions. While the polynomial in time captures the smooth time trend, the coefficient on the dummy variable captures the sudden change (discontinuity) in time trend due to the extension of the DM and is the main parameter of interest.
5. The pollution data suffers from missing observations and therefore we are unable to make use of all six extensions that occurred between 2004 and 2006 in our analysis. Also, the missing data pattern varies across pollutants and locations. The results reported here pertain to nine week window lengths around those extensions for which, not more than 20% of the data observations were missing.

## Further Reading

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- Block, Michelle L., Alison Elder, Richard L. Auten, Staci D. Bilbo, and Honglei Chen (2012) "The Outdoor Air Pollution and Brain Health Workshop", *NeuroToxicology*, forthcoming.
- Central Pollution Control Board. 2008a. "Epidemiological Study on Effect of Air Pollution on Human Health (Adults) Delhi." *Environmental Health Series 1*.
- Central Pollution Control Board. 2008b. "Study on Ambient Air Quality, Respiratory Symptoms and Lung Function of Children in Delhi." *Environmental Health Series 2*.
- Currie, Janet and Reed Walker (2011) "Traffic Congestion and Infant Health: Evidence from E-Z Pass", *American Economic Journal: Applied Economics*, 3(1): 65-90.
- Goel, Deepti and Sonam Gupta (2013) "Effect of Delhi Metro on Air Pollution in Delhi", Centre for Development Economics, Delhi School of Economics, Working Paper No. 229.
- Guttikunda, Sarath and Joshua Apte (2009) "Monitoring & Mapping Urban Air Pollution: A One Day Experiment in Delhi, India", *SIM-air Working Paper Series*, 29.

- Mohring, Herbert (1972) "Optimization and Scale Economies in Urban Bus Transportation", *American Economic Review*, 62(4): 591-604.
- Moretti, Enrico and Matthew J. Neidell (2011) "Pollution, Health, and Avoidance Behavior: Evidence from the Ports of Los Angeles", *Journal of Human Resources*, 46(1): 154-175.
- Vickery, William (1969) "Congestion Theory and Transport Investment", *American Economic Review*, 59(2): 251-60.

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