Using big data to estimate the environmental benefits of congestion pricing in the Los Angeles metropolitan area

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Project Objective

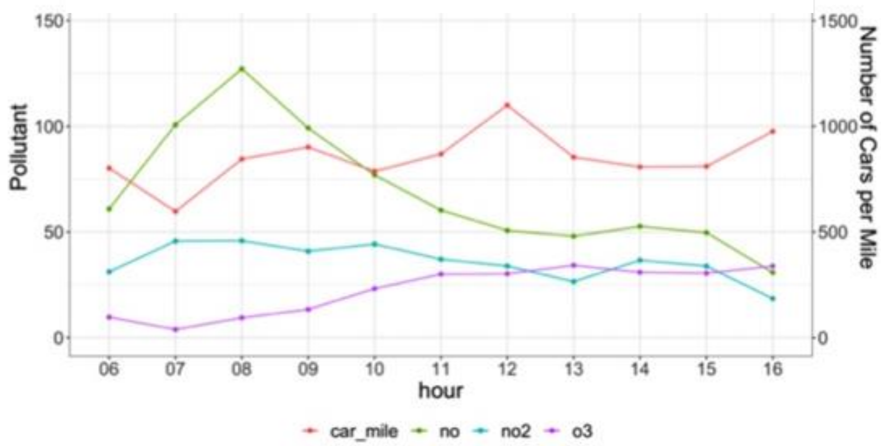
The purpose of this project is to measure the magnitude of the pollution reduction co-benefit generated by pricing congestion. In California, despite incentives for the adoption of cleaner vehicles and increased penetration of electric vehicles in the fleet, GHG emissions from transportation continue to increase. And when it comes to local air pollution, while tough regulations have certainly brought dramatic reductions in air pollution and improved health, Southern California remains the nation's smoggiest region, and continues to fail to meet federal Ozone standards.

Problem Statement

Los Angeles is now one of the global leaders in urban traffic congestion. On average, Angelinos spend 104 hours stuck in traffic each year. For a typical worker, this is equivalent to a total loss of 13 working days in a year. And, in total, the estimates of the social cost of traffic congestion in Los Angeles add up to $9.7 billion dollars per year, or $2,408 per driver. In response to this concern, LA's Metro board approved on February 28, 2019 a series of strategies for 're-imagining of LA County', which includes a congestion pricing feasibility study. With congestion pricing, drivers will see the price of their daily commutes increased, as they will be charged for the external costs of congestion in the form of increased delays. As a consequence, congestion pricing will create incentives for drivers to alter their commuting patterns, including adjusting the time of the commute, reducing overall vehicle miles traveled, and potentially even creating incentives for increased public transit usage. A direct co-benefit of congestion pricing is pollution reduction.

Research Methodology

Figure 1. Number of cars per mile and pollutants across the hours of the day in downtown Los Angeles



Understanding the potential pollution benefits of congestion pricing requires a careful understanding of the empirical relationship between pollution, traffic congestion, and speed. We have put together a comprehensive 'big data' to estimate two models. First, a model that examines the effects of traffic congestion, measured by cars per miles, on NO and NO2 emissions of vehicles in freeways. Second, a model that relates speed with NO and NO2 emissions from vehicles on local roads. Our dataset includes data on a rich network of detectors located on the freeways in Los Angeles that measure speed and flow in real-time, and novel and unexploited data from Aclima that measures in real-time the concentrations of various local air pollutants. Fig. 1 illustrates the richness of the data, by highlighting the variation of pollution across the hours of the day in downtown Los Angeles, while Fig.2 displays the variation of pollution across space.

We apply econometric techniques to estimate the effects of traffic density on pollution, and data visualization methods to display key patterns in the data useful for policymakers to prioritize areas of intervention. When calculating the marginal effects of cars per mile on pollution, we report results by geographical area and explore the role of past hours traffic on pollution in the following hours, effects of traffic on accumulated pollution, and the role of weather variables on the magnitude of the effects.

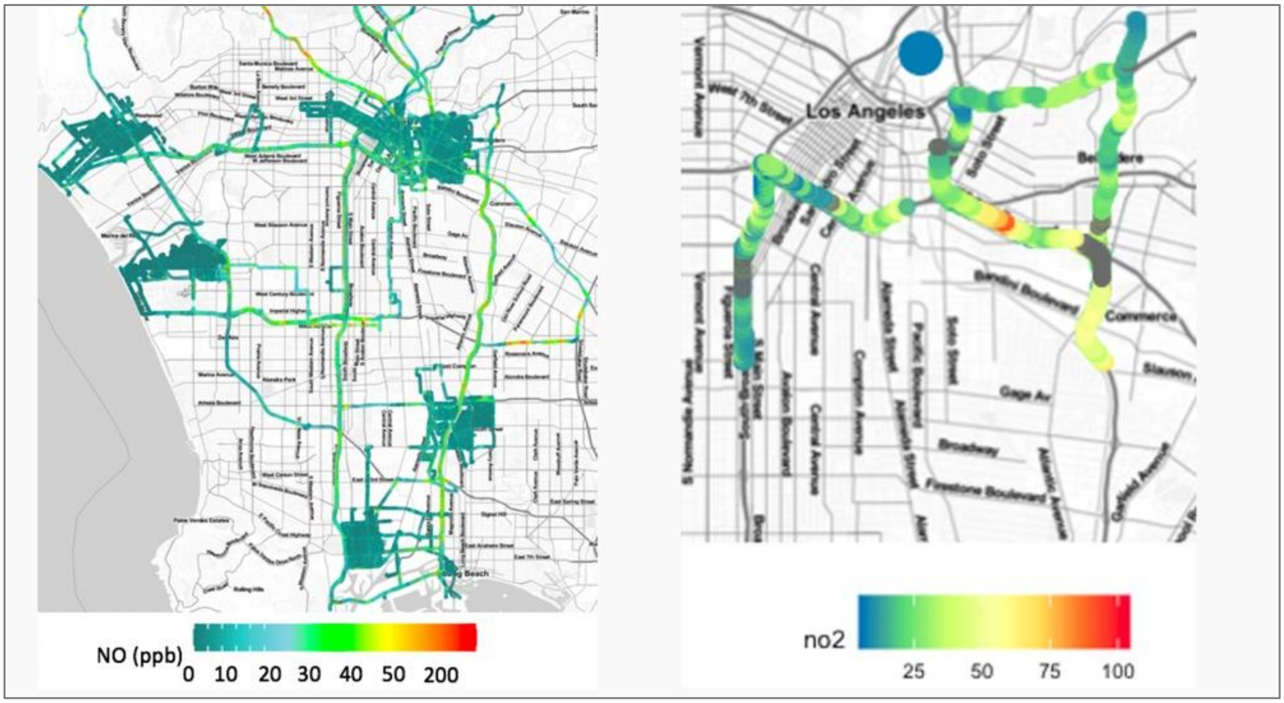


Figure 2. Distribution of pollution across space

Results

Our results suggest important relationships between traffic congestion and NO and NO2 in both freeways and local roads, and results are reported for different time periods. Our central results point to an elasticity of emissions with respect to traffic congestion in the order of 0.223 and 0.136 for NO and NO2 in the morning peak in freeways. That is an increase in 1% of cars per mile in the morning peak (roughly 11 vehicles) results in a 0.223 percent increase in NO (roughly 0.2712 ppb). Such estimates can serve as an important input in order to calculate the pollution benefits of congestion pricing. Therefore, we take our estimates and illustrate the pollution benefits from removing vehicles from the freeways. For example, removing 500 vehicles during the morning peak in a representative freeway results in a reduction of roughly 10% in NO. Our results underscore the importance of new sources of big data to inform the design of congestion pricing policies, and our models demonstrate non-trivial pollution effects of adding (removing) vehicles from freeways. In the end, from a pollution perspective, congestion pricing in freeways likely assures that, at time where congestion tolls are higher, individuals will substitute away from freeways.