Dissertation Abstract

This dissertation combines theoretical and empirical approaches and uses large dataset to address the efficiency and effectiveness of environmental policies. Specifically, I investigate the heterogeneity in decentralized air pollution, water pollution, and transportation policies, and identify implications for optimal policy design.

The first chapter is "Beggar-thy-Neighbor or Free-riding? Transboundary Behaviors in Decentralized Water Pollution Policies." Public policies with different degrees of centralization face optimization problems at different administrative levels, which motivates beggar-thy-neighbor and free-riding behaviors that lead to insufficient regulations at jurisdictional boundaries. This paper investigates whether states exhibit these behaviors when implementing nonpoint-source (NPS) water pollution policies. I compile a unique and comprehensive dataset of three NPS policies and hydrological information using ArcGIS. Depending on the policies' characteristics, I use a Probit model, a duration model with selection, and a Heckman selection model, respectively. I find that rivers within 30 km of state borders are less likely to be treated by the two more decentralized policies, i.e. Water Quality Assessment Program, especially the Total Maximum Daily Load (TMDL) Program, but receive larger amounts of grants under the relatively centralized NPS Pollution Management Program. States exhibit beggar-thy-neighbor behavior within 5 km upstream of state borders, with a 10.28% to 18.9% lower probability of TMDL development than intrastate rivers, and exhibit free-riding behavior within 10 km downstream of state borders, with a 25.71% to 55.81% lower probability of TMDL development. The free-riding behavior is affected by the upstream state's environmental and political-economic characteristics. Each behavior leads to a large deadweight loss.

The second chapter published in *Environmental and Resource Economics* is "Understanding the Heterogeneity in the Effect of Driving Restriction Policies on Air Quality: Evidence from Chinese Cities." Many cities around the world have adopted driving restriction policies to reduce vehicle emissions. However, evidence on the effectiveness of these policies is mixed. I exploit detailed and comprehensive data on Chinese cities to conduct a large-scale study of the effectiveness of a variety of driving restriction policies in a variety of locations. I estimate the monitor-specific short-run treatment effects of each driving restriction policy using a regression discontinuity in time approach, and the average treatment effect using a panel fixed-effect approach. The regression discontinuity in time estimation results show strong heterogeneity. Among the eight measures of air quality used, CO, NO_2, $PM2.5$, $PM10$, and AQI respond most to driving restriction policies. The average reduction of CO and NO_2 are consistent with back-of-the-envelope calculations for policies that effectively limit vehicle use. Using detailed information on the design of each policy, I show that policy details and pollution concentration are the major factors that affect the actual and estimated effects of driving restriction policies, and also a potential explanation for earlier studies that showed driving restriction policies had little effect.

The last chapter is "Estimating the Marginal External Cost of Traffic Congestion." External costs of traffic congestion in the US exceed $120 billion each year. Thus, the optimal regulation of traffic requires estimation of marginal external costs. We develop a robust methodology to estimate time-varying and location-specific congestion costs. The approach exploits readily available data and can be easily adapted to different roadway types and geographic scales. We illustrate the approach using detailed data for thousands of locations on California highways. We find that the mean congestion costs are on the order of $.10 per vehicle per mile but exceed $1 per vehicle per mile in congested cities during peak travel times. The highly variable nature of traffic conditions indicates that the second-best congestion charges do a poor job of correcting external costs. We show tolls based on average values only capture 15 to 69 percent of the welfare gain of an efficient Pigouvian policy. The methodology proposed here could be used by transportation planners to estimate tolls in real-time thus improving the policy efficiency.