Can Air Pollution Save Lives? Air Quality and Risky Behaviors on Roads

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Summary
- We study the impacts of air quality on accidents caused by violations using administrative data from Taiwan between 2009 - 2015.
- We find that a 1 µg/m³ increase in PM2.5 concentration leads to a 0.59% decrease in the total number of traffic accidents caused by violations with casualties.
- The cost of air pollution on cognitive performance and other associated health outcomes involving risk attitudes may be biased or underestimated.

Introduction
The socio-economic costs of air pollution have been widely documented. However, in this paper, we find a "benefit" of air pollution reducing road accidents caused by driver violations.

Using administrative traffic accident records and high-resolution air quality data of Taiwan, we identify air quality as a new factor for changing life-threatening risky behaviors.

This study further explores the transmission channels through which air quality influences risk behaviors and in turn brings down the number of road accidents.

Hypotheses
- Air pollution can simultaneously affect safety in two opposite ways: (1) decreasing traffic accidents through increased risk aversion and (2) increasing accidents through impaired cognition.
- If air pollution affects road risky behaviors through respiratory channels, the number of accidents caused by violations committed by non-enclosed vehicle drivers will decrease more than those by enclosed vehicle drivers.
- If air pollution affects road risky behaviors through visual channels, the effect would be stronger during times with ambient natural light, when air quality can be visually assessed, than during times without.

Data
- Administrative traffic accident data between 2009 and 2015.
- Daily air quality (PM2.5) data at district/township level, averaged from air quality data at 3844 km² grid resolution.

The endogeneity between pollution and accidents
Taking into account the endogeneity between pollution and accidents, we use wind directions as instrumental variables to introduce exogenous-variation in air quality

- Omitted variables: e.g., the variations in traffic volumes not controlled by the fixed effects
- Avoidance behaviors: individuals decide not to travel because of a high level of air pollution
- Reverse causality: traffic accidents may lead congestion and more exposure to pollution

Assumptions for a valid instrument:
- Relevance: wind direction affects air quality in Taiwan
- Exclusion restriction: wind direction would only affect road risk behaviors and accidents through changing air quality, conditional on weather conditions
- Independence: wind direction is independent from the errors of accidents on air pollution
- Monotonicity: the effects of wind direction on air pollution are monotonic

Wind directions and air quality in Taiwan

W | NE | E | SE | S | SW
---|---|---|---|---|---
PM2.5 concentration (µg/m³)
4.9 | 5.3 | 5.5 | 5.7 | 5.8 | 6.0

Empirical Strategy

THE FIRST STAGE

\[ AQ_{it} = \gamma AQ_{it-1} + W_{it} + \delta X_{it} + \epsilon_{it} \]

- \( AQ_{it} \): the air quality (pollutant) measure in district/township \( p \) in day \( t \)
- \( AQ_{it-1} \): if district/township \( p \) is in air quality zone \( q \)
- \( W_{it} \): the share of hours in the 24-hour period in which wind blows from a certain direction
- \( X_{it} \): weather condition variables
- \( \epsilon_{it} \): spatial and temporal fixed-effects

First Stage (Air Pollution on Wind Directions)

THE SECOND STAGE

(a nonlinear stage with Poisson regression)

\[ Acc = \exp(\beta AQ_{it-1} + \gamma AQ_{it} + \delta X_{it}) + \eta_{it} \]

- \( Acc \): the traffic accident related count in region \( i \) within a time period \( t \)
- \( \eta_{it} \): the residual \( AQ_{it-1} + AQ_{it} \) from the first stage
- \( X_{it} \): a vector of weather condition variables
- \( \delta \): spatial and temporal fixed-effects

Transmission Channels Test
- Respiratory and Visual
- A placebo test: the effect of ozone, which is generally found to have little effect on a nucleus of skin.

The nonlinear effects of air pollution on risky behaviors
- Based on each region’s average PM2.5 concentration, we stratify all regions into two groups: the better and worse 50.
- Nonlinear second stage with linear splines.

Conclusion
- We find that a 1 µg/m³ increase in PM2.5 concentration leads to a 0.59% decrease in accidents caused by driver violations.
- A nonlinear dose-response relationship between air pollution and risky behaviors: air pollution likely increases the degree of risk aversion at an increasing rate (or at a rate faster than that on reducing cognition).
- The cost of air pollution on cognitive performance and other associated health outcomes involving risk attitudes may be biased, if the effect on risk attitudes is not isolated.
- Air pollution can affect risk preferences through visual channel: the negative effects are only observed in times when air quality can be visually assessed.