An economic perspective on accountability research

Matthew Neidell
Coumbia University, NBER and IZA
Valuation: Cost benefit analysis

- $ in job loss, emissions compliance, ...
- # of deaths, hospitalizations, ...

[Image of an apple and an orange]
Valuation: Cost benefit analysis

- $ in job loss, emissions compliance, ...
- $ of deaths, hospitalizations, ...

\[\text{Apple} \quad \text{Apple}\]
Valuing benefits

- \( V = \text{mortality effect} + \text{hospital effect} + \ldots \)
  - Mortality effect = effect of pollution on mortality \( \times \) value of mortality risk
  - Hospital effect = effect of pollution on hospital \( \times \) hospital charge + lost work days \( \times \) wage rate
Valuing benefits

- $V = \text{mortality effect} + \text{hospital effect} + \ldots + \text{avoidance effect}$
  - Mortality effect = effect of pollution on mortality * value of mortality risk
  - Hospital effect = effect of pollution on hospital * hospital charge + lost work days * wage rate
  - Avoidance effect = effect of pollution on avoidance * cost of avoidance
Valuing benefits

• \( V = \text{mortality effect} + \text{hospital effect} + \ldots \)
  • Mortality effect = effect of pollution on mortality * value of mortality risk
  • Hospital effect = effect of pollution on hospital * hospital charge + lost work days * wage rate

• Include all health effects
  • Focus on “extreme” outcomes
    • Misses subtle effects: ear nose and throat (ENT), eyes, etc.
    • Absenteeism vs. presenteeism
  • New outcomes: human capital & worker productivity
    • Easily monetizable
    • More widespread: not just vulnerable
Extreme vs. subtle measures of health

sick

pollution

death

asthma/
s* absence

s**
Causal effect of pollution

• Economic models of residential location
  • Pollution exposure “endogenous”
• Quasi-experimental methods
  • Isolate “exogenous” sources of pollution $\rightarrow$ causal relationships
  • Placebo testing
Choosing where to live
Orange arrows show correlated factors
“Endogenous” exposure
“Endogenous” exposure
“Exogenous” variation in pollution
“Exogenous” variation in pollution
“Exogenous” variation in pollution
“Exogenous” variation in pollution

• Various ways to implement
  • Cross-sectional and fixed effect regressions
  • Difference in differences
  • Instrumental variables
  • Regression discontinuity

• Limitations
  • Response to changes
    • Rain $\rightarrow$ less time outside $\rightarrow$ less exposure
    • Regulation $\rightarrow$ employment $\rightarrow$ health
  • External validity
  • Construct validity
Example: worker productivity

• Collect data from farm
  • Workers paid piece rate → Daily measures of productivity
  • Workers followed over time
  • Daily ozone and confounders (co-pollutants, temperature, humidity, wind, rain, sun, ...)

• Daily regression
  • Firm not source of emissions
  • Control for worker sorting with fixed effect
  • Flexible controls for weather, seasonality
  • Concern: labor supply → test directly

• Findings
  • 10 ppb increase in ozone → 5.5% decrease in productivity
  • Apply to all farms: $700m in labor costs

Inspired by Michael Brauer’s work in Fraser Valley
Low levels of ozone related to productivity

Effect of ozone on worker productivity
Example: worker productivity

- Collect data from farm
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- Findings
  - 10 ppb increase in ozone → 5.5% decrease in productivity
  - Apply to all farms: $700m in labor costs
- Limitations
  - Exposure based on central monitoring site
  - Limited external validity: < 1% US (and similar) in agriculture
Extensions to the indoor workplace

• PM$_{2.5}$ penetrates indoors
• Manufacturing
  • Piece rate workers at pear packing factory (mean PM$_{2.5}$=8.9 μg/m$^3$)
  • Similar daily regression with worker fixed effects (FEs)
  • Finding: 1 μg/m$^3$ change in PM$_{2.5}$ → 0.6% change in productivity
  • Aggregate productivity benefits: $19.5b

• Service sector
  • Call center workers, partly performance based pay
  • Similar daily regression with worker FEs
  • Finding: 10 unit change in air pollution index (API) decreases calls by 0.3%
  • $2.2b to China (10 unit); $525m in Los Angeles (AQI < 100)

• Finance
  • Stock prices as proxy for investor behavior
  • Pollution → cognition, mood → risk aversion
  • Similar daily regression (no worker FEs)
  • Finding: significant negative correlation between PM$_{2.5}$ and daily returns
Heterogeneity of PM$_{2.5}$ effects on productivity

Effect of PM$_{2.5}$ on worker productivity
Placebo testing: Effect of pollution from all cities on stock market prices
Placebo testing: Statistical significance of effect of pollution from all cities on stock market prices
Long term effects: Evidence from the Acid Rain Program

• 1994 Acid Rain Program focused on SO$_2$
  • Decreased PM$_{2.5}$
  • Affected 110 plants
  • Limited behavioral responses
    • Minimal employment effects
    • Broad “treatment” areas (100 miles)

• Difference in differences “event study” from 1990-2005
  • Compare “close” vs. “far” counties over time
    • Use propensity-score to select “far” counties
  • Compare pre-Acid Rain Program period
  • Focus on prime working age 35-64
Difference in SO$_2$ between “close” and “far”
Difference in mortality between “close” and “far”
Testing model assumptions
Conclusion

• Economic perspective
  • Valuation
    • Making cents of benefits
    • Old & new outcomes
  • Economic models
    • Behavioral confounding $\rightarrow$ endogenous exposure
    • Quasi-experimental methods $\rightarrow$ exogenous exposure, placebo testing

• Worker productivity
  • Impacts on outdoor & indoor, low & high skilled
    • No relationship to labor supply
  • Effects on all workers, at low levels of pollution
  • Environmental regulations as a tool for promoting growth?

• Effects from long-term exposure
  • ARP as “exogenous” source of variation
  • Prime working age adults: benefits = $\sim$150b per year
  • Potential implications for Clean Power Plan
References & funding


• NIEHS (R21 ES019670-02), “The impact of environmental conditions on the productivity of agricultural workers.”