# Agglomeration, environmental regulation, and the polluting firm's location decisions

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# Agglomeration, Environmental Regulation and the Polluting Firm's Location Decisions


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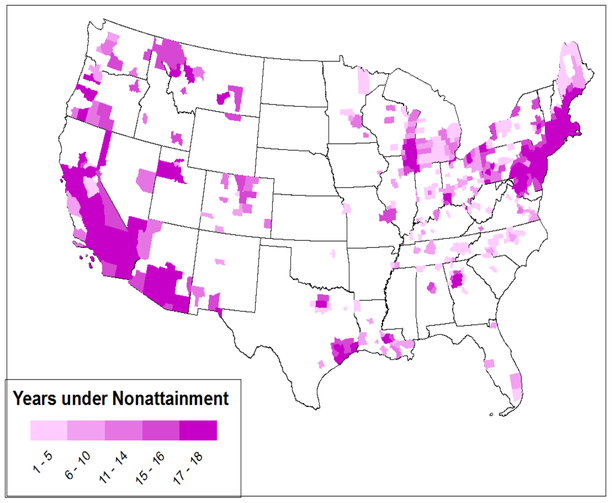
## Introduction

There are spatial and temporal heterogeneity of the location of polluting firms in the United States. For major air pollutants under Clean Air Act regulation: CO, $PM_{10}$,$SO_2$, $NO_2$, and VOC, seven pollution intensive industries contribute more than 74% of the total air emission from manufacturing sectors. Air pollution can cause severe damage on human health as well as ecosystem, so it is interesting to find out major factors that influence polluting firm's location decisions.




## Research Questions

This study attempts to address the following questions:

- Are new polluting plants more likely to be established in counties with weaker environmental regulations?
- Are localized or urbanized counties more attractive to new plant births?
- Do agglomeration effects reinforce or offset the effect of environmental regulation on firms' location choices?

## Data

| Variable | Definition |
|---|---|
| **New births** | Number of county level establishment births in two-digit SIC industries: 26,28,29,32,33,34,37. |
| **26-paper and allied products** | |
| **28-chemicals and allied products** | |
| **29-petroleum and coal products** | |
| **32-stone, clay and glass** | |
| **33-primary metal industries** | |
| **34-fabricated metal products** | |
| **37-transportation equipment** | |
| | |
| **Location quotient (LQ)** | Location quotient by industry and county. (Feldman, 1994) |
| **Attainment status (Att)** | Dummy variable = 1 if county out-of-attainment for any of the four pollutants: ozone, carbon minoxide, sulfer dioxide, particulate matter 10. |
| **Ln (pop)** | Natural log of population (1000s) by county. |
| **Ln (wage)** | Natural log of total annual payroll divided by total employment ($1000s) by county. |
| **Unemployment** | Unemployment rate by county. |
| **Education** | Percentage of population over 25 years old with a bachelor's degree or higher. |
| **Ln(tax)** | Natural log of per capita property tax by county. |
| **Amenity** | Natrual amenity scale by county. |
| **Road Density** | Length of local road divided by land area by county. |

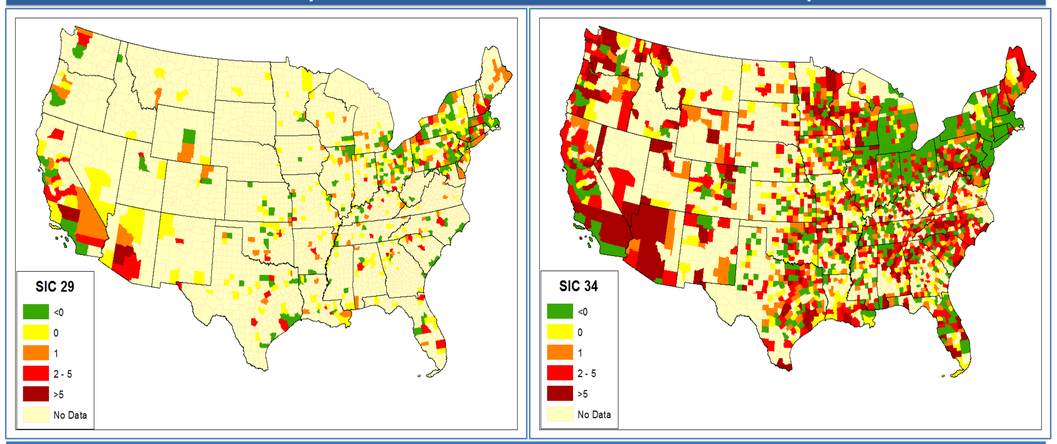
## Industry Air Emissions Contributions, 1995

| Pollutant | Paper | Chemical | Petroleum | Stone, clay, glass | Primary metal | Fabricated metal | Transportation equipment | Total |
|---|---|---|---|---|---|---|---|---|
| CO | 17.55% | 8.80% | 11.78% | 1.63% | 55.29% | 0.11% | 0.99% | 96.15% |
| $PM_{10}$ | 14.53% | 12.49% | 7.67% | 30.47% | 25.49% | 0.48% | 0.98% | 92.11% |
| $SO_2$ | 14.66% | 13.53% | 27.86% | 14.58% | 26.28% | 0.17% | 1.09% | 98.17% |
| $NO_2$ | 22.45% | 19.65% | 21.66% | 19.26% | 11.08% | 0.93% | 1.35% | 96.38% |
| VOC | 7.17% | 18.80% | 22.87% | 2.24% | 8.12% | 7.56% | 7.49% | 74.25% |

Data from US EPA Industry Sector Notebooks, various profiles, 1995.

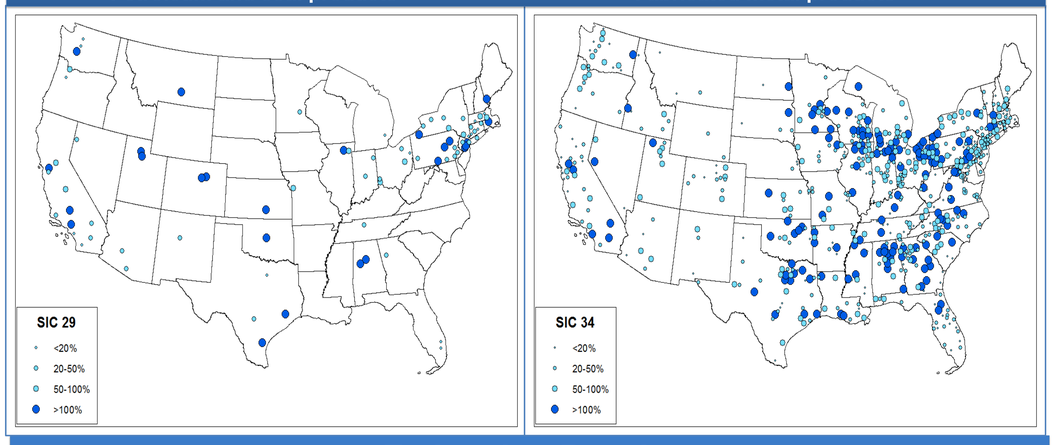
## Change in stock of establishments (1989-2006)

Petroleum and coal products | Fabricated metal products




## Industry concentration (2006)

Petroleum and coal products | Fabricated metal products




## Estimation Results

| New Births | Paper | Chemical | Petroleum | Stone, clay, glass | Primary metal industries | Fabricated metal | Transportation |
|---|---|---|---|---|---|---|---|
| **Non-Attainment** | negative | negative | negative | negative | negative | negative | insignificant |
| **LQ** | positive | positive | positive | positive | positive | positive | positive |
| **Ln(pop)** | positive | positive | positive | positive | positive | positive | positive |
| **Non-Att x LQ** | negative | mixed | mixed | insignificant | negative | negative | negative |
| **Non-Att x ln(pop)** | positive | positive | positive | positive | mixed | positive | insignificant |
| **Ln (wage)** | negative | negative | negative | negative | negative | negative | negative |
| **Unemployment** | negative | negative | mixed | negative | negative | negative | negative |
| **Education** | insignificant | positive | mixed | positive | negative | negative | positive |
| **Ln(tax)** | negative | mixed | negative | positive | negative | mixed | negative |
| **Amenity** | insignificant | positive | positive | positive | insignificant | positive | positive |
| **Road Density** | positive | positive | positive | insignificant | insignificant | positive | positive |

## Conceptual Framework

Following Becker and Henderson (2000), suppose an entrepreneur decides to open a new establishment, and he or she chooses the location for its branch where the expected profits are maximized. The total new births $y_{ct}$ at a county depends on a variety of county characteristics that may affect the expected profits of the new establishments. So the model of the new births can be expressed as:

$y_{ct}$ = number of new plants,
$R_{ct}$ = environmental regulation,
$A_{ct}$ = agglomeration economies,
$E_{ct}$ = variables measuring infrastructure and human capital
$Z_{ct}$ = control variables of county characteristics,
$e_{ct}$ = error term.

## Econometric Modeling

- Poisson model ( Hausman et al. 1984)
  - Fixed effects
  - Random effect
- Negative binomial model
- GMM estimation (Wooldridge 1991,1997, Windmeijer 2000)
  - Regulation and agglomeration variables maybe endogenous;
  - Directly fix the endogeneity issue
  - Consider variable $x_{ct}$ endogenous:
  - Use a quasi-differencing transformation:
    - $q_{ct} = \frac{y_{ct}}{\lambda_{ct}} - \frac{y_{ct-1}}{\lambda_{ct-1}} = \frac{e_{ct}}{\lambda_{ct}} - \frac{e_{ct-1}}{\lambda_{ct-1}}$
    - Let $Z_c^{t-2} = (x_{c1}, \ldots, x_{ct-2})$, then $E(q_{ct}|Z_c^{t-2}) = 0$
    - $Z_c^{t-2}$ can be used as instruments for $x_{ct}$, for $t = 2, \ldots, T$.

## Conclusion

Impacts of locational factors:

- Stringency of environmental regulation – negative
- Agglomeration economies – positive
- Interaction between regulation
  - Vary across industries
  - Extreme case: agglomeration dominates, making regulation ineffective
- Education – positive
- Wage – negative
- Unemployment – negative
- Property tax – negative

## References


Becker, R. & Henderson, V., 2000. Effects of air quality regulations on polluting industries effects of air quality regulations on polluting industries. The Journal of Political Economy, 108(2), pp.379-421.

Feldman, M., 1994. The Geography of Innovation, Dordrecht: Kluwer Academic.

Hausman, J.A., Hall, B.H. & Griliches, Z., 1984. Econometric models for count data with an application to the patents-R & D relationship. Econometrica, 52(4), pp.909-938.

Windmeijer, F., 2000. Moment conditions for fixed effects count data models with endogenous regressors. Economics Letters, 68(1), pp.21-24.

Wooldridge, J.M., 1991. Specification testing and quasi-maximum likelihood estimation. Journal of Econometrics, 48(1-2), pp.29-55.

Wooldridge, J.M., 1997. Multiplicative panel data models without the strict exogeneity assumption. Econometric Theory, 13, pp.667-678.