

AIR QUALITY'S EFFECT ON THE HOUSING MARKET

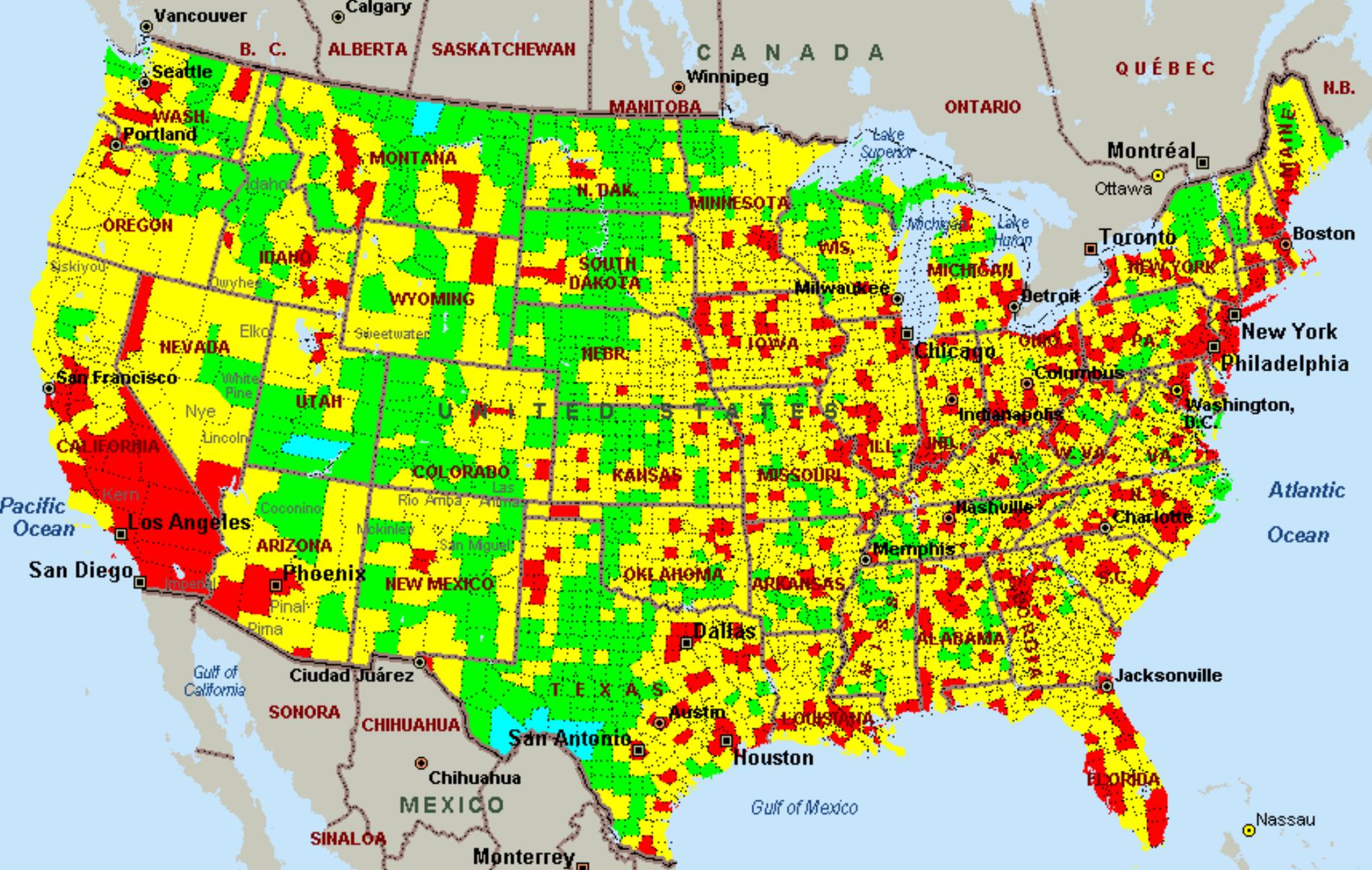


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“Does Air Quality Matter, Evidence from the Housing Market” Kenneth Chay & Michael Greenstone

- Efforts to regulate air pollution in the United States have been among the most controversial interventions mandated by the federal government.
 - Due to the lack of convincing empirical evidence on the costs and benefits of environmental regulation, contentious debates about the value of environmental policy are often based on conjecture and hyperbole.
- Consequently, credibly measuring the economic value of
- clean air to individuals is a topic of considerable interest to both economists and policy makers.



A **B** **C** **D** **F**

A=Best/Cleanest Cities in the US F=Worst/Dirtiest Cities in the US

AIR QUALITY DETERMINANTS

- The emission gradesheets compare US counties for eleven air pollutant emissions.

-carbon monoxide
-nitrogen oxides
-particulate matter (two sizes)
-sulphur dioxide
-diesel emissions

-lead compounds
-volatile organic compounds
-ammonia
-hazardous air pollutants
-acrolein.

- The grades are based on emission densities of pollutant tons per square mile.

THE AIR WE BREATHE

- If the air we breathe contained grade D concentrations of any of these, with each breath we could also inhale:
- 500,000,000,000,000 nitrogen dioxide molecules,
- or 3,000,000,000,000,000 ozone molecules
- or 2,000,000,000,000,000 sulphur dioxide molecules!



LOS ANGELES



MEXICO CITY



GREELEY, COLORADO



BERKELEY

HOW WE HARM OURSELVES

- **CARBON: Highway Vehicles, Non-Road Gasoline**
- **NOx: Highway Vehicles, Railroads, Diesels**
- **VOC: Highway Vehicles, solvent utilization**
- **PM10: Fugitive dust, waste disposal/recycling**
- **PM2.5: Fugitive dust, highway vehicles, open burning**
- **HAP: Consumer Products usage, surface coatings**
- **Diesel: Diesel engines**
- **Acrolein: structure fires, all aircraft types/operations, light/heavy duty gasoline vehicles**

THE CLEAN AIR ACT OF 1970

- Sec. 101. (a) The Congress finds –
 - (2) “that the growth in the amount and complexity of air pollution brought about by urbanization, industrial development, and the increasing use of motor vehicles, has resulted in mounting dangers to the public health and welfare, including injury to agricultural crops and livestock, damage to and the deterioration of property, and hazards to air and ground transportation”
 - (3) that air pollution prevention and air pollution control at its source is the primary responsibility of States and local governments

Clean Air Act Amendments in 1977 & 1990.

- The goal of the Act was to set and achieve NAAQS in every state by 1975.
- The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines
- The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics.

Section 107 (d)

- “The centerpiece of the CAAAs was the EPA’s **assignment of each county to either non-attainment or attainment status** based on whether the federally determined maximum allowable pollution concentration was or was not exceeded”
- (i) **nonattainment**, any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant. (i.e. county’s emission exceed an annual geometric mean of 75 mg/m³ or had a twenty-four hour concentration of greater than 260 mg/m³ more than once in a given year)
- (ii) **attainment**, any area that meets the national primary or secondary ambient air quality standard for the pollutant
- Polluter in non-attainment counties faced greater federal regulatory oversight than those in attainment counties

National Trends in Total Suspended Particulates Pollution, 1971-90

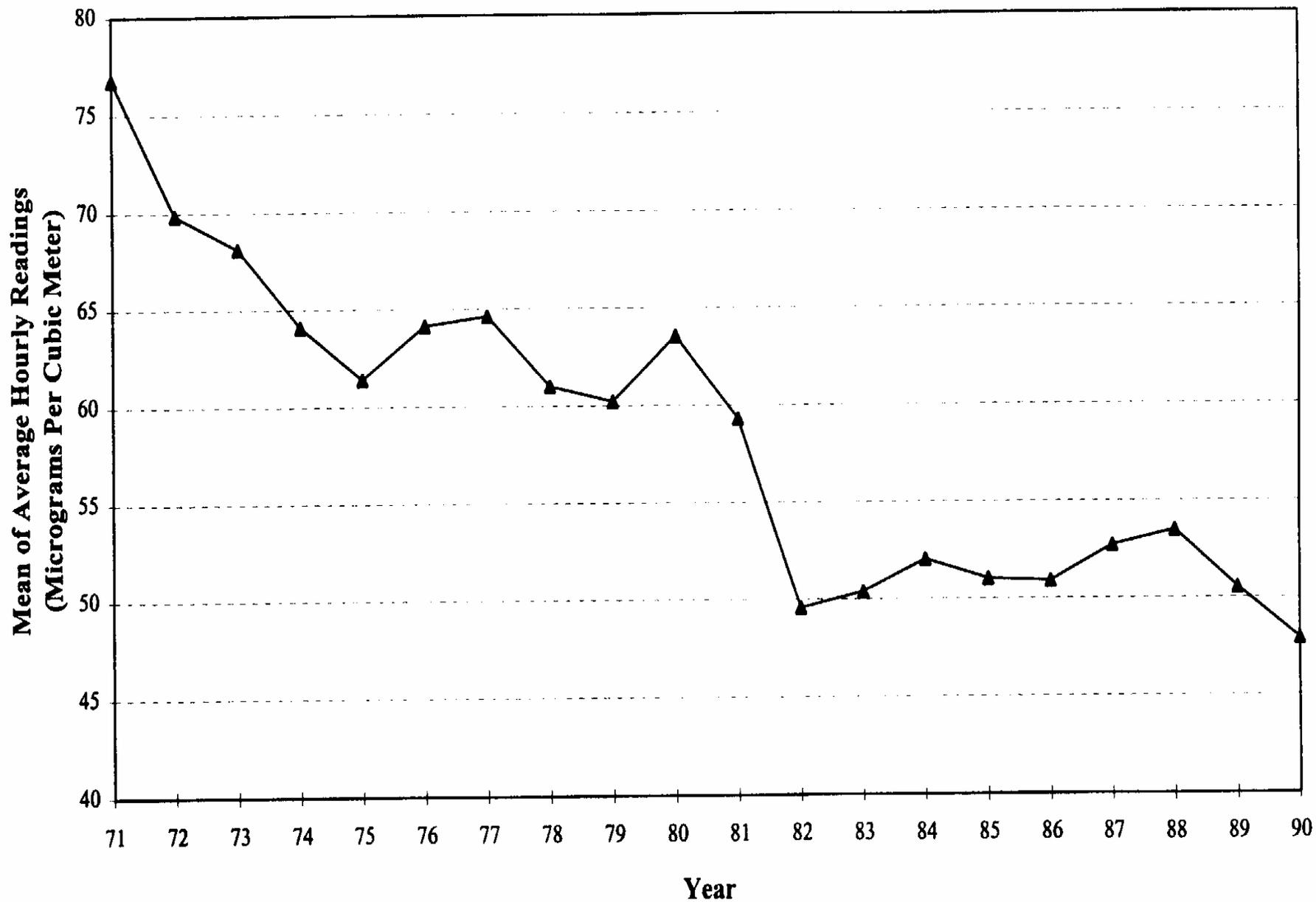


Table 1: Characteristics of Counties with Total Suspended Particulates Monitors

	Attainment Counties		Nonattainment Counties	
	(1)		(2)	
<u>Number of Counties Monitored</u>				
1971-2	810		287	
1977-79	1000		444	
1987-9	873		127	
<u>Share of U.S. Population in Monitored Counties</u>				
1971-2	0.414		0.396	
1977-79	0.399		0.463	
1987-9	0.516		0.262	
<u>Mean (Standard Deviation) of County-Specific Average Hourly Reading</u>				
1971-2	64.6	(29.1)	92.3	(30.5)
1977-79	54.8	(17.2)	78.2	(31.1)
1987-9	50.1	(14.5)	68.0	(19.1)

Hedonic Theory: What is it?

- **Hedonic demand theory (a.k.a Hedonic regression)**
 - Method of estimating demand or prices.
 - Breaks down the item being researched into its different characteristics, and obtains estimates of the value of each characteristic.
 - Assumes that there is a separate market for each characteristic.
 - Estimated using ordinary least squares (OLS) regression analysis.

Hedonic Theory: Example

- Refrigerators today cost more than a refrigerator did 20-30 yrs ago. But refrigerators today are also better. (e.g. icemaker instead of ice trays or water dispenser instead of leaving a jug in the fridge)
- These improved features are what is called **hedonicism** or utility. So instead of just looking at the mere price increase of refrigerators, economists look at the price increases caused by the addition of new refrigerator features (e.g. icemaker or water dispense).
- Commonly used in real estate economics and consumer price index (CPI) calculations.

Hedonic Theory: Air Quality

- Inferring the economic value of environmental amenities (i.e. air quality) is not immediately obvious
- Traditional approach to this problem has been to use the housing market to find the implicit prices of air quality (a non-market good).
- Hedonic theory predicts that the implicit price function relating housing prices to air quality will be positively sloped, assuming all else equal.

Hedonic Theory: Air Quality

- So Hedonic Theory basically says; holding all other determinants of property values constant, housing prices will rise as pollution levels fall.
- Intuitively makes sense that locations with high levels of pollution must have a lower housing price in order to attract people to live there.
- So if air quality does get factored into property values, then the housing market can potentially be used to measure the economic benefits of “pollution regulations that clean the air.”

Previous Research: The Setup

- Researchers have used simple regression analysis to estimate the relationship between location-specific property values and air pollution (measured by particulate matter) adjusted for differences across locations.
- The particulate matter regression coefficient from the cross-sectional housing price equation is then interpreted as the implicit price schedule for air quality.

Previous Research: Results

- The cross-sectional relationship between particulate matter and housing prices appears relatively weak.
- Smith and Huang's analysis of 86 estimates from thirty-seven cross-sectional studies suggests that a one unit (mg/m^3) decrease in total suspended particulates (TSPs) results in a 0.05-0.10 percent increase in property values.
- The estimates from the surveyed studies imply a median marginal willingness-to-pay (MWTP) of \$22.40 (in \$1982-84) for a one-unit reduction in TSPs.
- Using the median MWTP, if particulate levels decline from Pittsburgh's 1970 average of $133 \text{ mg}/\text{m}^3$ to Santa Barbara's 1970 average of $65 \text{ mg}/\text{m}^3$ ($68 \text{ mg}/\text{m}^3$ - a very significant reduction), then property values would only increase by only \$1,500.

C&G's Amendments

- Estimating whether air quality gets factored into property values was a much more difficult problem than previously recognized in research and literature.
- Chay and Greenstone state that areas with high levels of TSPs tend to have better-educated populations and higher per-capita income as well as population densities.

They argue that, "...since air pollution levels are not randomly assigned across locations, the "true" relationship may be obscured in the cross-sectional analyses approach by the unobserved determinants of housing prices that correlate with air pollution, and the "conventional" estimates may be biased."

- Hedonic Theory predicts that housing prices rise with air quality, all else equal: ALL ELSE IS NOT EQUAL IN REAL WORLD!

C&G's Research Design

- The conceptual idea underlying their study was to use the attainment/nonattainment status (from CAAs) of counties as “instruments” for county-level changes in air quality over the 1970s and 1980s.
 - Allowed them to relate the regulation-induced changes in particulate matter to coinciding changes in housing prices.
 - Their research design provides a more credible basis for evaluating the relationship between TSPs and housing prices than previous cross-sectional analyses.
- 1) The regulations are federally mandated, and, therefore, are less likely to be related to differences in tastes, characteristics, or underlying economic conditions across counties (this equalizes counties thus ensuring that all else is equal).
 - 2) The federal imposition of the law is presumably independent of the local political process determining the supply of local non-market amenities (all else equal condition again is held).

C&G Data Information

- Bought a variety of comprehensive and detailed data on county-level air pollution, the federally imposed environmental regulations, county characteristics, and property values for the 1970-1990 period.

C&G Additional Information

- Comprehensive microdata (i.e. extremely detailed data on housing prices and air pollution) covering the 1970-1990 period.
- Air pollution data comes from the Air Quality Subsystem Database
- Housing Data include the following:
 1. demographic and socioeconomic variables
 2. neighborhood characteristics
 3. fiscal and tax variables
 4. expenditures
 5. structural housing characteristics

C&G Research: Findings

- Chay and Greenstone found that TSP pollution regulations are causally related to both pollution reductions and housing price increases during the 1970s and 1980s.
- They also presume that regulation-induced changes in pollution represent an exogenous shift in the supply of clean air driven by the federal government.

C&G Research: Results

- Two striking empirical regularities emerged from the study
 - 1) Particulate matter declined substantially more in regulated than in unregulated counties during the 1970s and 1980s.
 - 2) At the same time, housing prices rose more in regulated counties.

C&G Research: Results Continued

- The evidence suggests that this approach identifies two causal effects:
 - 1) the impact of regulation on air quality improvements
 - 2) the impact of regulation on economic gains for home-owners
- The “causal” estimates imply that a one-unit reduction in suspended particulates results in a 0.7-1.5 percent increase in home values. This increase also varies little by region and demographic group.
- In addition, one set of calculations suggests that the pollution regulations may have resulted in over \$80 billion (in \$1982-84) of aggregate economic gains for home-owners in regulated counties during the 1970s and \$50 billion of benefits in the 1980s.

C&G Research: Conclusion

- Conventional cross-sectional estimates are unstable and indeterminate across specifications.
- Using regulation-induced changes in particulate matter leads to more reliable estimates of the capitalization of air quality into property values.
- Instrumental variables estimates (from C&G's research) are much larger, insensitive to specification of the model, and appear to purge the biases in the conventional estimates.

C&G Research: Conclusion

- It appears that environmental regulations reduced air pollution and that these reductions were capitalized into property values.
- Results from this study show the potential promise of using hedonic analysis of the housing market to measure the value of environmental resources and the monetary benefits of federal pollution regulations.

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