
Assessing the Impact of the National Air Ambient Quality Standard on the Ambient Levels of Particulate Matter.

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Introduction

Background

- Over the last few decades many efforts have been taken to improve air quality: in the US ambient Particulate Matters (PM10) concentrations have declined by approximately 30% (1990-2006) (EPA, 2007).
 - Adverse health effects associated with ambient exposure to air pollution persist (Dominici et al. 2006, Peng et al. 2008, Pope et al. 2009).
 - Increasing importance the evaluation of the accountability research (HEI 2003), aimed at evaluating the effects of air quality regulation on health outcome
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National Air Ambient Quality Standard (NAAQS)

NAAQS
for PM₁₀
(1987)

- Annual average of PM₁₀ < 50 µg/m³
- Daily average PM₁₀ < 150 µg/m³ for less than 3 times/yr

DESIGNATION

REDESIGNATION



1987

1991

1997

2006

Nonattainment → State Implementation Plan (SIP) → ? → Attainment

Attainment

Unclassified

Aims

Are the NAAQS for PM_{10} , the designation process and the subsequent SIP implementation effective in reducing PM_{10} levels?

Group A
counties designated as in attainment or unclassified with respect to the 1987 NAAQS and maintained their status

Group B
counties designated as nonattainment with respect to the 1987 NAAQS and subsequently redesigned as in attainment

If air pollution control program adopted to meet the NAAQS are effective in reducing air pollution levels, than counties in group B will experience a sharper decrease in PM_{10} levels than counties in group A.

Materials and methods

Data

- Monthly time series of PM₁₀ levels for 100 US counties for the period 1987-2007 (source: US EPA AirData database)
 - County specific attainment status at 1991 and 2006 (source: Federal Register Notice)
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Long term trend in PM_{10} levels and attainment status

Two stage Bayesian hierarchical model:

1 $\log(PM_{10})_t^c = \beta_0^c + \beta_1^c(t - \bar{t}) + \beta_2^c I^c + \beta_3^c(t - \bar{t}) I^c + \varepsilon_t^c$

• $I^c=0$: $\log(PM_{10})_t^c = \beta_0^c + \beta_1^c(t - \bar{t}) + \varepsilon_t^c$ Monthly rate of change in PM_{10} (group A)

• $I^c=1$: $\log(PM_{10})_t^c = (\beta_0^c + \beta_2^c) + (\beta_1^c + \beta_3^c)(t - \bar{t}) + \varepsilon_t^c$

Monthly rate of change in PM_{10} (group B)

2 $\beta^c | \beta \sim N_4(\beta, \Psi)$ for each county $c=1, \dots, 82$

Effects of changes in attainment status on long term trend in PM_{10} levels

Parameter of interest: posterior probability of β_3

β_3 = monthly rate of change in PM (group B) -
monthly rate of change in PM10 (group A)

$\beta_3 < 0$  PM_{10} levels for counties in group B are decreasing faster than for counties in group A

Counties that are making a serious effort to comply to the NAAQS have a sharper decline in PM_{10} levels

Sensitivity analysis

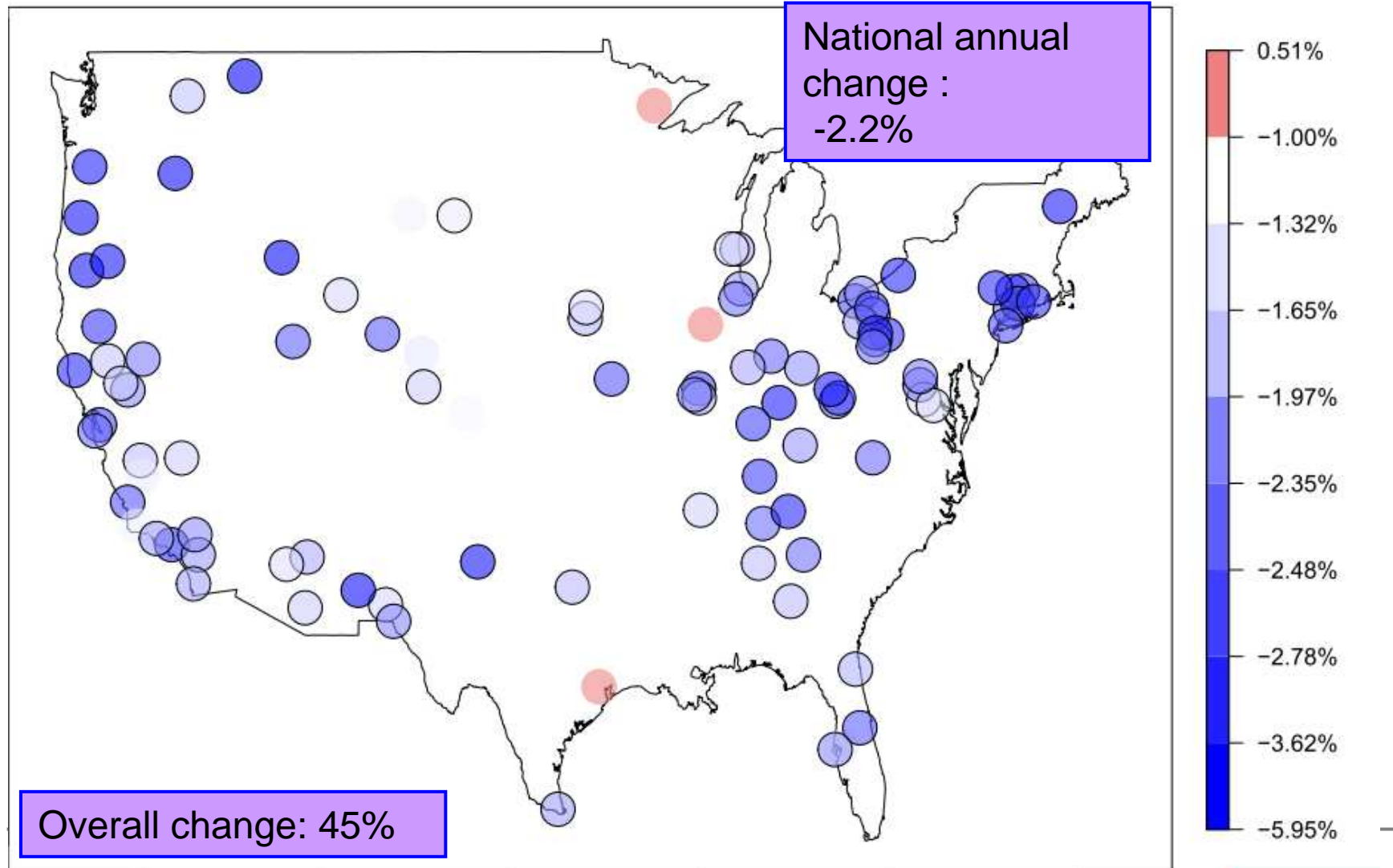
- adjustment by county specific measures of the socio-economic status (SES)

Alternative modeling and estimating approaches

- linear mixed-effects model (REML)
 - linear mixed effect model adjusted by county specific measures of SES
 - linear regression (OLS);
 - linear regression (OLS with robust standard errors)
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Results

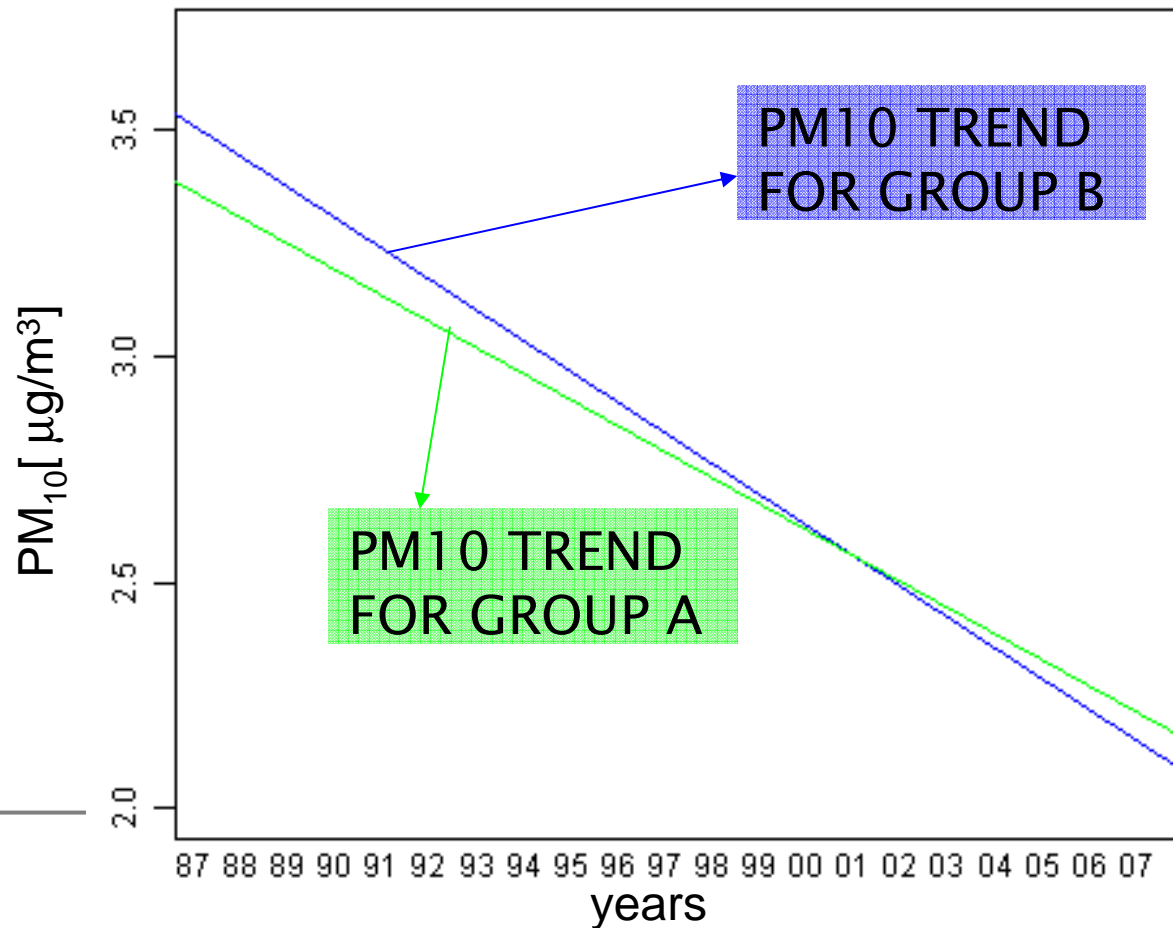
Yearly percentage change in PM₁₀ levels (yrs 1987-2007)



Overall PM₁₀ trend and change in attainment status

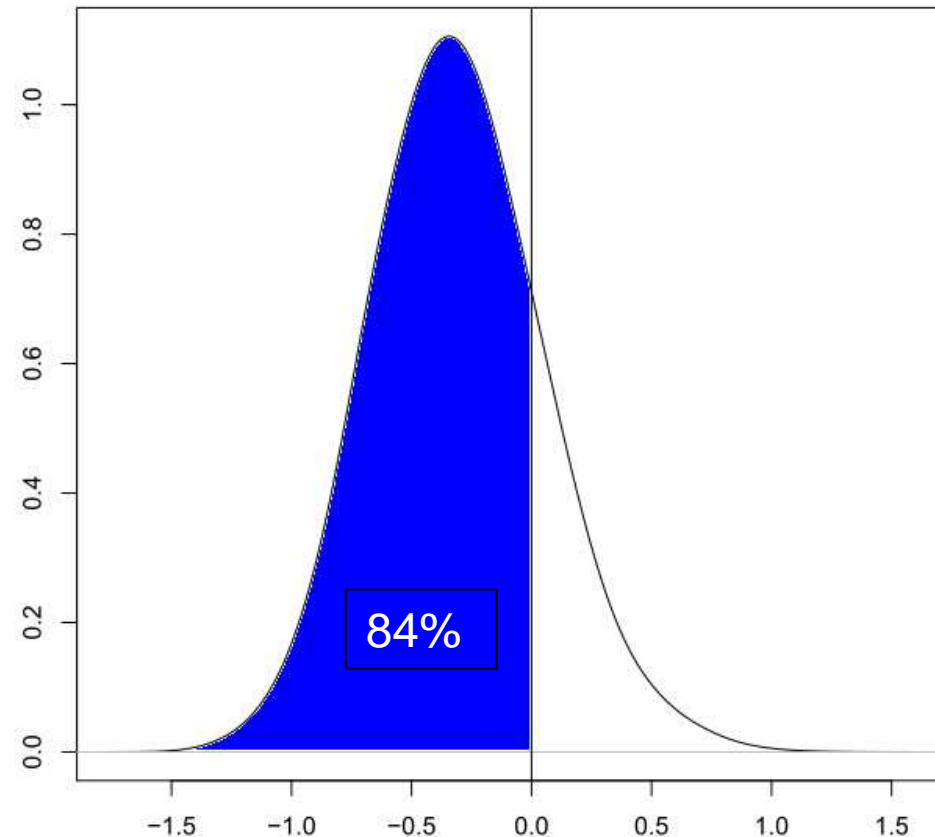
Group A (N=68)		
Var	Est	95\%CI
β_0	3.340	(3.279,3.401)
β_1	-2.077	(-2.339,-1.816)

Group B (N=14)		
Var	Est	95\%CI
$\beta_0+\beta_2$	3.411	(3.043,3.739)
$\beta_1+\beta_3$	-2.224	(-3.076,-1.107)



Overall PM₁₀ trend and change in attainment status

- Posterior probability of $\beta_3 < 0 = 84\%$
- strong **evidence** that designation as nonattainment status and subsequent redesignation as in attainment, determines a faster decline in PM₁₀ concentrations than being always in attainment.



Conclusions

Conclusions

- Counties transitioning from nonattainment to attainment (**group B**) status during the period 1987-2007 experienced a **sharper decline** in PM_{10} with respect to counties that were always in attainment (**group A**).
 - NAAQS + designation process: effective in reducing PM_{10} levels.
 - These analyses could be repeated routinely for each revision in the NAAQS.
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Limitations and further analysis

Limitation

- We considered as only potential confounder the SES, without taking into account other factors
- Lack of information about county-specific SIP
- We only considered the designation as attainment or nonattainment counties in two time points

Further analysis

- statistical model that allows for random changing point corresponding to every change in the designation status.
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Thank you for your attention!
