Air Pollution and Procyclical Mortality

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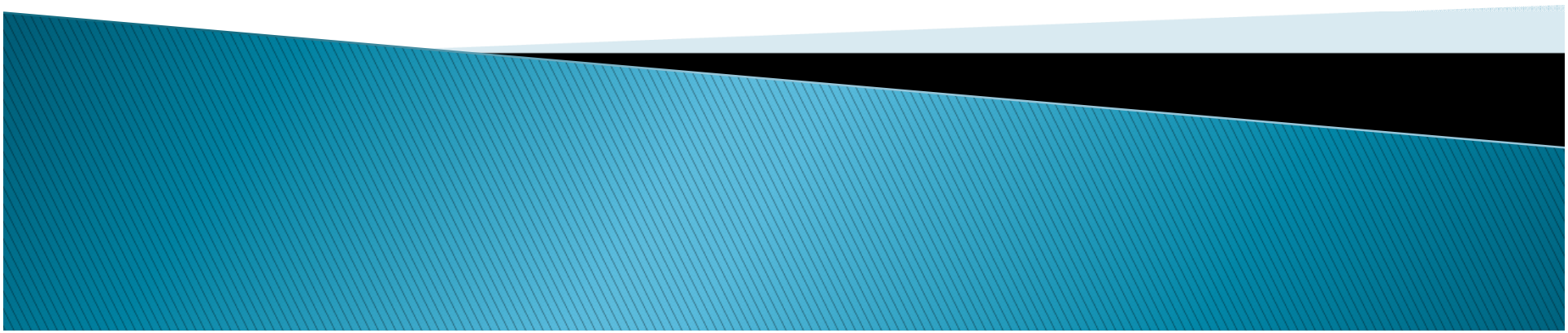
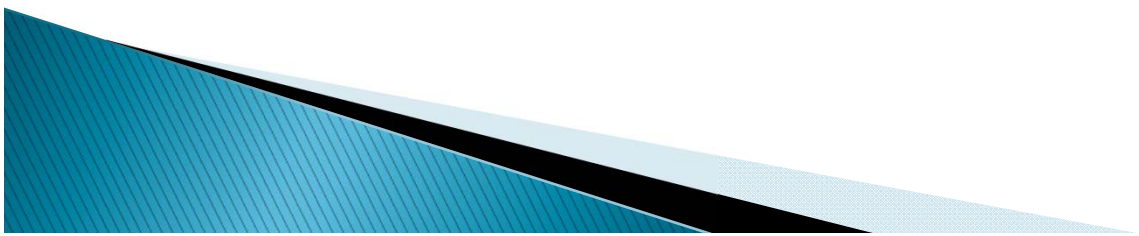


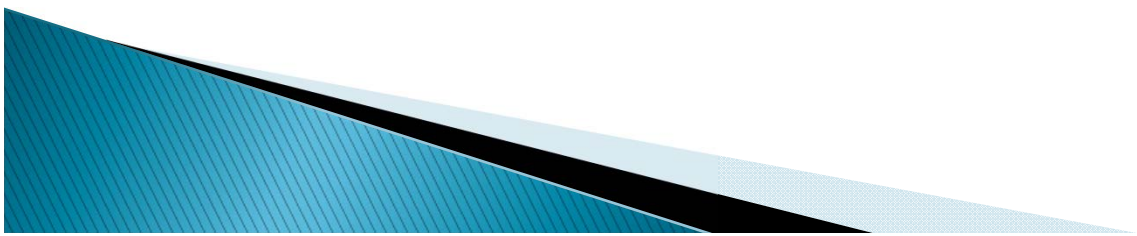
Motivation

- Health is countercyclical
  - Mortality is procyclical – death rates rise in expansions and fall in recessions
- Mechanisms behind this procyclicality are not well understood
  - Work hours/intensity
  - Health behaviors (e.g. smoking, drinking)
  - Driving
  - Pollution



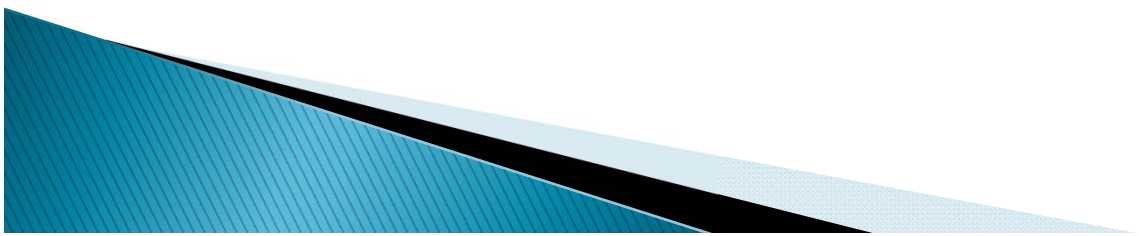
Motivation

- We investigate the contribution of air pollution to the procyclicality of mortality
- State-year level data on mortality rates, total, by cause of death, and by age
- State-year level data on ambient concentrations of two pollutants
  - Carbon monoxide (CO)
  - Particulate Matter (PM10)
- Proxy for macroeconomy: unemployment rate
- Is pollution correlated with mortality rates? Does including pollution in mortality regressions attenuate the coefficient on unemployment?



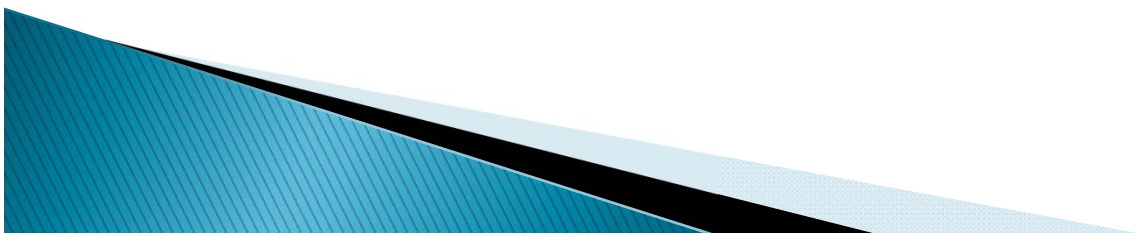
Results

- Substantiate prior results that mortality is procyclical
  - a one percentage point increase in the unemployment rate is associated with a 0.28% decrease in the total mortality rate
- CO is significantly correlated with mortality and substantially attenuates the relationship between mortality and unemployment
  - The association above is reduced to 0.12% after controlling for pollution
- The attenuation is particularly large on the mortality rate from respiratory disease



Background

- Recessions are good for your health
  - Ruhm (2000) – mortality
  - Ruhm (2005) – obesity, exercise, smoking
  - Gruber and Frakes (2006) – BMI, obesity
  - Cotti and Tefft (2011) – car crashes
- Pollution is bad for your health
  - Chay and Greenstone (2003) – infant mortality from particulates
  - Currie and Neidell (2005) – infant mortality from CO in CA
  - Currie et. al. (2009) – infant health outcomes (including birth weight) from CO in NJ
  - Knittel et. al. (2011) – infant mortality from PM10 in CA



Research Design

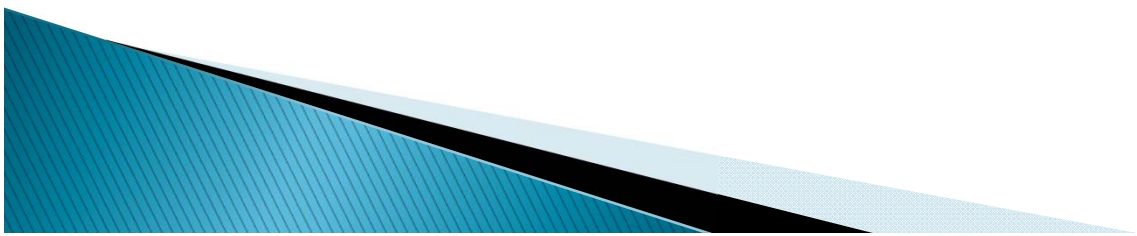
- Estimating equation:

$$M_{jt} = \alpha_j + X_{jt}\beta + E_{jt}\gamma + \lambda_t + \epsilon_{jt}$$

- The estimate of γ gives the relationship between the macroeconomy and health
- We add pollution:

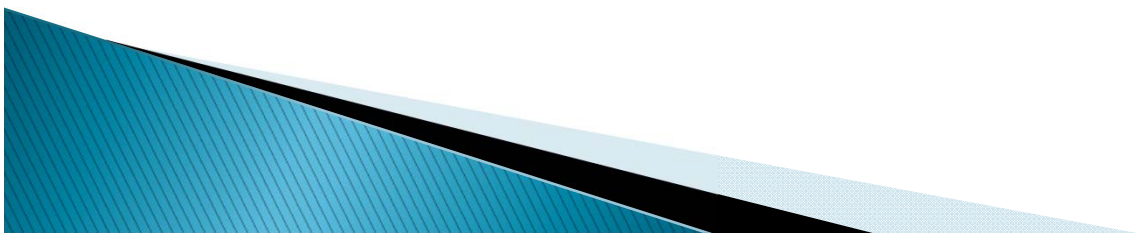
$$M_{jt} = \alpha_j + X_{jt}\beta + E_{jt}\gamma + P_{jt}\delta + \lambda_t + \epsilon_{jt}$$

- We are interested in both
  - The effect of pollution δ
  - How including pollution attenuates the relationship between the macroeconomy and health γ



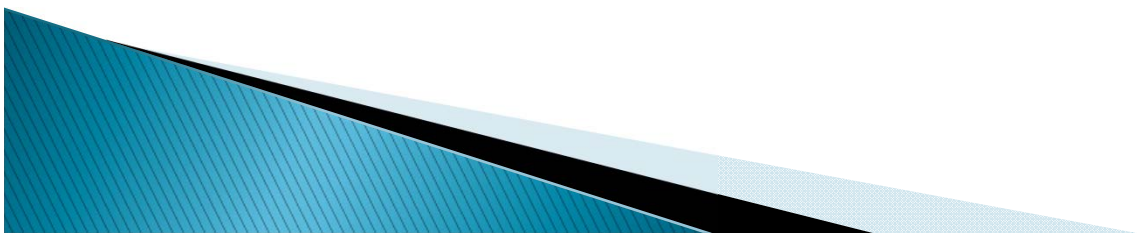
Concerns/Caveats

- Data issues
  - Pollution
  - Macroeconomic proxy (unemployment rate)
- Omitted Variables Bias
  - Lots of things change with the business cycle



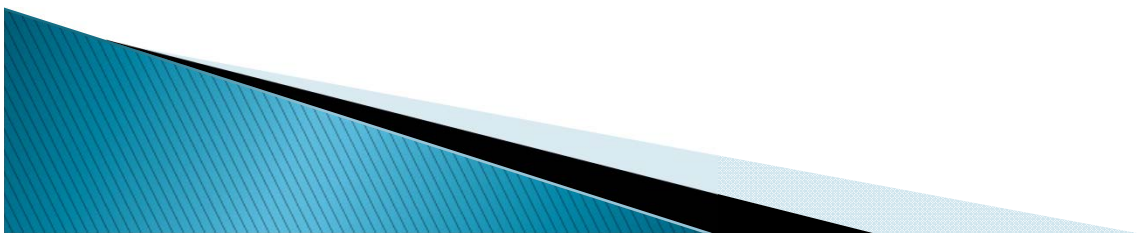
Data

- Pollution data from EPA's *Air Quality System* (AQS) database
- Annual summaries of readings of individual monitors throughout the US
- Two pollutants we look at are CO and PM10
  - Availability of data
  - Prior literature linking these pollutants to mortality
- CO: 1980 – 2010, 1,463 monitors
- PM10: 1982 – 2010, 4,502 monitors



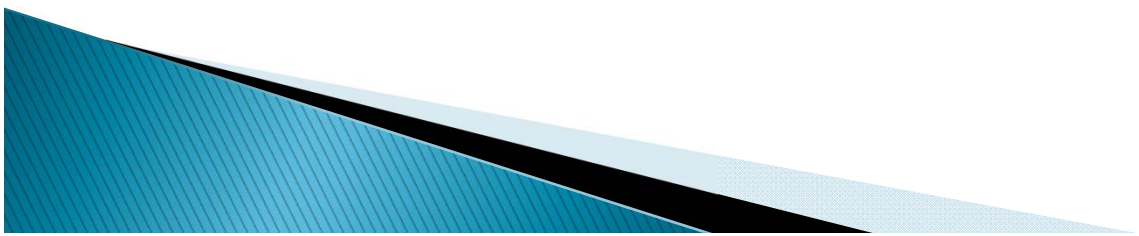
Data

- Monitors frequently enter and exit the panel
  - Median number of years for CO monitor is 7, for PM10 monitor is 6
- Concern that monitor siting decisions are "strategic"
  - Code of Federal Regulations
- Aggregate to state
  - Weight each monitor by county population
- 1,484 state-year observations of CO and 1,337 state-year observations of PM10



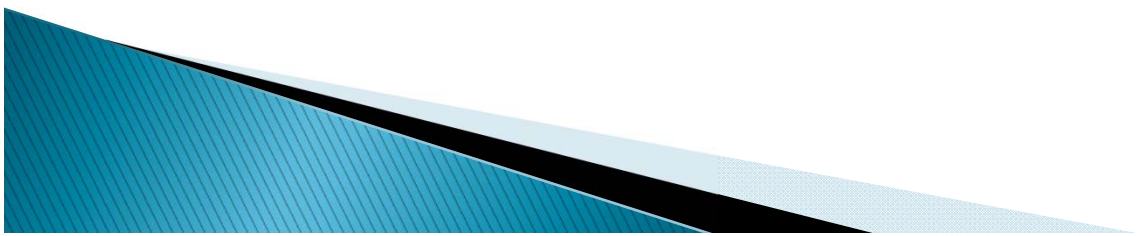
Data

- Our macroeconomic proxy is the unemployment rate
- From the Department of Labor's *Local Area Unemployment Statistics* (LAUS) database
  - 1981–2009



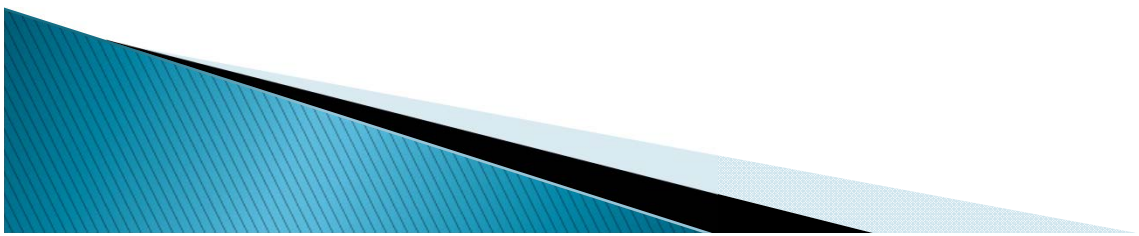
Data

- Mortality data from the Center for Disease Control and Prevention's *Compressed Mortality Files* (CMF)
- Only publicly available through 1988; we have through 2007
- By state-year: population count and death count



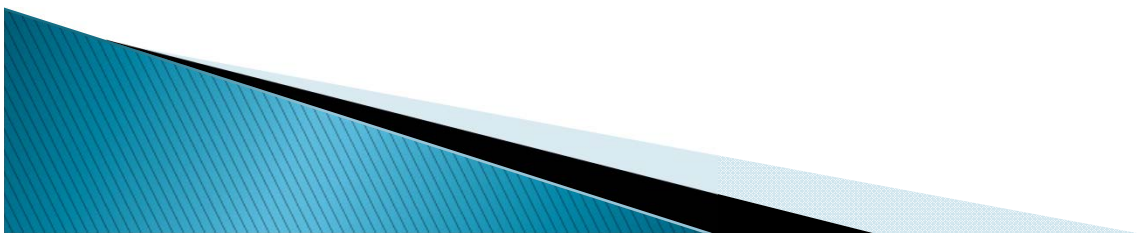
Data

- Deaths for eleven causes
  - respiratory, cardiovascular, acute myocardial infarction (heart attack), ischemic heart disease, cerebrovascular disease (stroke), cancer, accidents (total, vehicular, and non-vehicle), suicide, and homicide
- Deaths for six age groups
  - infants, 1-19, 20-54, 55-64, 65+, 85+



Data

- Demographic controls from March CPS
  - Gender
  - Race
  - Education
- Miles per capita from US Department of Transportation Highway Statistics Series



Data

- Restrict analysis to state-year observations for which we have all variables, including both CO and PM10
- 1,109 state-year observations from 1982-2007

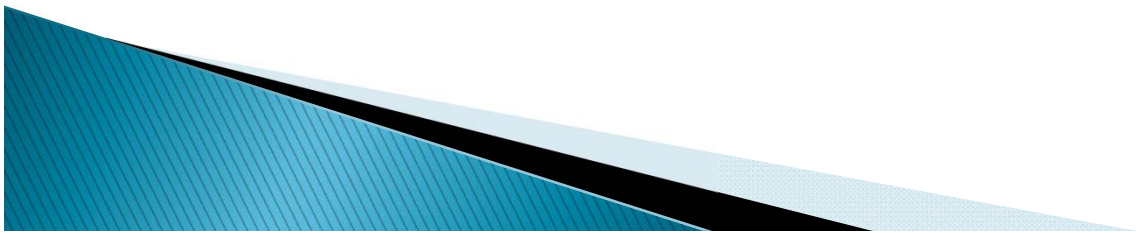


Table 1: Sample Means for Selected Variables

	Mean	Standard Error
Emissions		
PM10 concentration ($\mu g/m^3$)	27.877	0.228
CO concentration (ppm)	0.933	0.013
State unemployment rate (%)	5.466	0.049
Mortality Rates (per 1000)		
Total	8.594	0.04
Respiratory	0.733	0.005
Cardiovascular	3.382	0.023
Acute Myocardial Infarction (Heart Attack)	0.775	0.009
Ischemic Heart Disease	1.344	0.022
Cerebrovascular Disease (Stroke)	0.576	0.004
Cancer	1.975	0.01
Accident	0.396	0.003
Vehicle Accident	0.178	0.002
Non-vehicle Accident	0.218	0.002
Suicide	0.126	0.001
Homicide	0.073	0.002
< 1 year old	8.418	0.075
1-19 years old	0.41	0.004
20-54 years old	2.246	0.016
55-64 years old	10.764	0.063
≥ 65 years old	50.253	0.122
≥ 85 years old	150.251	0.304
State Population Shares		
< 1 year old	0.014	0.000
1-19 years old	0.272	0.001
20-54 years old	0.499	0.001
55-64 years old	0.090	0.000
≥ 65 years old	0.124	0.001
Female	0.514	0.000
Black (non-Hispanic)	0.117	0.004
Other nonwhite (non-Hispanic)	0.054	0.003
Hispanic	0.066	0.003
High school incomplete	0.180	0.002
High school graduate/12th grade completed	0.356	0.002
Some college/<4 years completed	0.229	0.002
College graduate/4+ years completed	0.236	0.002

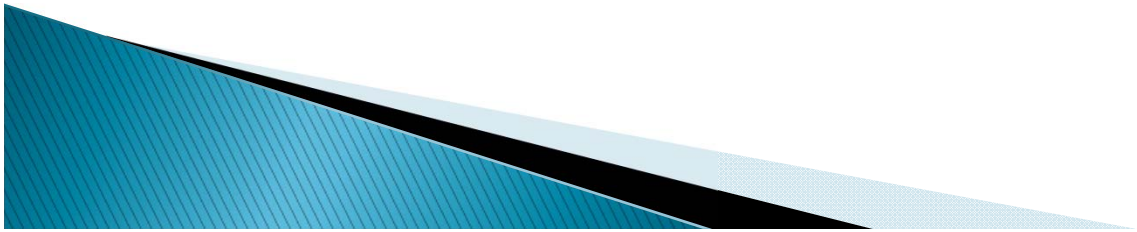
Note: Summary statistics are over the state-year observations, from 1982-2007, including only those 1109 observations for which we have PM10 [illegible] concentrations.

Results – Total Mortality

Table 3: Econometric Estimates of the Determinants of Total Mortality

Regressor	(1)	(2)	(3)	(4)
State unemployment rate (%)	-0.00276*	-0.00234	-0.00136	-0.00121
	(0.00157)	(0.00148)	(0.00139)	(0.00139)
PM10		0.00505		0.00215
		(0.00402)		(0.00307)
CO			0.0224**	0.0218**
			(0.0110)	(0.0108)
Demographic controls?	Yes	Yes	Yes	Yes
Observations	1,109	1,109	1,109	1,109
R-squared	0.980	0.980	0.982	0.982

Note: *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is the natural log of the total mortality rate. Standard errors clustered at the state are in parentheses. State- and year-fixed effects are included but not reported. Regressions are weighted by state population.



Results – Cause-Specific Mortality

Table 4: Econometric Estimates of the Determinants of Mortality from Specific Diseases

Regressor	Respiratory		Cardiovascular		Heart Attack	
	(a)	(b)	(a)	(b)	(a)	(b)
State unemployment rate (%)	-0.00337	-0.00133	-0.00769***	-0.00711***	-0.0225***	-0.0213***
	(0.00419)	(0.00352)	(0.00228)	(0.00245)	(0.00514)	(0.00436)
PM10		-0.00328		-0.00402		-0.0114
		(0.00620)		(0.00385)		(0.0110)
CO		0.0368**		0.0144*		0.0341
		(0.0141)		(0.00780)		(0.0213)
	Ischemic Heart Disease		**Stroke**		**Cancer**	
	(a)	(b)	(a)	(b)	(a)	(b)
State unemployment rate (%)	-0.00873	-0.00593	-0.00923**	-0.00709**	-0.000258	0.000732
	(0.00777)	(0.00820)	(0.00388)	(0.00317)	(0.00126)	(0.00109)
PM10		-0.0119		-0.00468		0.00154
		(0.0156)		(0.00636)		(0.00272)
CO		0.0601**		0.0403*		0.0137*
		(0.0277)		(0.0210)		(0.00708)

Note: *** p<0.01, ** p<0.05, * p<0.1. Dependent variables are the natural logs of the specified cause-specific mortality rate. Standard errors clustered at the state are in parentheses. State- and year-fixed effects and all demographic controls shown in Table 2 are included here in all columns but not reported (n=1109). Regressions are weighted by state population.

Results – Cause-Specific Mortality

Table 5: Econometric Estimates of the Determinants of External Causes of Death

Regressor	Accident		Vehicle Accident		Non-Vehicle Accident	
	(a)	(b)	(a)	(b)	(a)	(b)
State unemployment rate (%)	-0.00994**	-0.00580	-0.0266***	-0.0237***	-0.000333	0.00501
	(0.00428)	(0.00411)	(0.00420)	(0.00446)	(0.00664)	(0.00617)
PM10		0.0303***		0.0227**		0.0322***
		(0.00955)		(0.00990)		(0.0108)
CO		0.0260		0.0162		0.0426*
		(0.0166)		(0.0135)		(0.0227)

	Suicide		Homicide	
	(a)	(b)	(a)	(b)
State unemployment rate (%)	0.0194***	0.0198***	0.00636	0.00810
	(0.00566)	(0.00528)	(0.0117)	(0.00970)
PM10		0.00751		-0.00642
		(0.00749)		(0.0248)
CO		-0.00241		0.0362
		(0.0121)		(0.0498)

Note: *** p<0.01, ** p<0.05, * p<0.1. Dependent variables are the natural logs of the specified cause-specific mortality rate. Standard errors clustered at the state are in parentheses. State- and year-fixed effects and all demographic controls shown in Table 2 are included here in all columns but not reported (n=1109). Regressions are weighted by state population.

Results – Age-Specific Mortality

Table 6: Econometric Estimates of Determinants of Age-Specific Mortality

Regressor	< 1 Year Olds		1-19 Year Olds		20-54 Year Olds	
	(a)	(b)	(a)	(b)	(a)	(b)
State unemployment rate (%)	-0.00629*	-0.00306	-0.0148***	-0.0136***	0.00436	0.00815**
	(0.00353)	(0.00326)	(0.00452)	(0.00421)	(0.00395)	(0.00328)
PM10		0.00594		-0.00170		0.00641
		(0.00552)		(0.00801)		(0.00823)
CO		0.0420***		0.0218*		0.0522*
		(0.0142)		(0.0129)		(0.0287)
VARIABLES	55-64 Year Olds		≥65 Year Olds		≥85 Year Olds	
	(a)	(b)	(a)	(b)	(a)	(b)
State unemployment rate (%)	-0.00405*	-0.00253	-0.00290**	-0.00181	0.00146	0.00214
	(0.00216)	(0.00206)	(0.00130)	(0.00120)	(0.00255)	(0.00238)
PM10		0.000861		0.000135		0.000389
		(0.00436)		(0.00222)		(0.00242)
CO		0.0229**		0.0167*		0.0106**
		(0.00944)		(0.00831)		(0.00522)

Note: *** p<0.01, ** p<0.05, * p<0.1. Dependent variables are the natural logs of the specified age-specific mortality rate. Standard errors clustered at the state are in parentheses. State- and year-fixed effects and all demographic controls shown in Table 2 are included here in all columns but not reported (n=1109). Regressions are weighted by state population within each age group.

Results Summary

- Mortality is negatively correlated with unemployment
- After controlling for pollution, this correlation is substantially attenuated
- CO has a particularly large effect on mortality from respiratory and ischemic heart disease, and a particularly large attenuation of the correlation between unemployment and mortality
- CO affects the procyclicality of mortality among infants and the elderly
- PM10 is correlated with accident mortality rates, suggesting omitted variables bias

Discussion

- Good economic times kill you, partly because of pollution
- Omitted variables
  - Unemployment is a proxy for "the macroeconomy," so might be pollution
- IV
  - Attainment status – seems to be weak at state level
- Alternative macro proxy
  - GSP
- County-level