Ambient Air Pollution and Infant Mortality in Emerging Economies: Evidence from Santiago, Chile

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Introduction

- Policy makers need estimates of the benefits of reducing air pollution for benefit-cost analysis (Arrow, Cropper et al. Science 1996)

- Transferability of estimates from developed countries to developing ones?

- Why estimates from Santiago, Chile?

Methods, Data and Results

- **Spatial mapping of PM10 →** allows to accurately impute air pollution concentration throughout Santiago's municipalities (~ metropolitan boroughs/districts)

- **Panel dataset →** Municipality-level FE capture possible municipality-specific confounding effects

$$M_{iw} = \beta_0 + \beta_1 P_{iw} + \beta_2 W_{iw} + \beta_3 D_M + \beta_4 D_Y + \beta_5 y_i + \epsilon_i + \epsilon_{iw}$$

- **IV estimation →** Thermal Inversions provide exogenous variation to address possible time-varying confounding effects

Air Pollution Concentrations & Thermal Inversions

- Air pollutions concentrations driven by emissions and limited ventilation
  - Due to geography and thermal inversions

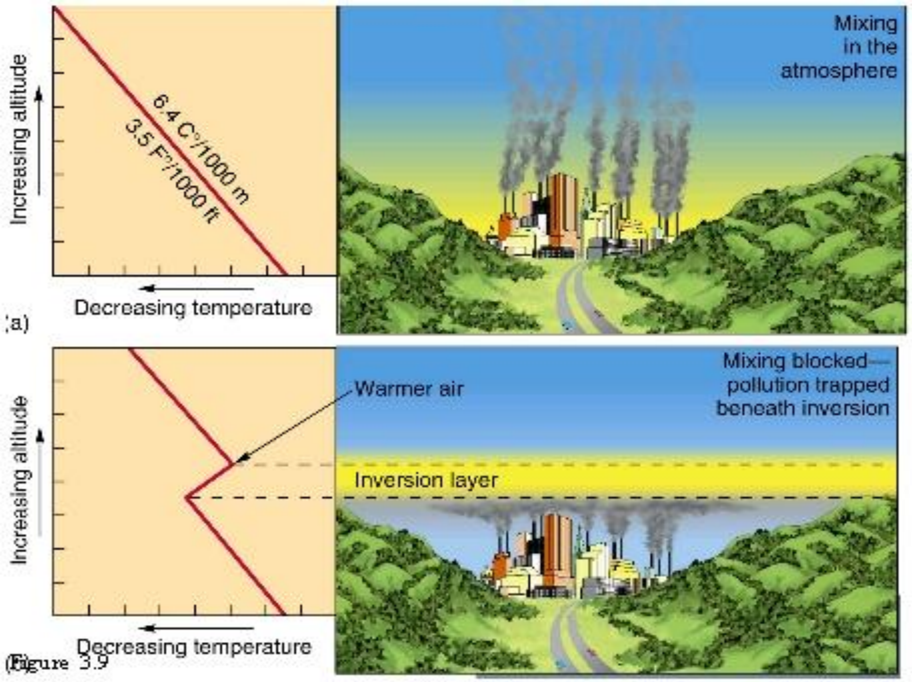
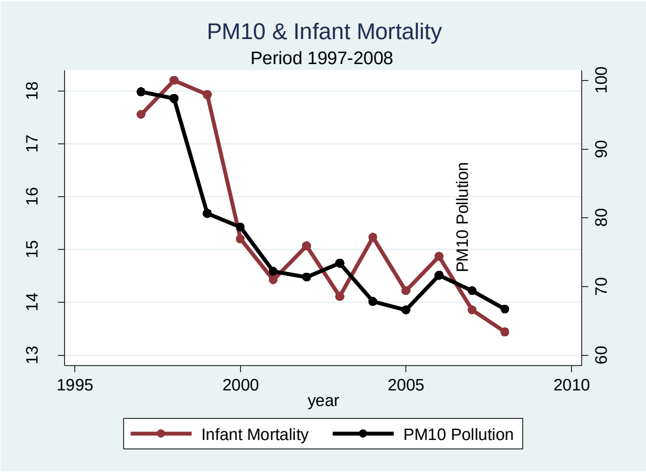
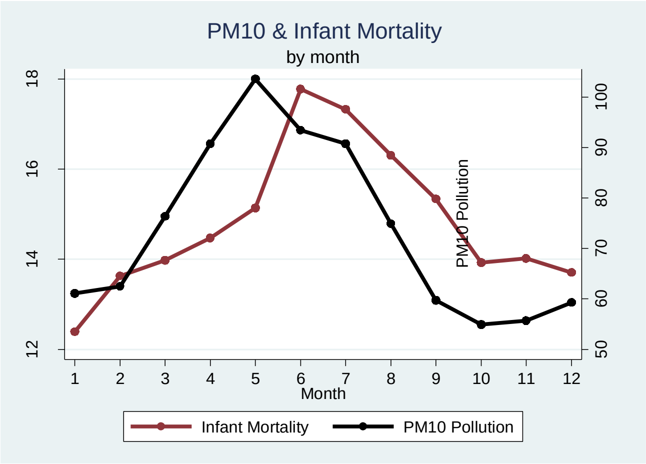


Figure 3.9

Descriptive Statistics

	Mean	Standard Deviation			Obs.
		Overall	Between municipalities	Within municipalities	
PM10 ($\mu g/m^3$)	77.18	28.43	8.78	26.36	18,800
Infant mortality rate (per 100,000)	15.53	28.37	2.66	5.76	18,800





WHO guideline for PM10 is $20\mu g/m^3$ (previously 35 $\mu g/m^3$)

First Stage Regressions

	PM10 Pollution Concentrations			
	2SLS		FE 2SLS	
	(1)	(2)	(3)	(4)
Temperature Difference. Elevation 1068 vs. 550 m	0.794***	1.797***	0.795***	1.862***
	(0.021)	(0.103)	(0.028)	(0.127)
TempDiff_squared	-0.048***	-0.082***	-0.048***	-0.104***
	(0.004)	(0.024)	(0.003)	(0.008)
TempDif_cubic	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.000)	(0.000)
WindSpeed at 1068m	-0.842***	-0.832***	-0.843***	-0.833***
	(0.108)	(0.101)	(0.052)	(0.054)
WindSpeed_squared	0.080***	0.079***	0.080***	0.079***
	(0.012)	(0.011)	(0.007)	(0.007)
Barometric Air Pressure at 1068 m	-32.551***	-32.898***	-32.114***	-32.312***
	(8.322)	(8.187)	(3.311)	(3.477)
Barometric Air Pressure_squared	0.018***	0.018***	0.018***	0.018***
	(0.005)	(0.005)	(0.002)	(0.002)
MunicipalityGroundElevation*TempDiff		-0.002***		-0.002***
		(0.000)		(0.000)
MuniGroundElev*TempDiff_squared		0.000		0.000***
		(0.000)		(0.000)
Month-year dummies and municipality-specific time trends	Yes	Yes	Yes	Yes
Wu-Hausman p-value	0.002	0.006	0.004	0.007
F test on instruments	756.9	616.3	659.7	564.4
UnderID p-value	0	0	0	0
R-squared	0.743	0.753	0.722	0.735
Number of comuna2010			34	34
Observations	18,800	18,800	18,800	18,800

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Estimates of the Effect on Infant Mortality

	Infant Mortality Rate					
	OLS	FE	2SLS		FE 2SLS	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
PM10	-0.039	-0.039	0.422**	0.360**	0.424**	0.382**
	(0.105)	(0.109)	(0.184)	(0.179)	(0.184)	(0.178)
- Month-year dummies and municipality-specific time-trends	Yes	Yes	Yes	Yes	Yes	Yes
- Ground-level elevation interacted with instruments			No	Yes	No	Yes
Observations	18,800	18,800	18,800	18,800	18,800	18,800

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

- Interpretation of estimate (column 6):
  - A 10-$\mu g/m^3$ reduction in average exposure to ambient PM10 yields ~20 fewer infant deaths a year (per 100,000 live births) [.382*52=19.9]

Summary of findings and Conclusions

- A 10-$\mu g/m^3$ reduction in PM10 yields a 2.46% reduction in infant mortality rate
  - Larger than those for developed countries (> 2 x California), but smaller than for Mexico City (< 1/6 x CDMX).

- Chile Ministry for Environment's CBA used concentration-response estimate = 1.1% (< 2.46%)

- Using Chile's VSL, infant lives saved due to PM10 reductions over period 1997-2008 can be valued at an additional US$ 4 billion (~ **€** 3.5 billion)

THANK YOU !

Mapping of Air Pollutants

- Imputation of air pollution P_{iw} for each municipality i using geospatial mapping
  - *Kriging* method exploits the spatial correlation of the monitoring stations and enhances the accuracy of the spatial interpolation
  - *Kriging* is Best Linear Unbiased (spatial) Predictor (BLUP)