School Buses, Diesel Eissions, and Respiratory Health

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1. Introduction

school buses. Recent research found that within-bus concentrations of particulate matter differential trends in health outcomes over the retrofit period, adopters and non-adopters experienced comparable trends in the pre-retrofit period.

To put our results in context, we combine our empirical results with the health valuation literature and perform a conservative back of the envelope benefit-cost analysis. Calculations estimate program benefits at over 20 times program costs. This interpretation suggests that if the 48 states not aggressively pursuing school bus retrofits riding these buses spent nearly 45 minutes per day on the bus (Adar et al. (2008)). The average bus in the United States is over 9 years, and the average is substantially higher in many states. Research indicates that, per mile, school buses are twice as polluting as semi trucks. The average bus emits nearly 15 pounds of particulate matter and approximately 400 pounds of smog-forming nitrogen oxidc.0nd hydrocarbons per year (Monahan 2006).

In addition to pollution affecting ambient levels, school bus emissions have large local effects. Research indicates that people living near roads are exposed to pollution levels that are significantly greater than ambient levels (Pearson et al. (2000).0nd Wilhelm.0nd Ritz (2003)). Further, emissions from.idling buses lined up outsidc schools concentrate pollution within schoolyard.0nd tsidc scthemselves.

Acute pollution exposure is especially high for children who ridc buses. Evidcnce suggests that diesel emissions enter buses. Air pollution concentrations within mobile sources may be as much as 10 timc.0mbient le vels (Shikiya et al. (1989), Chan et al. (1991).0nd Lawryk et al. (1996)). Adar et al. (2008) installed pollution monitors in a

Diesel Emissions and Respiratory Health

Diesel fumes contain high levels of particulate matter, other air toxics, nitrogen oxides, and hydrocarbons. Even at relatively low levels, these contaminants are known to exacerbate or cause asthma and other respiratory ailments (Brunekreef and Holgate (2002)). Air toxics defined broadly are associated with asthma, lung inflammation, coughing, wheezing, and reduced lung function (Peden (2002)). The fine particulate matter common in diesel emissions is strongly linked to reduced lung function and increased incidences of pneumonia (Cohen and Nikula (1999) and substantial progress retrofitting buses.[1] Otherwise, the program is similar to those under consideration in other states. State senate bill ESSB6072 provided $5 million in annual funding for the five years spanning 2003-2008. The legislation's primary goal was to retrofit older school buses with modern pollution control equipment. Legislative priorities included targeting buses with model years

as the retrofit type (DOC/CCV), the date of the retrofit, and the cost of the retrofit. Bus-specific data is aggregated to the district level to construct a fleet profile consisting of the cumulative share of buses having undergone each type of retrofit over the sample period.

Finally, we match both program data and

school districts’ retrofit programs were in progress, and our primary analysis does not include them in treatment nor control groups.

Summary Statistics

Summary statistics, broken down by retrofit type and health outcome for adopters and non-adopters, are presented in Tables 1 a

for children under 17 in adopter districts

3.12 pleurisy and pneumonia cases per 100000 adults per month. Table 2 suggests that bus retrofits may have reduced pleurisy and pneumonia cases for both children and adults with chronic respiratory ailments.

In short, summary statistics suggest potentially important effects of DOC and CCV retrofits on children's incidences of bronchitis, asthma, pleurisy, and pneumonia. Retrofits seem to reduce bronchitis, asthma, pleurisy, and pneumonia incidence for adults with chronic respiratory ailments as well. The summar

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economically important and typically statistically significant as well. Results indicate that, after controlling for changes to a quasi-control group, adopter districts experienced 7.3 fewer bronchitis and asthmi cises per 100000 children per month. Similarly, after controlling for confounding factors, adopter districts experienced 1.8 fewer bronchitis the school district is a CCV retrofit adopter.[7] The quasi-control group remains school districts that did not retrofit any buses with either DOCs or CCVs by summer 2006.

CCV regression results are presented in Tables 5 and 6. T-statistics, based on robust standard errors, are again reported in parentheses below the coefficient estimates. The key difference-in-difference (DID) coefficients in Table 5 are all economically and statistically significant. Results indicate that, after controlling for changes to a quasi-control group, CCV adopter districts experi101291 frequently implemented in districts with high initial asthma, bronchitis, pleurisy, and districts are systematically smaller, but we analyze health outcome variables scaled by population size. Note also that non-adopters adopt the program shortly after our sample period ends.

∉ *School bus retrofit decisions and implementation occur at the school district level*. In contrast, most air quality and public health programs are instituted at the county, state, or national level.

Sensitivity: Other Assumptions

districts also experienced 39 percent fewer children’s pleurisy and pneumonia cases per month.

Asthma and bronchitis illness reductions occurred for both children and adults with chronic conditions. This suggests that cl benefit calculations exclude non-respiratory illnesses, long-term health effects, suffering

References

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Table 3. Regression Results for All Retrofits:
Bronchitis and Asthma Cases (per 100000 individuals)

	Dependent Variable: Cases Among Sensitive Populations	**Dependent Variable:** Cases Among Children	**Dependent Variable:** Cases Among Adults w/ Chronic Illness
Constant	4.55**	18.52**	0.682**
	(5.63)	(4.99)	(2.79)
Adopter District?	4.62**	13.68**	2.05**
“Treatment”	(4.63)	(3.31)	(3.63)
Post Installation?	0.281	-2.65	1.04
“lime”	(0.18)	(-0.40)	(1.52)
Treatment * Time	-3.04*	-7.30	-1.77**
	(-1.82)	(-1.05)	(-2.04)
Observations	860	860	860
F-statistics	9.35	8.94	8.34
Prob > F	0.001	0.001	0.001

Notes:

Table 5. Regression Results for CCV Retrofits:
Bronchitis and Asthma Cases (per 100000 individuals)

	Dependent Variable: Cases Among Sensitive Populations	**Dependent Variable:** Cases Among Children	**Dependent Variable:** Cases Among Adults w/ Chronic Illness
Constant	4.55**	18.52**	0.682**
	(5.61)	(4.97)	(2.78)
CCV Adopter District?	7.03**	23.91**	
“Treatment”	(5.68)	(4.20)	

Table 7. Treatment vs. Control Group Characteristics

Characteristic	Adopter Districts	Non-Adopter Districts	Difference	p-value for Difference

Table 9. Sensitivity Analysis Results for All Retrofits:
Cases Among Healthy Adults (per 100000 individuals)

	Dependent Variable: Bronchitis and Asthma Cases Among Healthy Adults	**Dependent Variable:** Pleurisy and Pneumonia Cases Among Healthy Adults