The B.E. Journal of Economic Analysis & Policy

Appendix to accompany

Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime

Jessica Wolpaw Reyes [a, b]

Contributions
October 2007, Volume 7, Issue 1

[a] Department of Economics, Amherst College, Amherst MA 01002 USA.
Telephone (413) 542-8517; Fax (413) 542-2090; Email jwreyes@amherst.edu.

[b] National Bureau of Economic Research, USA.

Appendix Tables

APPENDIX TABLE 1 — Blood Lead Summary and Trends

	Year of observation					
	1976	1977	1978	1979	1980	1988 to 1991
All ages	16.1	14.2	14.1	11.9	9.6	3.4
Children (age 10 years or less)	17.4	14.7	14.5	12.0	8.4	3.5
Children by region						
northeast	14.9	15.5	15.4	10.9	10.0	4.8
midwest	17.4	12.1	14.1	12.7		4.1
south	17.3	14.0	13.9	11.7	8.4	3.2
west	17.6	14.2	14.5	11.2	9.0	2.9
Children by income						
poverty (below $6,000)	22.0	16.8	18.2	13.5	8.9	
low ($6,000-10,000)	19.6	15.1	16.2	12.4	11.5	
middle ($10,000-20,000)	16.0	14.0	14.3	11.5	8.1	
high (above $20,000)	15.1	14.0	12.4	11.5	7.3	
Children by race						
white	16.2	14.0	13.5	11.6	7.7	3.1
black	22.6	18.2	20.2	14.5	11.9	5.3
other	18.0	20.9	18.5	12.3		4.0

Notes. Tabulation of blood lead (μg/dL) from National Health and Nutrition Examination Survey data. Data for 1976 to 1980 is from NHANES II, data for 1988-1991 is from NHANES III. Income is measured in 1976 dollars.

APPENDIX TABLE 2 — Lead Exposure by State, 1975-1985

State		Gasoline Lead (grams per gallon)			Per-Capita Lead (kilograms per person)			Air Lead ($\mu g/m^3$)		
		1975	1980	1985	1975	1980	1985	1975	1980	1985
AL	Alabama	1.91	0.88	0.20	1.09	0.51	0.11	0.87	0.51	0.31
AK	Alaska	1.39	0.65	0.23	0.80	0.34	0.14	1.18	0.67	0.34
AZ	Arizona	1.68	0.73	0.20	0.97	0.41	0.11	0.96	0.44	0.23
AR	Arkansas	2.05	0.95	0.29	1.24	0.56	0.18	0.83	0.41	0.20
CA	California	1.41	0.49	0.22	0.71	0.25	0.11	1.62	0.64	0.17
CO	Colorado	1.71	0.74	0.16	0.91	0.40	0.09	1.30	0.46	0.20
CT	Connecticut	1.65	0.68	0.18	0.74	0.30	0.08	1.00	0.57	0.17
DE	Delaware	1.67	0.69	0.07	0.88	0.37	0.04	0.70	0.45	0.14
DC	Dist. of Columbia	1.51	0.56	0.14	0.51	0.14	0.04	0.98	0.68	0.16
FL	Florida	1.92	0.75	0.15	1.02	0.41	0.08	0.85	0.35	0.19
GA	Georgia	1.90	0.82	0.17	1.15	0.50	0.11	0.83	0.45	0.13
HI	Hawaii	1.61	0.55	0.47	0.54	0.19	0.16	0.65	0.24	0.06
ID	Idaho	1.46	0.78	0.33	0.87	0.42	0.18	1.42	0.50	0.25
IL	Illinois	1.51	0.67	0.17	0.68	0.30	0.08	1.69	0.37	0.16
IN	Indiana	1.77	0.84	0.24	1.00	0.48	0.14	0.87	0.37	0.33
IA	Iowa	1.64	0.84	0.25	0.95	0.43	0.14	0.68	0.28	0.13
KS	Kansas	1.72	0.79	0.25	1.04	0.49	0.15	0.40	0.26	0.09
KY	Kentucky	1.81	0.89	0.26	0.98	0.48	0.14	0.81	0.39	0.19
LA	Louisiana	1.91	0.75	0.17	0.98	0.40	0.08	0.83	0.39	0.15
ME	Maine	1.76	0.94	0.27	0.94	0.47	0.15	0.49	0.31	0.15
MD	Maryland	1.56	0.63	0.15	0.73	0.31	0.07	0.98	0.42	0.15
MA	Massachusetts	1.69	0.80	0.18	0.71	0.34	0.08	0.86	0.48	0.20
MI	Michigan	1.46	0.69	0.16	0.73	0.32	0.08	0.87	0.21	0.11
MN	Minnesota	1.69	0.70	0.16	0.90	0.38	0.08	0.62	0.61	0.15
MS	Mississippi	1.92	0.91	0.28	1.05	0.50	0.16	0.57	0.29	0.12
MO	Missouri	1.84	0.88	0.26	1.04	0.51	0.16	0.78	0.55	0.26
MT	Montana	1.43	0.79	0.27	0.93	0.53	0.17	0.30	0.26	0.95
NE	Nebraska	1.71	0.81	0.19	1.09	0.51	0.12	0.61	0.31	0.30
NV	Nevada	1.66	0.70	0.26	1.21	0.48	0.16	1.72	0.49	0.20
NH	New Hampshire	1.69	0.77	0.18	0.83	0.35	0.09	0.44	0.14	0.11
NJ	New Jersey	1.56	0.64	0.17	0.73	0.30	0.08	1.02	0.42	0.32
NM	New Mexico	1.67	0.72	0.17	1.14	0.49	0.10	0.33	0.75	0.26
NY	New York	1.57	0.67	0.19	0.49	0.21	0.07	0.86	0.30	0.23
NC	North Carolina	1.99	0.88	0.21	1.09	0.48	0.12	0.93	0.35	0.13
ND	North Dakota	1.71	0.80	0.23	0.99	0.50	0.16	0.66	0.14	0.10
OH	Ohio	1.65	0.69	0.18	0.83	0.35	0.09	0.75	0.44	0.17
OK	Oklahoma	1.91	0.72	0.27	1.23	0.47	0.18	0.56	0.26	0.11
OR	Oregon	1.57	0.69	0.40	0.92	0.34	0.19	0.77	0.41	0.16
PA	Pennsylvania	1.63	0.69	0.25	0.69	0.31	0.11	0.83	0.36	0.27
RI	Rhode Island	1.65	0.70	0.18	0.70	0.29	0.07	0.91	0.55	0.21
SC	South Carolina	1.98	0.85	0.21	1.11	0.48	0.12	0.81	0.36	0.12
SD	South Dakota	1.72	0.84	0.24	1.10	0.52	0.16	0.33	0.19	0.01
TN	Tennessee	1.94	0.85	0.22	1.14	0.50	0.13	1.31	0.43	0.35
TX	Texas	2.10	0.86	0.21	1.35	0.54	0.14	0.53	0.27	0.18
UT	Utah	1.69	0.75	0.26	0.95	0.39	0.13	0.98	0.16	0.27
VT	Vermont	1.72	0.83	0.22	0.86	0.38	0.12	0.68	0.03	0.03
VA	Virginia	1.60	0.73	0.20	0.85	0.39	0.11	0.45	0.34	0.10
WA	Washington	1.57	0.68	0.28	0.79	0.34	0.14	0.74	0.42	0.28
WV	West Virginia	1.60	0.72	0.19	0.78	0.35	0.09	0.87	0.27	0.10
WI	Wisconsin	1.56	0.76	0.20	0.78	0.39	0.10	0.80	0.30	0.17
WY	Wyoming	1.41	0.71	0.28	1.40	0.66	0.24	0.21	0.02	0.01
	United States	1.68	0.72	0.21	0.86	0.37	0.11	0.93	0.40	0.19

APPENDIX TABLE 3 — States with Extreme Values of Population, Population Density, and Per-capita Lead

Population (top five)		*Population Density* (top five)		*Per-Capita Lead* (bottom five)	
1. CA	21,537,849	1. NY	47,307	1. NY	0.49
2. NY	18,003,485	2. DC	31,107	2. DC	0.51
3. TX	12,568,843	3. NJ	17,037	3. HI	0.54
4. PA	11,906,095	4. CO	14,794	4. IL	0.68
5. IL	11,291,743	5. IL	14,722	5. PA	0.69
Median	2,880,847	Median	4,395	Median	0.93

Notes. Values are for each state in 1975, as described in the Data Appendix. Population is number of people in the state. Population density is the average density within which people live, where density is measured as people per square mile. Per-capita lead is measured in kilograms of lead per person per year.

APPENDIX TABLE 4 — Spline for Violent Crime

Sample		Grams per Gallon	Per-Capita Lead	IV
Full Sample	Lead in 1st quartile	0.775 **	0.734 **	1.048 **
		(0.337)	(0.238)	(0.463)
	Lead in 2nd quartile	0.710 *	0.176	0.896 *
		(0.441)	(0.453)	(0.544)
	Lead in 3rd quartile	1.277 **	0.789 *	1.579 **
		(0.632)	(0.425)	(0.739)
	Lead in 4th quartile	0.975 **	0.820 *	1.081 **
		(0.481)	(0.434)	(0.554)
Drop NY	Lead in 1st quartile	1.007 **	0.955 **	1.345 **
		(0.309)	(0.244)	(0.422)
	Lead in 2nd quartile	0.890 **	0.977 **	1.102 **
		(0.377)	(0.313)	(0.463)
	Lead in 3rd quartile	1.626 **	1.139 **	1.994 **
		(0.559)	(0.365)	(0.637)
	Lead in 4th quartile	1.194 **	1.302 **	1.305 **
		(0.441)	(0.372)	(0.518)
Drop NY, CA, DC	Lead in 1st quartile	0.786 **	0.831 **	1.064 **
		(0.334)	(0.246)	(0.453)
	Lead in 2nd quartile	1.052 **	0.955 **	1.277 **
		(0.427)	(0.310)	(0.518)
	Lead in 3rd quartile	1.931 **	1.115 **	2.252 **
		(0.484)	(0.334)	(0.565)
	Lead in 4th quartile	1.133 **	1.223 **	1.300 **
		(0.386)	(0.370)	(0.443)

Notes. Results shown are for the regression of log per capita violent crime on a spline of effective lead exposure. The cutpoints for the spline are at the quartiles of the effective lead measure. Coefficients shown are average elasticities of violent crime with respect to lead over the sample period and within each quartile. The regression includes all state-level controls and state and year fixed effects. The lead measures are described in the text and Data Appendix. "IV" represents the lead measure using grams per gallon as an instrument for air lead. Standard errors are shown in parentheses and are Huber-White robust and corrected for serial correlation in a short panel by clustering on state. Observations are weighted by state population. Significance is indicated by ** for p-values below 0.05 and * for p-values below 0.10.

APPENDIX TABLE 5 — Alternate Murder Results

Specification	Sample		Grams per Gallon	Per-Capita Lead	IV
Linear	*Full Sample*		0.369	-0.199	0.411
			(0.596)	(0.569)	(0.710)
	Drop NY		0.684	0.524 *	0.780
			(0.561)	(0.326)	(0.679)
	Drop 3 States		1.075 **	0.699 **	1.281 **
			(0.393)	(0.232)	(0.469)
Log	*Full Sample*		-0.070	0.027	-0.003
			(0.416)	(0.382)	(0.579)
	Drop NY		0.216	0.300	0.373
			(0.509)	(0.445)	(0.674)
	Drop 3 States		0.310	0.428	0.604
			(0.402)	(0.318)	(0.512)
Spline	*Full Sample*	Lead in 1st quartile	-0.080	0.214	-0.139
			(0.408)	(0.304)	(0.560)
		Lead in 2nd quartile	-0.220	-0.265	-0.243
			(0.579)	(0.621)	(0.710)
		Lead in 3rd quartile	-0.135	-0.355	-0.119
			(1.040)	(0.608)	(1.231)
		Lead in 4th quartile	1.883 **	0.573	1.902 **
			(0.814)	(0.516)	(0.984)
	Drop NY	Lead in 1st quartile	0.261	0.466	0.308
			(0.471)	(0.409)	(0.640)
		Lead in 2nd quartile	0.032	0.763 *	0.048
			(0.599)	(0.455)	(0.736)
		Lead in 3rd quartile	0.620	0.139	0.783
			(0.838)	(0.514)	(0.965)
		Lead in 4th quartile	2.137 **	1.097 **	2.156 **
			(0.744)	(0.497)	(0.914)
	Drop 3 States	Lead in 1st quartile	0.119	0.481 *	0.158
			(0.410)	(0.277)	(0.544)
		Lead in 2nd quartile	0.431	0.901 **	0.519
			(0.555)	(0.342)	(0.668)
		Lead in 3rd quartile	1.221 **	0.315	1.420 **
			(0.507)	(0.379)	(0.589)
		Lead in 4th quartile	2.046 **	1.201 **	2.346 **
			(0.631)	(0.323)	(0.723)

Notes. Results shown are for the regression of log per capita murder on effective lead exposure. The baseline linear specification is identical to that shown in Column 9 of Table 6. The regression includes all state-level controls and state and year fixed effects. For the spline, cutpoints are at the quartiles of the effective lead measure. The lead measures are described in the text and Data Appendix. Coefficients shown are average elasticities of murder with respect to lead over the sample period and within each quartile. Standard errors are shown in parentheses and are Huber-White robust and corrected for serial correlation in a short panel by clustering on state. Observations are weighted by state population. Significance is indicated by ** for p-values below 0.05 and * for p-values below 0.10.

Appendix

Estimation of the Magnitude of the Effect of Lead on Crime

The calculation linking ADHD to crime proceeds as follows. Needleman and Bellinger (1981) report the relative prevalence in a low lead group and a high lead group of hyperactivity, impulsivity, distractability, and low overall functioning. Dalsgaard (2003), Satterfield (1987), and Moffitt and Silva (1988) each report the prevalence for a non-ADHD group and an ADHD group of delinquent or criminal behavior. High lead increases the likelihood of hyperactivity, impulsivity, and attention deficit by 2.7 times, and ADHD in turn increases the likelihood of delinquent or criminal behavior by 5-6 times. Using the lead and behavior levels in the samples, this yields an elasticity of 0.49 of delinquent or criminal behavior with respect to lead.

The calculation linking lead to reduced IQ to more crime proceeds as follows. NHANES data reports that children's average blood lead dropped from 18 μg/dL to 3 mcg/dL between 1976 and 1990. Canfield *et al.* report a slope of IQ with respect to blood lead of 0.74 per 1 μg/dL in the range 1 to 10 μg/dL and 0.125 in higher ranges. Herrnstein and Murray report data from the NLSY that yield an elasticity of being stopped by the police with respect to IQ of 0.75, and also report a mean criminal IQ is 93. Using these values to following the path from lead to IQ to crime yields an elasiticty of 0.06 of being stopped by the police with respect to blood lead.

The calculation linking blood lead levels to juvenile delinquency proceeds as follows. NHANES data reports that children's average blood lead dropped from 18 μg/dL to 3 μg/dL between 1976 and 1990. Dietrich *et al.* (2001) report several regressions of the number of juvenile delinquent acts (self reports and parental reports) on several measures of blood lead. I use these reported coefficients (ranging from 0.090 to 0.194), together with the means of the data (average 3.5 delinquent acts), to calculate the elasticity of the number of delinquent acts with respect to blood lead.

Data Appendix

Blood Lead Data

Blood lead data is from the National Health and Nutrition Examination Survey (NHANES II). This survey was conducted by the National Center for Health Statistics, between 1976 and 1980, on a nationwide probability sample of approximately 28,000 persons 6 months through 74 years of age from the civilian, noninstitutionalized population of the United States. It also included physical examination and testing, including direct measures of blood lead concentrations on 10,049 individuals, 9,372 of whom were born in the United States and 2,322 of whom were under the age of 6. While there was a 27% non-response rate at the examination phase, Forthofer (1983) uses a comparison to the 1976 National Health Interview Survey to show that "the nonresponse and poststratiftcation adjustments performed by the National Center for Health Statistics" have effectively eliminated non-response bias. The NHANES II data include the blood lead concentration, the date the sample was taken, and basic individual demographics.

Note that the NHANES III measured blood lead levels of 26,818 individuals in the period 1988 to 1991, but the later time period makes these data not useful for the current analysis. By 1990, lead exposure and levels were extremely low, and what little lead exposure there was came almost entirely from non-gasoline sources (e.g. paint lead, industrial emissions, other emissions, or soil residue of past emissions).

Air Lead Data

Air lead data come from the EPA's Aerometric Information Retrieval System (AIRS). The AIRS data, obtained through a Freedom of Information Act request, include quarterly readings of air lead concentrations at designated monitors throughout the United States. These data are available starting in 1960. I use a data file with the average lead reading within each quarter of each year for each monitor for the years 1960 to 2000. Air lead concentration is measured in $\mu g/m^3$, and the AIRS data reports the second maximum average quarterly mean of lead for each monitor in each quarter for which there were measurements. Air lead exposure for a state-year is the weighted average of all lead measures for counties in that state in that year, using county populations as the weight. Many states have incomplete or missing data (as discussed in the text). Counties without monitors or lead readings are omitted when calculating the state average.

Gasoline Data

Shares of grades of gasoline

The primary data for shares of grades of gasoline for the years 1956 to 1984 come from the *Yearly Report of Gasoline Sales by States*. Ethyl Corporation was the primary manufacturer of the tetraethyl lead additive for gasoline, and published monthly and annual marketing reports for the petroleum industry. The data show gasoline sales reported to Ethyl Corporation by oil refiners manufacturing more than 95% of the motor gasoline consumed in the United States. I use the data for motor gasoline sales only, and do not use the separate data on aviation fuels.

Data for the years 1956 to 1971 come directly from the *Yearly Report of Gasoline Sales by States* for the year 1976. The 1976 report contains historical data on the share of premium gasoline in each state in each year from 1956 to 1976. Unleaded gasoline was not introduced until 1971-2, so the share premium completely defines the shares of existing grades of gasoline (leaded non-premium and leaded premium) in the years prior to 1972.

Data for the years 1972 to 1975 are calculated from the *Yearly Report of Gasoline Sales by States* for the year 1976. Unleaded non-premium (regular) gasoline was introduced on a very small scale in 1971-1972. However, for the years 1972 to 1975 the available Ethyl reports only tabulate the shares of non-premium and premium grades: they do not show the shares of unleaded non-premium and leaded non-premium separately for the years 1972 to 1975. The report *does* show the exact shares in 1976. I therefore make an *ad hoc* calculation (as advised by individuals in the petroleum industry) for the years 1972 to 1975 using the following method. First, I place states into three categories based on the share unleaded represents of non-premium gasoline in that state in 1976 [= share unleaded non-premium / (share unleaded non-premium + share leaded non-premium)]. These three categories are: share unleaded of non-premium less than 20%, share between 20% and 28%, and share above 28%. (The mean share was 23%.) This produces three groups of almost equal size. I then assume that the low group introduced unleaded non-premium gasoline in 1973, the middle group introduced unleaded non-premium gasoline in 1972, and the high group introduced unleaded non-premium gasoline in 1971. For each state, I start the state at 0% share in the year in which I assume it introduced unleaded non-premium, and then linearly trend it up to the 1976 share available in the Ethyl data. I assume the share of unleaded premium is zero in these years, which is reasonable since unleaded premium was definitely not introduced in any significant amount before 1976, and was primarily introduced between 1979 and 1981.

Data for the years 1976 to 1984 come directly from the *Yearly Report of*

Gasoline Sales by States for the years 1976 to 1984. The report in each year contains the shares of unleaded gasoline, leaded non-premium, and leaded premium gasoline in each state in that year. (The 1981 report is the first to break unleaded gasoline into unleaded non-premium and unleaded premium, but that is not significant when calculating lead content since all unleaded gasoline contains virtually no lead.) The years 1976 to 1984 represent the main portion of the phase-out of leaded gasoline (more than 80% of the phase-out), so it is ideal that this time period also has the most detailed data on shares of grades of gasoline. It also includes monthly data.

Data for the years 1985 to 1990 are calculated from the *Yearly Report of Gasoline Sales by States* for the year 1984 and the *Petroleum Marketing Annual* for the years 1985 to 1989, published by the Energy Information Administration (EIA) of the Department of Energy. (The Ethyl reports stop in 1984, making it necessary to use a different source of data for the shares of different grades for the years 1985 to 1989.) The *Petroleum Marketing Annuals* for the years 1985 to 1989 show data on the sales to end-users of each grade of gasoline in each state in the years 1983 to 1989. The sales are reported in thousands of gallons, and the grades reported are unleaded regular (unleaded non-premium), leaded regular (leaded non-premium), and premium (unleaded premium). By 1985, essentially all premium gasoline was unleaded: L.M. Gibbs (1993) writes that "leaded premium gasoline essentially disappeared in 1981." Consequently, the absence of a distinction between unleaded premium and leaded premium for the years 1983 to 1989 is not a problem, and the "premium" gasoline is assumed to be *unleaded* premium. Based on the EIA sales numbers, I calculate the share of each of these grades in each state in each year from 1985 to 1989. I then calculate the percentage change from the previous year in the share non-premium leaded. To calculate the share non-premium leaded in the year 1985 in a state, I apply the percentage change between 1984 and 1985 (calculated from the EIA data) to the 1984 Ethyl share non-premium leaded. For each subsequent year, I calculate the share non-premium leaded using the percentage change from the previous year (calculated from the EIA data) applied to the share non-premium leaded calculated for the previous year. This procedure makes full use of the information the EIA data provides about the path over time of the share non-premium leaded, yet maintains a smooth transition and remains consistent with the Ethyl data. Examination of the shares calculated in this manner confirms that this is appropriate. It is also obvious that the shares of leaded gasoline were so low by 1985 that this calculation could not significantly affect the overall calculations.

Grams of lead per gallon

The grams of lead per gallon for the different grades of gasoline come from the *Petroleum Products Survey: Motor Gasolines Winter* and *Petroleum*

Products Survey: Motor Gasolines Summer for the years 1947 through 1989, published by the National Institute for Petroleum Energy Research (NIPER) of the Department of Energy. These are measured from samples of motor gasoline sent to NIPER each year and are tabulated for 17 different districts in the United States. There is slight seasonal variation between winter and summer gasoline, so I use only the summer values for consistency except when analysis is done monthly. For the years 1947 to 1974, lead content (grams per gallon) is available separately for "regular" (leaded non-premium) and "premium" (leaded premium) grades. For the years 1975 to 1980, grams per gallon are reported for "unleaded" (unleaded non-premium), "regular" (leaded non-premium), and "premium" (leaded premium) grades. For the year 1981, grams per gallon are reported for "leaded below 93 octane" (leaded non-premium) and "leaded above 93 octane" (leaded premium) grades. For the years 1982 to 1989, grams per gallon are reported only for the "leaded below 93 octane" (leaded non-premium) grade. According to individuals at NIPER, there was so little leaded premium gasoline by 1982 that it was no longer sampled. L.M. Gibbs (1993) writes that "leaded premium gasoline essentially disappeared in 1981."

I note that investigation of the data reveals that the lead contents for years prior to 1975 are actually for *leaded* non-premium and *leaded* premium grades even though they are called simply "regular" and "premium" grades. It does not appear that any unleaded gasoline was included in these samples. When unleaded gasoline was sampled, starting in 1975, it was broken out separately. (No excess decline in lead content is observed in the years 1972 to 1974 that would indicate that unleaded gasolines were included in these measurements prior to 1975.)

The NIPER reports therefore provide the grams per gallon for each grade of gasoline for each year 1947 to 1989 in each of the 17 districts. Based on the listing of districts provided in the reports, I determine in which district a state lies and use the appropriate grams per gallon numbers for that state.

Gallons of gasoline consumed

The total gallons of gasoline taxed in each state in each year are available from the Federal Highway Administration for the years 1950 to 1995. Values are available for Alaska and Hawaii only after they became states in 1959. Therefore, for the years 1950 to 1958 for Alaska and Hawaii, I calculate the state's total gallons by calculating the year-to-year growth rate of total gallons for the other 48 states for the years 1950 to 1959 and applying these growth rates backwards to the 1959 gallons for the state.

Population and population density

State populations and population densities are calculated from the

decennial U.S. Censuses, using tract-level data. These were accessed as the Integrated Public Use Microdata samples provided by the University of Minnesota. The average population density within which people in a state live is calculated as the population-weighted average of population density across census tracts in the state and year = $\Sigma_{\text{tracts } t}$ [pop of tract (*t,y*) / pop of state (*s,y*)] x (pop density (*t,y*)] where population density is measured in people per square mile.

Per-capita lead

Per-capita lead is defined as: Per Capita Lead (s,y) = Grams of Lead per Gallon (s,y) x Total Gallons (s,y) / Population (s,y).

Experienced lead

Experienced lead is defined as: Experienced Lead (s,y) = Per Capita Lead (s,y) x average population density.

Migration

Effective exposure measures are corrected for cross-state migration as follows. The 1970, 1980, 1990, and 2000 IPUMS are used to calculate the matrix of state of birth - state of residence probabilities for each census year and each age. These values are designated as $p\,(\,b \mid s,y,a\,)$ where b is state of birth, s is state of residence, y is year, and a is age. Values for intercensal years are then linearly interpolated to create a full set of values $p\,(\,b \mid s,y,a\,)$. Note that

$$\Sigma_b \;\; p\,(\,b \mid s,y,a\,) = 1 \quad \text{for any given } s,y,a \;\; .$$

The effective lead exposure measure is then modified to account for migration between birth state and state of residence:

(6') Migration Corrected Effective Lead (*c,s,y*) =

$$\Sigma_a \;\; [\;\text{Arrests}(c,\,a,\,1985) \;\; / \;\; \text{Arrests}\,(c,\,\textit{total},\,1985)\;] \;\; x$$
$$\{\;\; \Sigma_b \;\; p\,(\,b \mid s,y,a\,) \;\; x \;[\;\text{Lead}\,(b,\,y\text{-}a) + \text{Lead}\,(b,\,y\text{-}a\text{+}1)$$
$$+\;\text{Lead}\,(b,\,y\text{-}a\text{+}2) + \;\text{Lead}\,(b,\,y\text{-}a\text{+}3)\;] \;\; / \;\; 4 \;\;\}$$

where *c* is a specific crime category.

Crime Data

All crime data by state by year is from *Uniform Crime Reports for the United States*, published annually by the Federal Bureau of Investigation.

State-level variables

Abortion

Abortion rates are from the Statistical Abstract of the United States, published annually by the U.S. Bureau of Census. Abortion rates are measured as abortions per 1000 births. The original source of the data is *The Abortion Fact Book* published by The Alan Guttmacher Institute.

Unemployment

State unemployment rates are from the Statistical Abstract of the United States, published annually by the U.S. Bureau of Census. The unemployment rate represents the percent unemployed among the civilian non-institutional population 16 years of age and older.

Income

Income per capita is from the Statistical Abstract of the United States, published annually by the U.S. Bureau of Census. It is converted into 2000 dollars.

Poverty

Poverty rates are from the Statistical Abstract of the United States, published annually by the U.S. Bureau of Census. The poverty rate is the percentage of the state population below the federal poverty line as defined in that year.

Maternal characteristics

Rates of teen pregnancy, mother with less than high school education, and no prenatal care in the first trimester are calculated from the Vital Statistics of the United States, published annually by the National Center for Health Statistics. The rate of teen pregnancy is calculated as all live births to women age 19 and under, divided by all live births. Share of mothers with less than high school education is calculated as number of mothers giving birth who have less than a high school education, divided by the total number of mothers giving birth. No prenatal care in the first trimester is calculated similarly.

AFDC generosity

Generosity of Aid to Families with Dependent Children (AFDC) is from the Statistical Abstract of the United States, published annually by the U.S. Bureau of Census. AFDC generosity is measured as the average yearly AFDC payment per family receiving aid (12 times the average monthly payment), lagged by 15 years and converted into 2000 dollars.

Prisoners

Data on prisoners is from Correctional Populations in the United States, published annually by the Bureau of Justice Statistics. It is measured as prisoners per 1000 population and is lagged by one year.

Police

Data on police is from the Uniform Crime Reports for the United States, published annually by the Federal Bureau of Investigation. It is measured as police per 1000 population and is lagged by one year.

Gun laws

Data on gun laws is from Lott and Mustard (1997). The variable indicates whether the state had a non-discretionary concealed handgun law in that year. Such a law requires local law enforcement authorities to grant concealed weapons permits to anyone meeting certain pre-established criteria.

Beer consumption

Beer consumption is from the Brewers Almanacs, published by the Beer Institute. It is measured as consumption of malt beverages in gallons consumed per capita.

Population age shares

Population age shares are calculated from the Surveillance, Epidemiology, and End Results (SEER) Public-Use Data on the age distribution of the population, calculated and published by the National Cancer Institute. These data are used to calculate the shares of the population in each state that are in five-year age ranges between 15 years and 45 years.