Output and pollution abatement in a U.S. state emission function

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ONLINE APPENDIX

Data

The sample consists of 48 states for the period 1973-1994, with the exception of 1987; a total of 1008 observations. The dataset includes the following state-level variables: sulphur dioxide (SO_2) and nitrogen oxides (NO_x) emissions, gross output, the prices of the inputs, labor, capital, energy, materials and pollution abatement expenditures. Emissions are measured in million tons.[1] For the rest of the variables, all values are in millions of current dollars and prices are normalized to 1.0 in 1992. The construction of these variables (except abatement expenditures) is described in detail in Empora and Mamuneas (2011). Finally, the spillover pollution variable is also constructed in order to model a state's emissions as a function of its neighbors' emissions.

The variable used for pollution abatement expenditures is the pollution abatement gross annual operating costs by state, total across all media types, measured in millions of dollars; "operating expenses for pollution abatement equipment are easier for PACE survey respondents to identify separately. Abatement capital expenses may be difficult to disentangle from investments in production process changes that have little to do with pollution abatement... Operating costs are more consistent year-to-year" (Levinson, 1999: 18).[2] These expenditures are deflated by the price of gross output. Pollution abatement expenditures come from the Pollution Abatement Cost and Expenditures (PACE) survey conducted annually by the US Bureau of the Census (the data are published in Current Industrial Reports: Pollution Abatement Costs and Expenditures, MA-200, various years). The PACE survey collected data from manufacturing establishments about their pollution abatement operating and capital costs from 1973-1994

[1] The emissions data were originally published in the U.S. Environmental Protection Agency (EPA) National Air Pollutant Emission Trends and National Emissions Inventory (NEI), Emissions Inventory & Analysis Group; Air Quality Assessment Division, Office of Air Quality Planning and Standards. This data set was first used in List and Gallet (1999).

[2] Kinds of operating costs are: depreciation (only for pollution abatement structures and equipment), salaries and wages, fuel and electricity, contract work/services, materials, leasing materials include the cost of materials, parts and etc used as operating supplies for pollution abatement or for repairing and maintaining the pollution abatement capital equipment) and other costs (for example payments to government, underground storage tanks, etc.).

(except 1987), when it was discontinued. Data were again collected for 1999, but the 1999 PACE survey was quite different than the previous ones raising compatibility issues. (Becker and Shadbegian (2005) provide details on the differences between the 1994 and 1999 PACE survey.) The latest survey was conducted in 2005. This latest survey is more compatible to the 1994 PACE survey but, due to the long break in the time series, the data in this paper are confided up to the year 1994.

The spillover pollution variable is constructed using weighting matrices (with the leading diagonal terms equal to zero) along with data on the SO_2 and NO_x emission density for each state (emissions of a state divided by its size).[3] Two alternative weighting schemes are used in the empirical estimations: the first is the nearest neighbor weighting scheme. It employs a weight that defines two states as neighbours if the distance between the two states is less than the median distance between two states in the sample (the sample median distance between states is 1091 miles; the mean distance is 1194.5 miles). This is the one discussed in this paper. The second is one in which weights are based on the inverse distances between the states. Thus the two weighting schemes are distance-based ones, with the distance between states taken from Wolf (2000).[4]

[3] The state size is from U.S. Census Bureau, 2000 Census of Population and Housing, Summary Population and Housing Characteristics (http://www.census.gov/compendia/statab/geography_environment/land_and_land_use/).

[4] The U.S. EPA's Clean Air Interstate Rule (CAIR) program also provides information about which states air emissions affect the "downwind" states (http://www.epa.gov/cair/). The information can be used to construct a weighting scheme that assigns a weight of one if states accept inflows of pollution from the other states (zero otherwise). This weight, although is probably more suitable in specifying pollution relationships between states, it comes with a downside; it does not include all the states in the sample. It covers only the "... 27 eastern states and the District of Columbia. Air emissions in these states contribute to unhealthy levels of ground-level ozone, fine particles or both in downwind states." It is therefore not used in the current study.

Table A1. Descriptive statistics (1973-1994)

Variable	Mean	Std. Dev.	Min	Max
SO_2 emissions	0.5149	0.5990	0.0019	3.4065
NO_x emissions	0.4791	0.4575	0.0192	2.9562
Gross Output	152292.9	178489.8	9527.957	1228333
Abatement	259.7043	319.9868	0.9711	2232.03
Price of labor	0.6852	0.2289	0.3115	1.0361
Price of capital	0.8602	0.1926	0.4641	1.6531
Price of materials	0.76249	0.1984	0.3739	1.0503
Price of energy	0.8558	0.3018	0.2061	1.3261
SO_2 spillovers	135.61	75.075	0.8044	248.61
NO_x spillovers	108.79	60.501	1.7979	196.23
Obs.	1008			

Emissions are measured in million tons. Gross output and abatement are measured in millions of 1992 US$.

Table A2. Panel data unit root tests

Variable (levels)	Im, Pesaran and Shin (2003)	Levin, Lin and Chu (2002)	Maddala and Wu (1999)
SO_2 emissions	p-value=0.041	p-value=0.000	p-value=0.000
NO_x emissions	p-value=0.000	p-value=0.000	p-value=0.000
Gross Output	p-value=0.139	p-value=0.000	p-value= 0.983
Abatement	p-value=0.071	p-value=0.000	p-value=0.029
Rel.price of capital	p-value=0.001	p-value=0.000	p-value=0.957
Rel. price of materials	p-value=0.000	p-value=0.000	p-value=0.000
Rel. price of energy	p-value=0.364	p-value=0.0007	p-value=1.000
$SO_{2,t-1}$	p-value=0.714	p-value=0.0048	p-value=0.002
$NO_{x,t-1}$	p-value=0.000	p-value=0.0000	p-value=0.000
Spill $SO_{2,t-1}$	p-value=0.086	p-value=0.000	p-value=0.946
Spill $NO_{x,t-1}$	p-value=0.000	p-value=0.000	p-value=0.000
Residuals SO_2	p-value=0.000	p-value=0.000	p-value=0.000
Residuals NO_x	p-value=0.000	p-value=0.000	p-value=0.000

Panel unit root tests include a constant and a time trend. Null hypothesis: unit root. The tests without time trend also reject the null hypothesis of unit root in SO_2 and NO_x emissions.
The residuals are from the linear regressions of SO_2 and NO_x, respectively, on all the independent variables in the model.
The 48 contiguous states are included in the dataset. The states of Alaska, District of Columbia and Hawaii are excluded from the sample.

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