Companion Appendix to "On the Productive Effects of Public Capital Maintenance: Evidence from U.S. States"

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Semiparametric partially linear smooth-coefficient approach

To estimate equation (5) we follow a three-step process (see also Chou et al., 2004). In the first step, all coefficients are assumed to be smoothing functions of Z_{it} and are estimated by applying a local least-squares method with a kernel weight function:

$$\begin{pmatrix}\hat{\alpha}(Z_{it})\\ \hat{\beta}(Z_{it})\end{pmatrix} = \left(\sum_{s=1}^{n} XW_s XW_s' k\left(\frac{Z_{it}-Z_s}{h}\right)\right)^{-1} \sum_{s=1}^{n} XW_s \hat{TFP}_s k\left(\frac{Z_{it}-Z_s}{h}\right) \tag{A1}$$

where $XW_s \equiv (W_s, X_s)'$, $k(.)$ is a kernel function and h is the smoothing parameter (bandwidth). We use a standard normal (Gaussian) kernel $k(u) = e^{-u^2/2}/\sqrt{2\pi}$ and choose the bandwidth via $h = c \times Z_{sd} \times n^{-1/5}$, where Z_{sd} is the sample standard deviation of $\{Z_t\}_{t=1}^{n}$ and c is a constant set equal to 2.0. Unlike (5), the estimator $\hat{\alpha}(Z_{it})$ in (A1) depends on Z_{it} in the first step, ignoring the fact that α is a vector of constant coefficients. Subtracting $X_{it}'\hat{\beta}(Z_{it})$ from both sides of (5) yields:

$$\hat{TFP}_{it} - X_{it}'\hat{\beta}(Z_{it}) = W_{it}'\alpha + X_{it}'\left(\beta(Z_{it}) - \hat{\beta}(Z_{it})\right) + u_{it} \equiv W_{it}'\alpha + \varepsilon_{it} \tag{A2}$$

where $\varepsilon_{it} \equiv X_{it}'\left(\beta(Z_{it}) - \hat{\beta}(Z_{it})\right) + u_{it}$. The next stage is to run a least-squares regression of (A2):

$$\hat{\alpha} = \left(\sum_{it=1}^{n} W_{it}W_{it}'\right)^{-1} \sum_{it=1}^{n} W_{it}\left(\hat{TFP}_{it} - X_{it}'\hat{\beta}(Z_{it})\right) \tag{A3}$$

The final step is to use the second-stage linear part estimates, $\hat{\alpha}$, to redefine the dependent variable in (5), and return to the simple smooth-coefficient environment of Li et al. (2002). Subtracting $W_{it}'\hat{\alpha}$ from both sides of (5) we get:

$$\hat{TFP}_{it} - W_{it}'\hat{\alpha} = W_{it}'(\alpha - \hat{\alpha}) + X_{it}'\beta(Z_{it}) + u_{it} \equiv X_{it}'\beta(Z_{it}) + \nu_{it} \tag{A4}$$

where $\nu_{it} \equiv W_{it}'(\alpha - \hat{\alpha}) + u_{it}$. The smooth-coefficient functions can then be estimated, as proposed by Li et al. (2002), using a local least-squares method similar to the first step:

$$\hat{\beta}(Z_{it}) = \left(\sum_{s=1}^{n} X_s X_s' k\left(\frac{Z_{it}-Z_s}{h}\right)\right)^{-1} \sum_{s=1}^{n} X_s\left(\hat{TFP}_s - W_s'\hat{\alpha}\right) k\left(\frac{Z_{it}-Z_s}{h}\right) \tag{A5}$$

For details on the consistency and asymptotic normality of $\hat{\beta}(Z_{it})$ see also Li and Racine (2007).

Table A: Average Output Elasticities by State in the Absence of Spillovers, 1978-2000

State	$\theta_1(Z_{it})$	$\theta_2(Z_{it})$	State	$\theta_1(Z_{it})$	$\theta_2(Z_{it})$
NORTHEAST			Virginia	0.0078	0.0144
			(VA)	(0.0012)	(0.0022)
Maine	0.0106	0.0144	West Virginia	0.0046	0.0107
(ME)	(0.0006)	(0.0055)	(WV)	(0.0014)	(0.0025)
New Hampshire	0.0098	0.0006	North Carolina	0.0057	0.0102
(NH)	(0.0006)	(0.0066)	(NC)	(0.0012)	(0.0022)
Vermont	0.0119	-0.0012	South Carolina	0.0063	0.0118
(VT)	(0.0009)	(0.0083)	(SC)	(0.0012)	(0.0022)
Massachusetts	0.0057	0.0104	Georgia	-0.0015	0.0002
(MA)	(0.0014)	(0.0019)	(GA)	(0.0008)	(0.0005)
Rhode Island	0.0055	0.0108	Florida	0.0022	0.0068
(RI)	(0.0013)	(0.0022)	(FL)	(0.0014)	(0.0022)
Connecticut	0.0063	0.0111	Kentucky	0.0029	0.0027
(CT)	(0.0013)	(0.0023)	(KY)	(0.0012)	(0.0009)
New York	0.0114	0.0253	Tennessee	-0.0001	0.0013
(NY)	(0.0003)	(0.0008)	(TN)	(0.0008)	(0.0003)
Pennsylvania	0.0088	0.0131	Mississippi	0.0066	0.0082
(PA)	(0.0004)	(0.0047)	(MS)	(0.0008)	(0.0013)
New Jersey	0.0103	0.0204	Alabama	0.0090	0.0142
(NJ)	(0.0004)	(0.0019)	(AL)	(0.0008)	(0.0018)
			Oklahoma	0.0064	0.0080
MIDWEST			(OK)	(0.0008)	(0.0015)
			Texas	0.0034	0.0054
Wisconsin	0.0104	0.0210	(TX)	(0.0012)	(0.0016)
(WI)	(0.0006)	(0.0019)	Arkansas	0.0098	0.0187
Michigan	0.0086	-0.0092	(AR)	(0.0006)	(0.0019)
(MI)	(0.0006)	(0.0063)	Louisiana	0.0035	0.0055
Illinois	0.0107	0.0233	(LA)	(0.0012)	(0.0016)
(IL)	(0.0005)	(0.0015)			
Indiana	0.0106	0.0198	WEST		
(IN)	(0.0006)	(0.0016)			
Ohio	0.0102	0.0177	Idaho	-0.0004	0.0032
(OH)	(0.0006)	(0.0018)	(ID)	(0.0013)	(0.0019)
North Dakota	0.0037	0.0059	Montana	-0.00002	0.0009
(ND)	(0.0011)	(0.0018)	(MT)	(0.0009)	(0.0007)
South Dakota	0.0043	0.0049	Wyoming	0.0042	-0.0020
(SD)	(0.0009)	(0.0010)	(WY)	(0.0024)	(0.0006)
Nebraska	0.0006	0.0025	Nevada	-0.0021	-0.0008
(NE)	(0.0009)	(0.0008)	(NV)	(0.0011)	(0.0006)
Kansas	0.0075	0.0109	Utah	0.0015	0.0020
(KS)	(0.0008)	(0.0018)	(UT)	(0.0010)	(0.0009)
Minnesota	0.0050	0.0060	Colorado	0.0060	0.0097
(MN)	(0.0008)	(0.0010)	(CO)	(0.0012)	(0.0019)
Iowa	0.0059	0.0060	Arizona	0.0015	0.0010
(IA)	(0.0006)	(0.0010)	(AZ)	(0.0013	(0.0013)
Missouri	0.0085	0.0119	New Mexico	0.0014	0.0023
(MO)	(0.0007)	(0.0014)	(NM)	(0.0014)	(0.0027)
			Washington	0.0052	0.0067
SOUTH			(WA)	(0.0010)	(0.0013)
			Oregon	0.0092	0.0145
Delaware	0.0044	0.0093	(OR)	(0.0006)	(0.0016)
(DE)	(0.0014)	(0.0023)	California	0.0096	0.0245
Maryland	0.0044	0.0107	(CA)	(0.0003)	(0.0011)
(MD)	(0.0012)	(0.0027)			

Notes: See Table 2 of the paper.

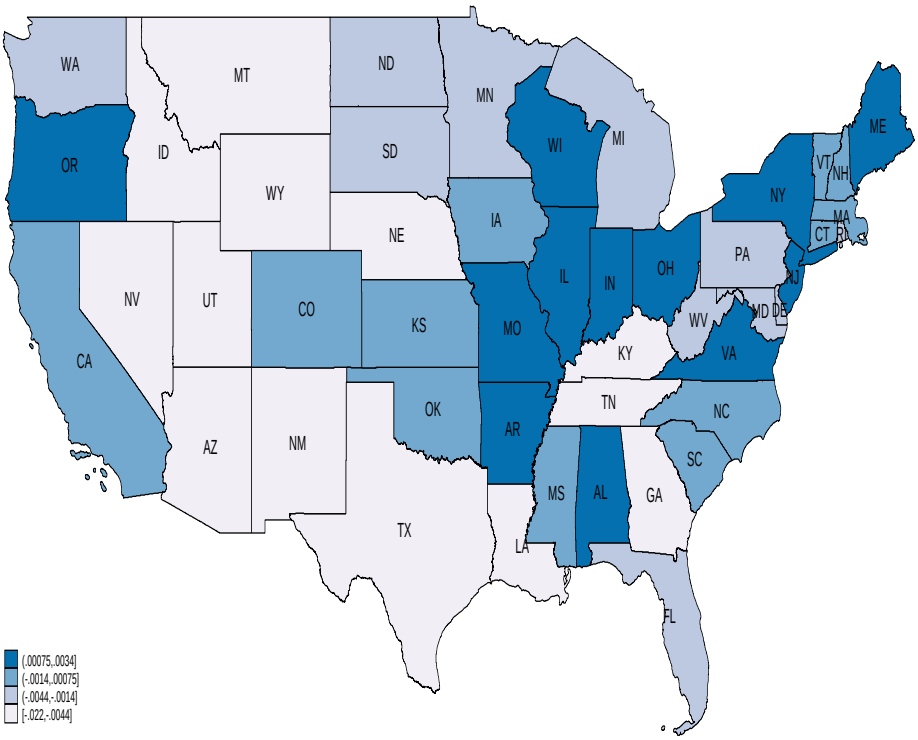

Figure A: Output elasticity of own-state capital spending, $\theta_1(Z_{it})$: Mean estimates by state, 1978-2000

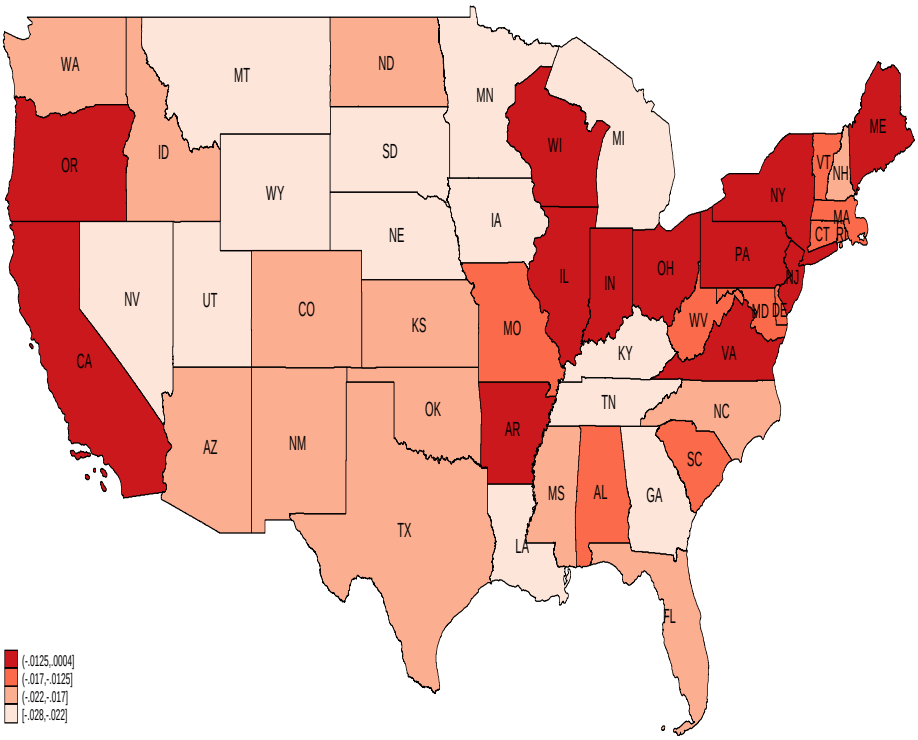

Figure B: Output elasticity of own-state O&M spending, $\theta_2(Z_{it})$:
Mean estimates by state, 1978-2000

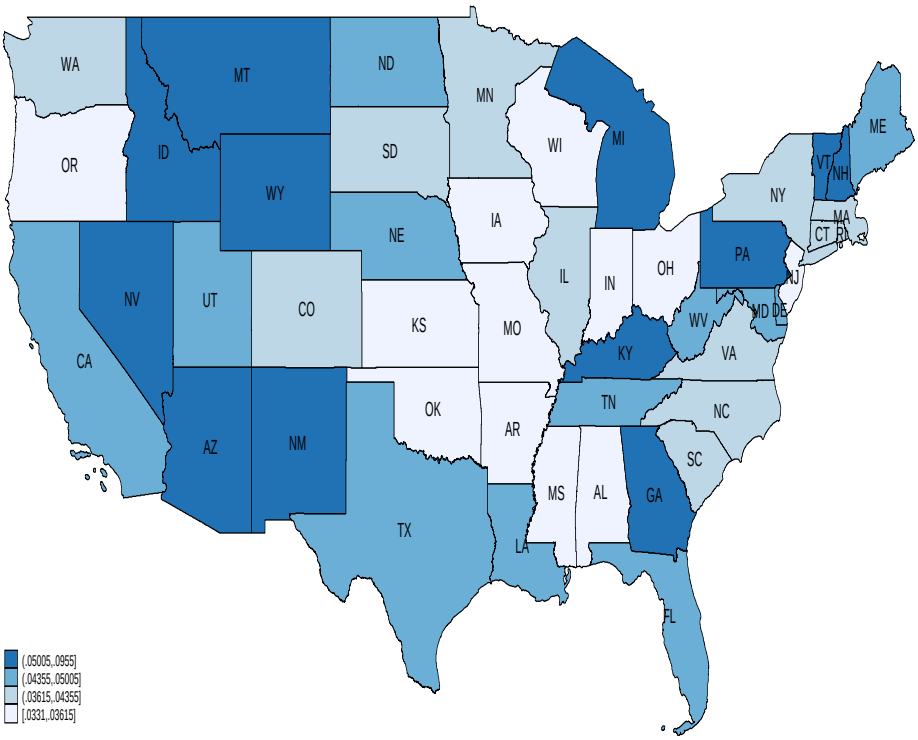

Figure C: Output elasticity of capital spending by other states, $\theta_3(Z_{it})$: Mean estimates by state, 1978-2000