The Local Consequences of Federal Mandates

Evidence from the Clean Water Act

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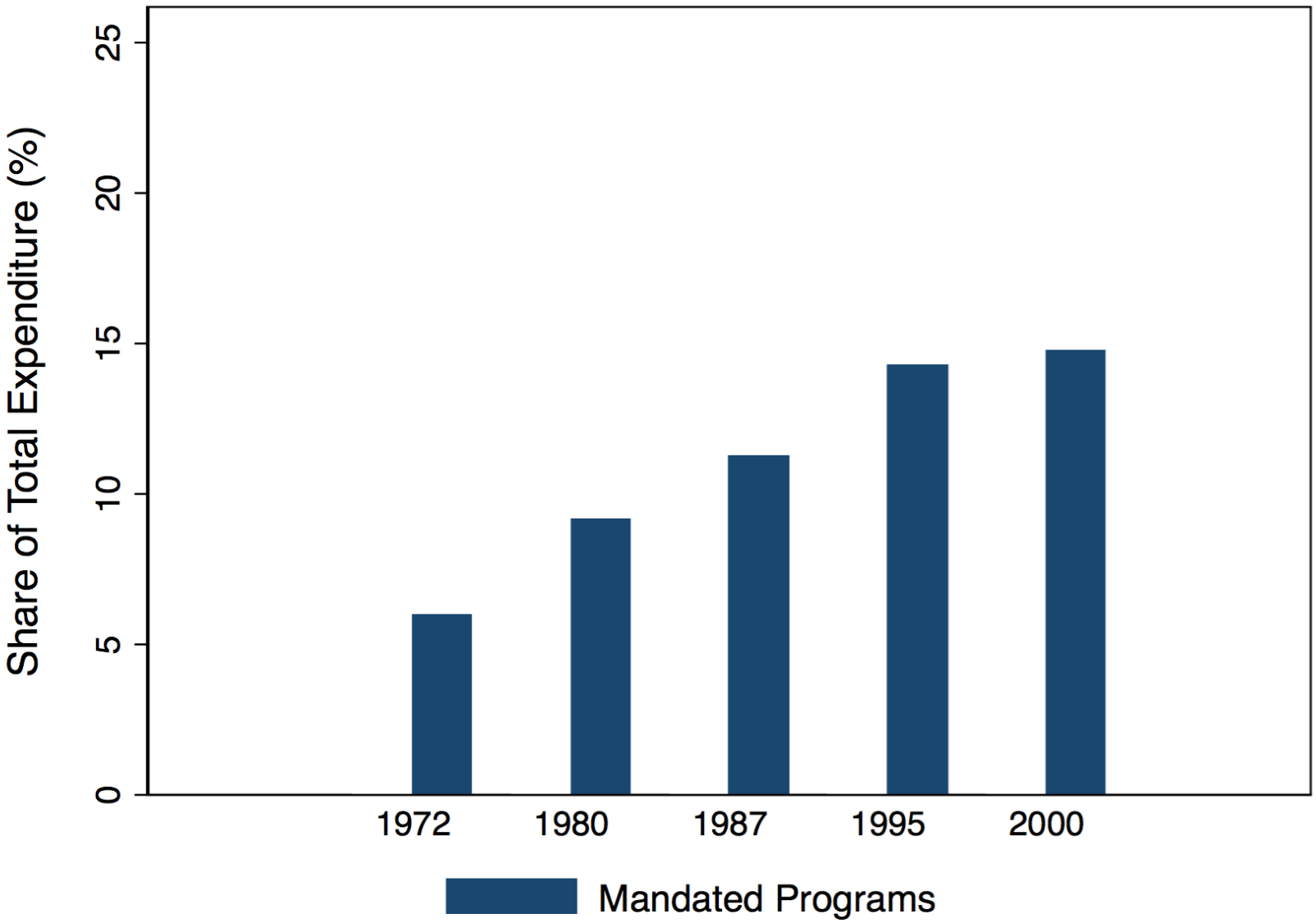
Trends in Federally–Mandated Local Spending



Source: US Advisory Commission on Intergovernmental Relations; Census of Governments

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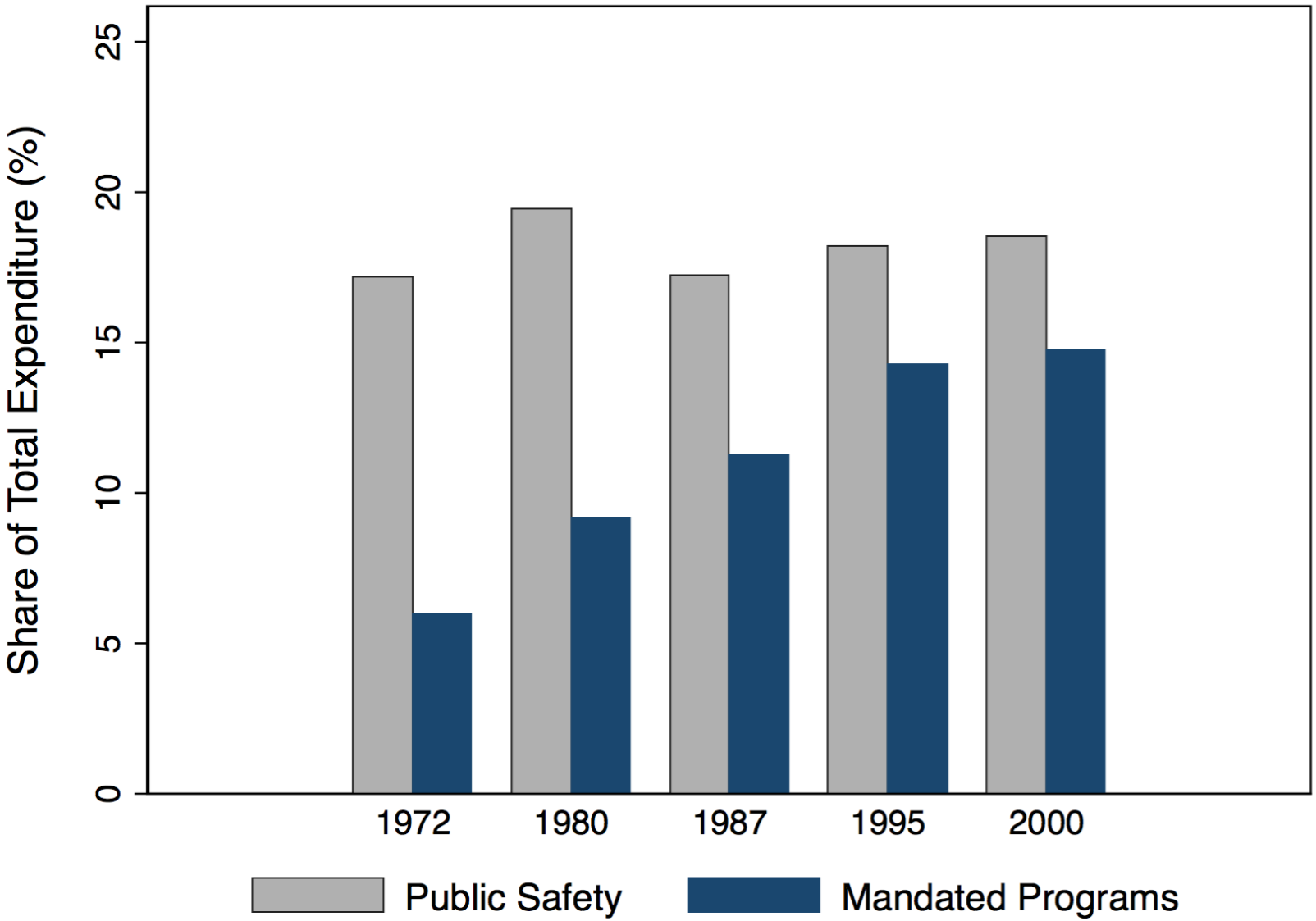


Source: US Advisory Commission on Intergovernmental Relations; Census of Governments

Can mandates be locally beneficial?

Examples: Clean Air Act, Safe Drinking Water Act,
lead paint abatement, Solid Waste Management, No Child Left Behind

They are **costly and inflexible** to local preferences

- Mandate relief legislation in NY (2017) and VA (2018)
- Existing research suggests mandates distort local budgets:
  (US Advisory Commission on Intergovernmental Relations 1994; Conference of Mayors 1993; Lake et al. 1979; Baicker 2001; Boylan & Mocan 2013)

However, mandates **may correct for under-provision of public goods**:

- Externalities
- Credit constraints
- Coordination failures (transaction costs, "race to the bottom")

This Paper

1. How do municipal budgets respond to federal spending mandates?
   - Funding source (Data from Census of Governments, 1967-1992)

2. Are mandated public goods valued by local residents?
   - Water Quality (Data from STORET Legacy & NWIS, 1957-2007)
   - Housing prices (Data from Census, 1970-1990)
     - (Brueckner 1979; Rosen 1974; Oates 1969)
   - Population (Banzhaf & Walsh 2008; Kahn 2000; Tiebout 1956)
   - Skill composition (Sieg et al 2004)

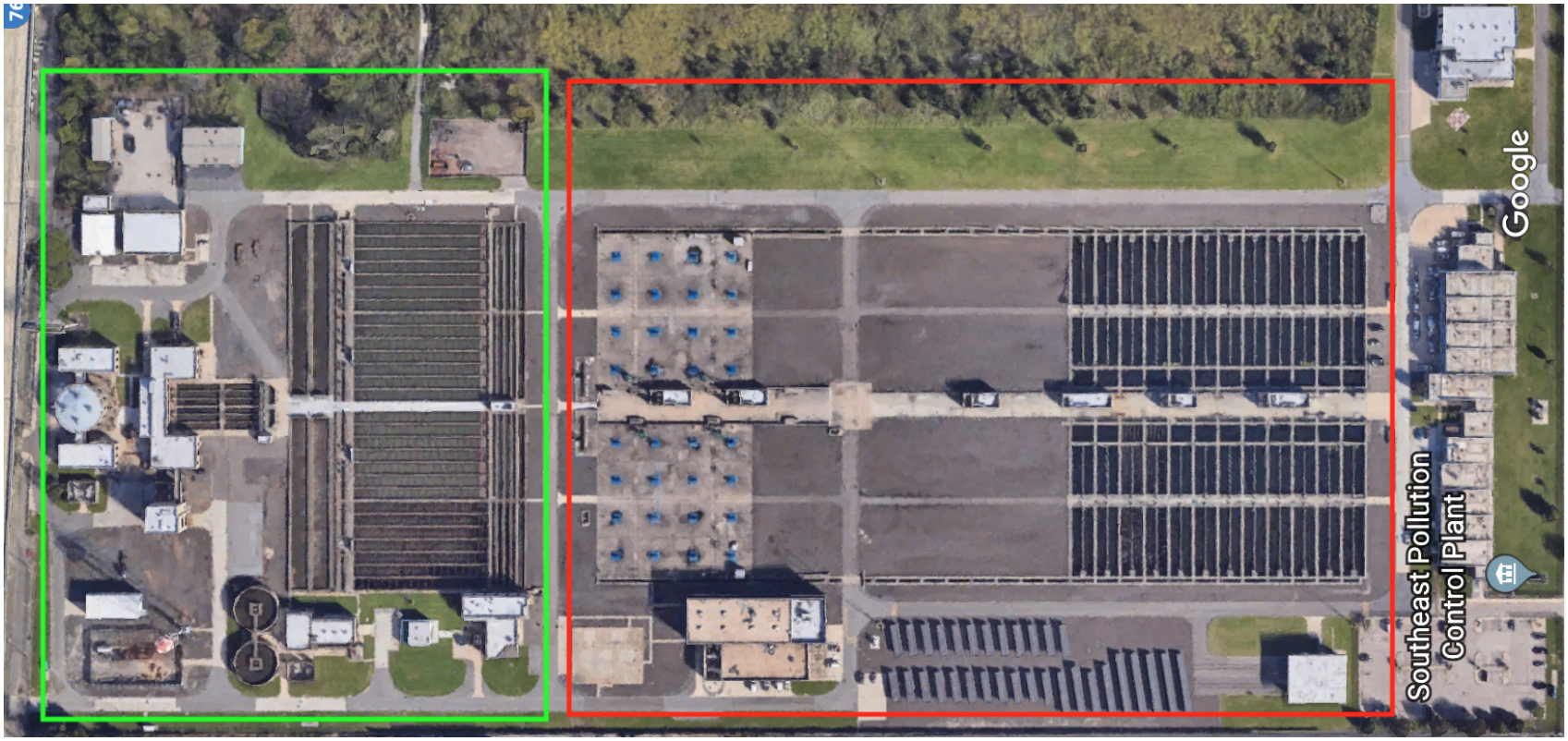
The 1972 Clean Water Act

Required municipalities to invest in wastewater treatment infrastructure

- Goal: eliminate all untreated pollution into surface waters
  - (not focused on drinking water)
- Affected over 10,000 local governments, as well as industry
- Enforced through heavy fines, federal sanctions, and lawsuits

Primary vs Secondary Treatment

Philadelphia Southwest Plant



Primary (pre-CWA)

Secondary (post-CWA)

Source: GoogleEarth (Philadelphia) PhillyPlant

This Paper

CWA required noncompliant municipalities to invest in large-scale wastewater treatment infrastructure

Empirical Challenge: whether mandate binds for a municipality is likely correlated with local spending/growth outcomes

- Instrument for *ex ante* compliance
  - Leverage variation in:

    (i) Riparian (river) connections across cities

    (ii) State variation in pre-CWA pollution abatement

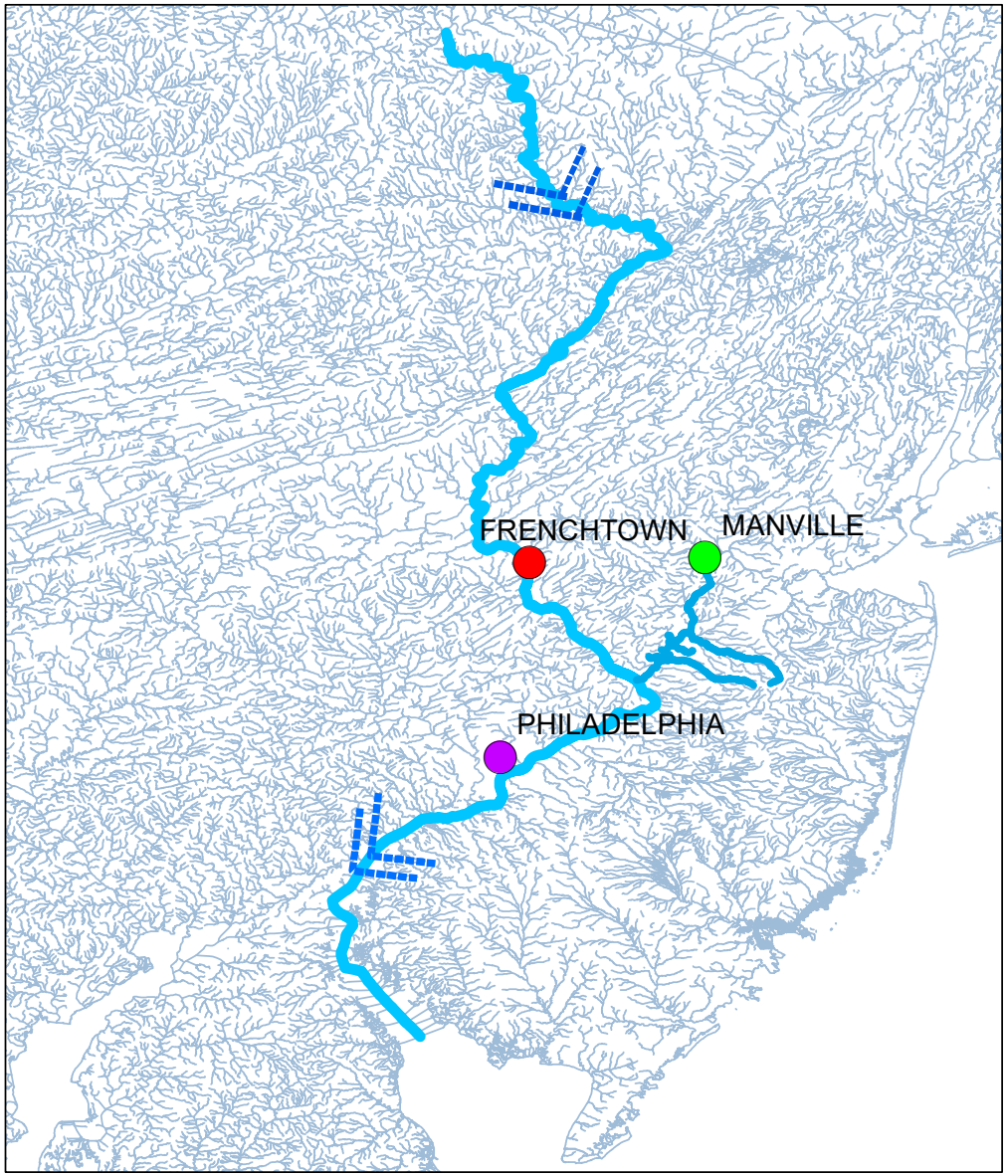
Instrument for *ex ante* compliance

- Pressure from downstream neighbors → better technology
- Litigation more likely in states with more *ex ante* pollution regulation

Example: Missouri v. Chicago (1901)

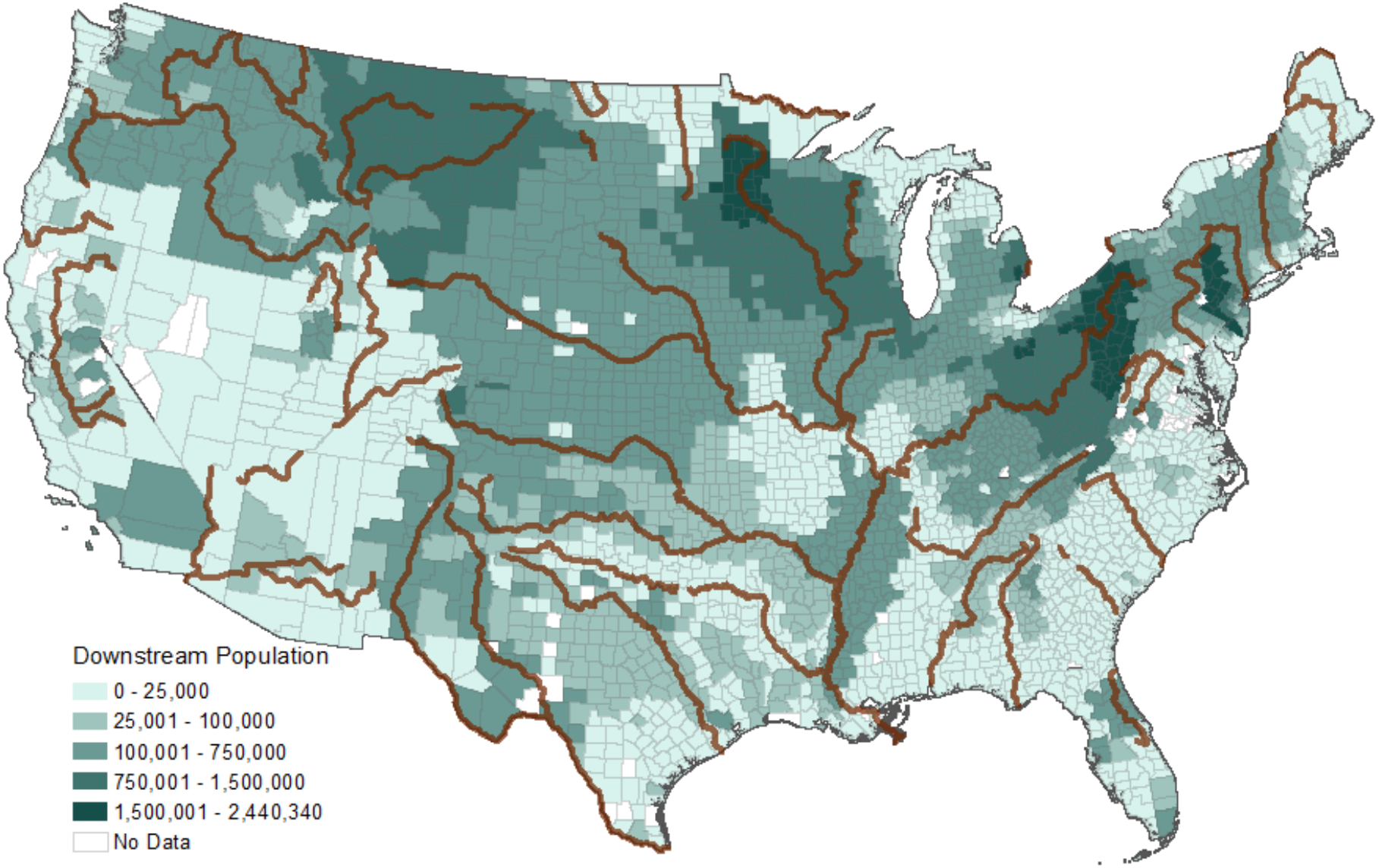
- Also: Butler v. White Plains (1901); Gould v. City of Rochester (1887); Sammons v. City of Gloversville (1903); Winchell v. Waukesha (1901); Good v. Altoona (1884); Morgan v. Danbury (1896), etc.
- "*Rigorous wastewater treatment methods were born amid the unhealthy background of injunctions and court orders between cities*" (Melosi 2000)

Downstream population calculation



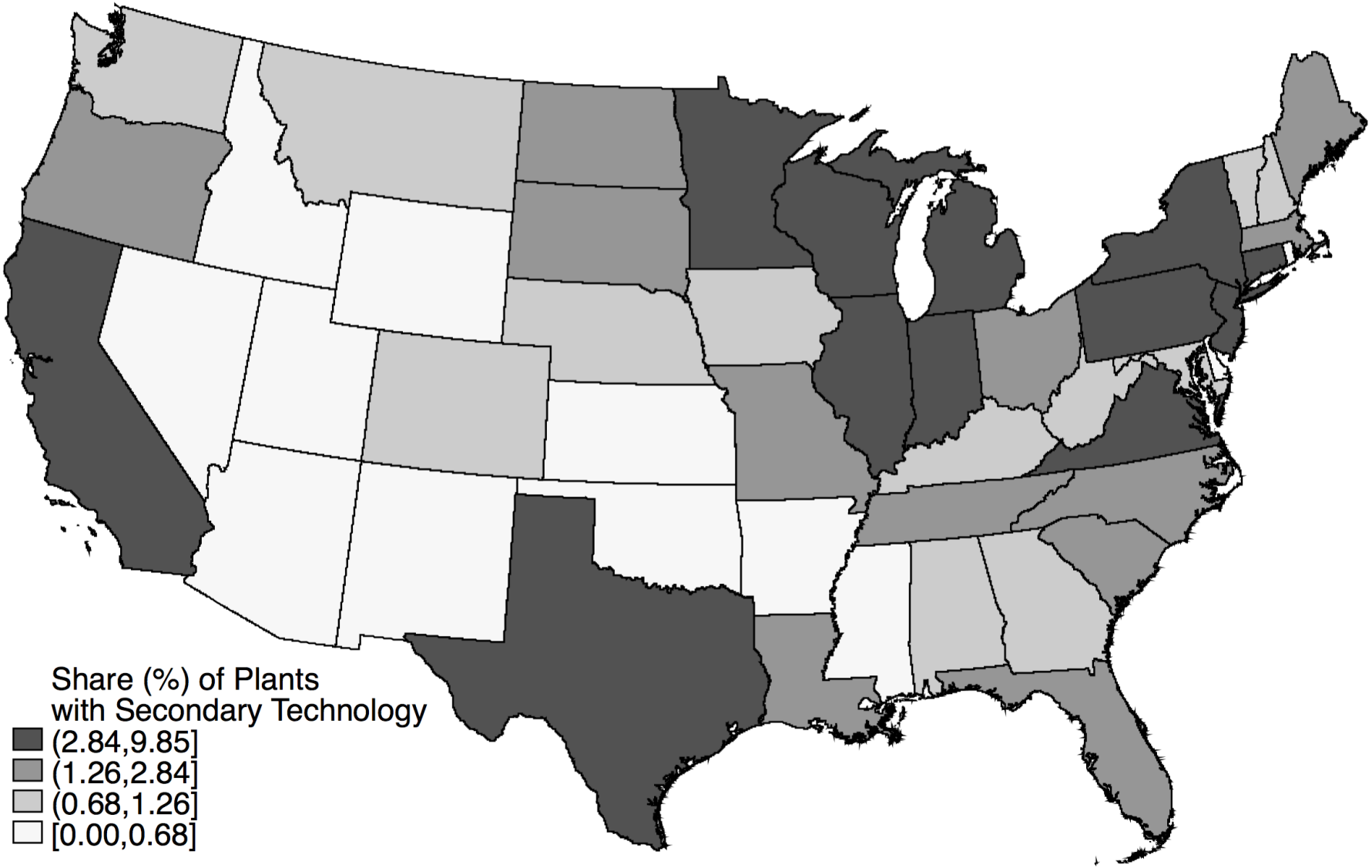
Source: USGS National Hydrography Dataset

Distribution of downstream population size



Source: USGS, Census, author's own calculation.

State composition of compliant plants at baseline (1972)



Source: Clean Watershed Needs Survey (1972). Each shade of gray corresponds to a quartile.

Two Stage Least Squares

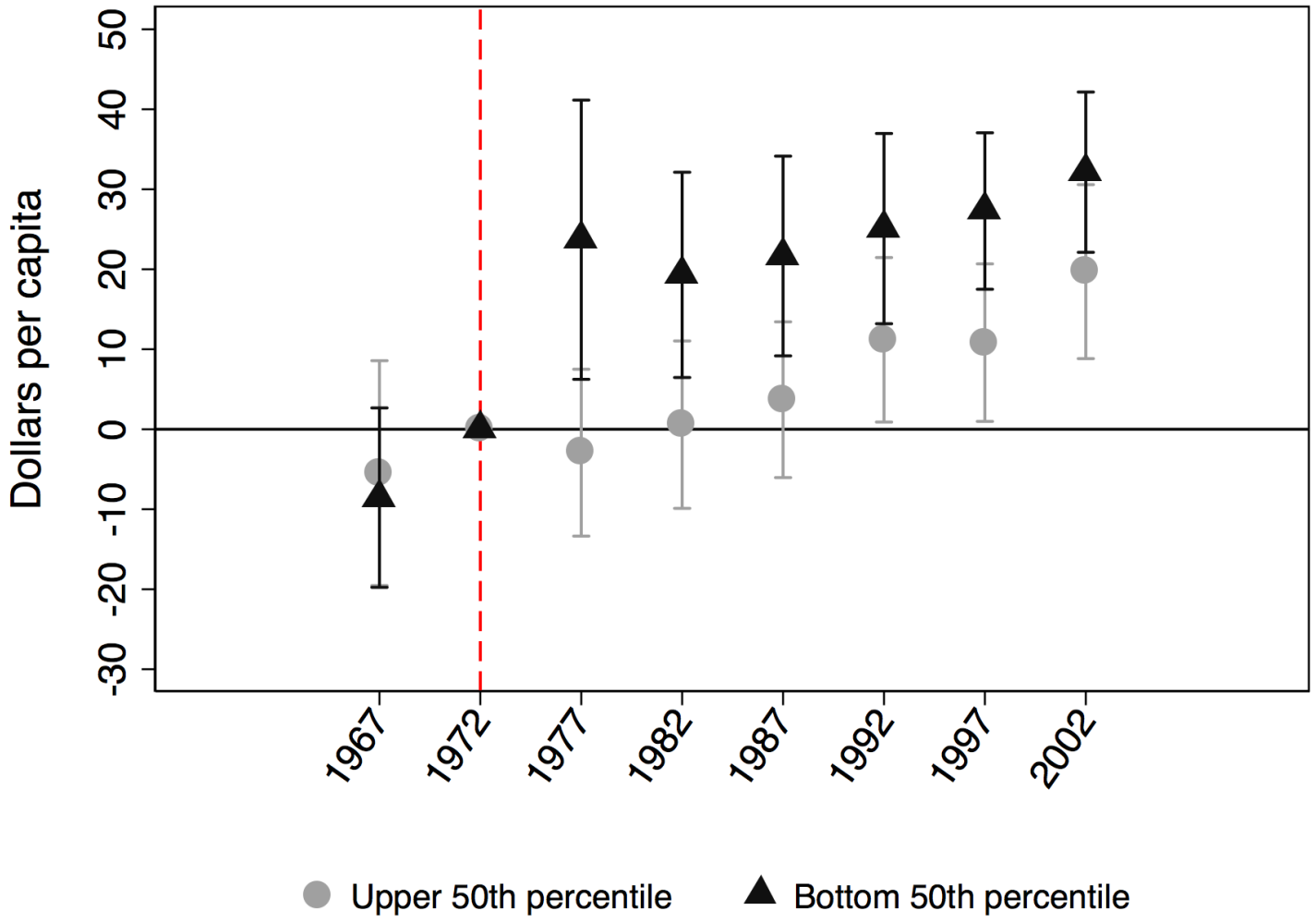
$$y_{ist} = \beta_{IV}\widehat{(P_i \times POST_t)} + \mathbf{X_i}\Theta_t + (\gamma_r \times t) + \nu_i + \tau_t + \epsilon_{ist}$$

$$P_i \times POST_t = \alpha_1(D_i \times S_s \times POST_t) + \alpha_2(D_i \times POST_t) + \alpha_3(S_s \times POST_t) + \mathbf{X_i}\Lambda_t + (\gamma_r \times t) + \kappa_i + \tau_t + \varepsilon_{it}$$

y_{ist} = some outcome, such as expenditures or population
P_i = indicator for *ex ante* non-compliance
(e.g., primary treatment as of 1972 for city i)
$POST_t$ = indicator for post-CWA years (e.g., 1977-2002)
D_i = A city's downstream population as of 1970
S_s = share of plants that are compliant in state s as of 1972
$\mathbf{X}$ = time trends in baseline city characteristics, including:
· income per capita, industry mix, intergovernmental grant receipt, population of river, watershed)
$(\gamma_r \times t)$ = Region-specific linear time trends
κ_i = city fixed effect; τ_t = year fixed effects

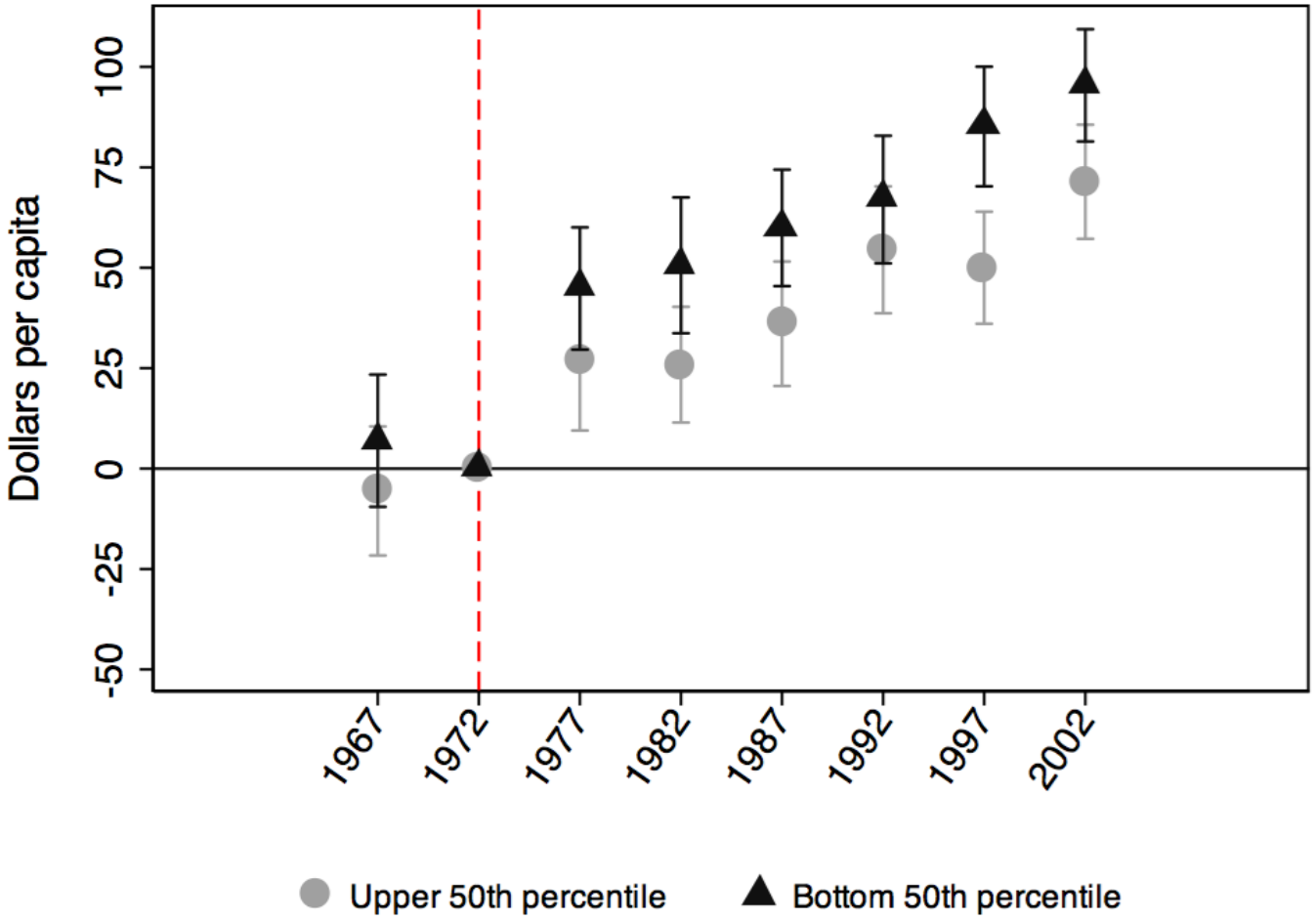
Exclusion: Fixed differences across cities in historic downstream population and baseline state compliance do not directly affect post-CWA changes in finances and growth, *except* through treatment technology

Wastewater expenditures by size of downstream population



Note: Figure plots $(\delta_{t\times\underline{50}} + \delta_t)$ in black and δ_t in gray from:
$y_{ist} = \sum_t \delta_{t\times\underline{50}}(I_{\underline{50}} \times S_s \times \gamma_t) + \sum_t \delta_t(S_s \times \gamma_t) + (N_R \times \gamma_t) + \varepsilon_i + \epsilon_{ist}$; where $I_{\underline{50}}$ indicates downstream population percentile. Includes river population by year FE.

Wastewater expenditures by size of '72 state compliance



Note: Figure plots $(\sigma_{t\times\underline{50}} + \sigma_t)$ in black and σ_t in gray from :
$y_{it} = \sum_t \sigma_{t\times\underline{50}}(I_{\underline{50}} \times \gamma_t) + \sum_t \sigma_t(\gamma_t) + \nu_i + \varepsilon_{it}$; where $I_{\underline{50}}$ indicates a city's state has share of compliant treatment plants as of 1972 in the bottom 50th percentile.

Pretrends of City Characteristics by Treatment Status

	Secondary Treatment as of 1972		Mean of Control Group
Outcome	(1)	(2)	(5)
Federal Infrastructure grants pc ($)	20.983***	24.446***	14.63
	(6.394)	(6.337)	
Ln(Population)	0.046***	0.035**	24,549
	(0.016)	(0.015)	
Total Expenditures pc ($)	71.458	48.132	1032.09
	(46.889)	(46.677)	
Sewerage Expenditures pc ($)	68.133***	60.453***	66.67
	(15.216)	(15.328)	
Total Revenues pc ($)	-27.091	-30.600	1019.02
	(58.585)	(59.460)	
Total User Fees pc ($)	-10.137	-7.767	111.91
	(9.832)	(10.073)	
Wastewater User Fees pc ($)	6.024**	6.496**	31.41
	(2.521)	(2.560)	
Controls		Y	
Observations	2590	2590	

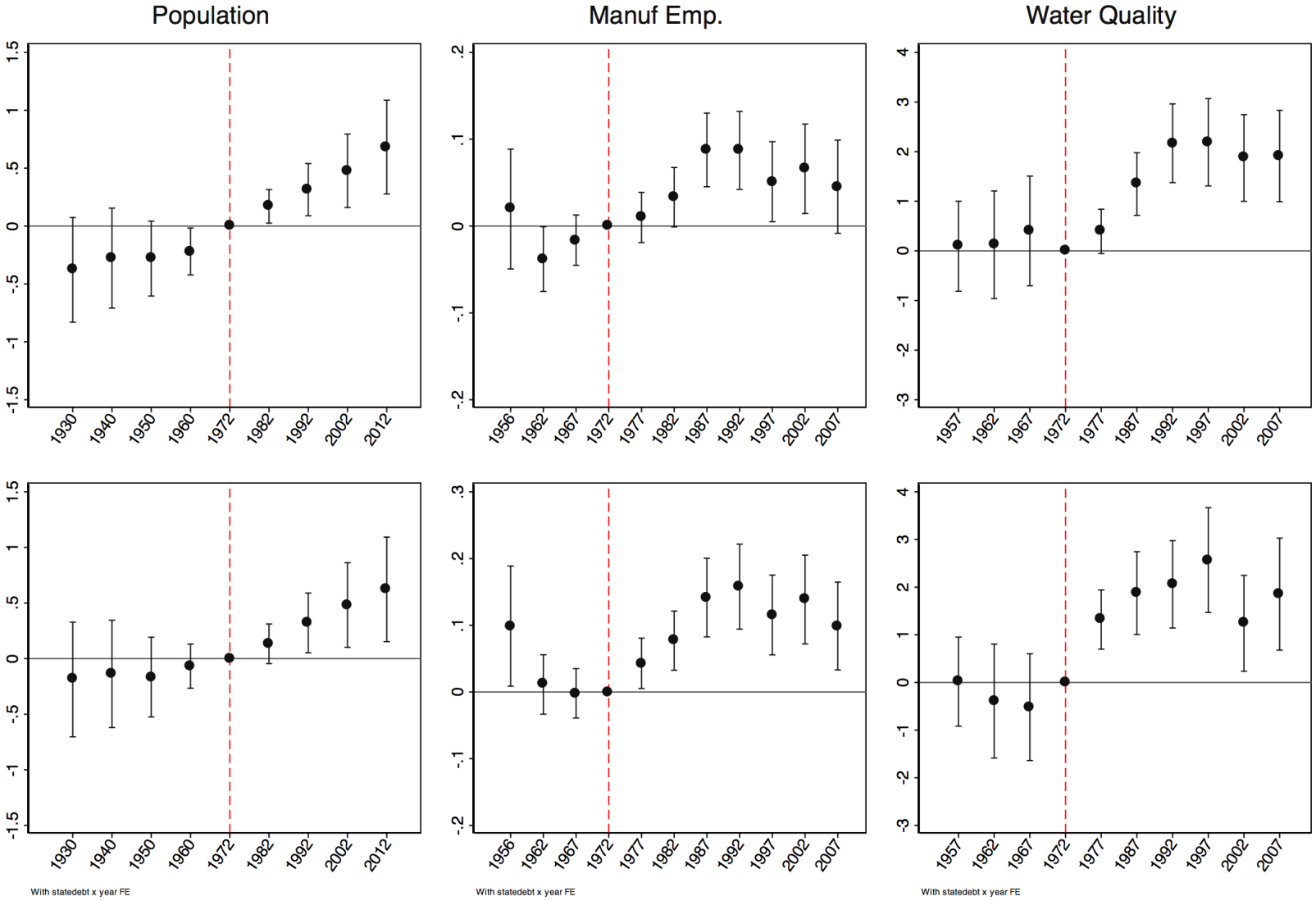
Note: Table provides estimates of β from $f_{irt} = \beta \text{Control}_{ir} + \gamma_r + \tau_t + \epsilon_{ic}$ where f_{irt} is a pre-CWA characteristic for city i in region r. Includes pre-CWA years, 1967 and 1972.

Pretrends of City Characteristics by Treatment Status

	Secondary Treatment as of 1972		Above Median Exposure to Instrument		Mean of Control Group
Outcome	(1)	(2)	(3)	(4)	(5)
Federal Infrastructure grants pc ($)	20.983***	24.446***	0.342	4.583	14.63
	(6.394)	(6.337)	(5.631)	(7.900)	
Ln(Population)	0.046***	0.035**	-0.011	-0.028	24,549
	(0.016)	(0.015)	(0.013)	(0.019)	
Total Expenditures pc ($)	71.458	48.132	9.800	-90.762	1032.09
	(46.889)	(46.677)	(41.159)	(57.829)	
Sewerage Expenditures pc ($)	68.133***	60.453***	33.992**	18.221	66.67
	(15.216)	(15.328)	(13.415)	(19.109)	
Total Revenues pc ($)	-27.091	-30.600	-67.511	-95.004	1019.02
	(58.585)	(59.460)	(51.351)	(73.667)	
Total User Fees pc ($)	-10.137	-7.767	-5.075	5.793	111.91
	(9.832)	(10.073)	(8.625)	(12.488)	
Wastewater User Fees pc ($)	6.024**	6.496**	-0.414	-4.158	31.41
	(2.521)	(2.560)	(2.216)	(3.179)	
Controls		Y		Y	
Observations	2590	2590	2590	2590	

Note: Table provides estimates of β from $f_{irt} = \beta \text{Control}_{ir} + \gamma_r + \tau_t + \epsilon_{ic}$ where f_{irt} is a pre-CWA characteristic for city i in region r. Includes pre-CWA years, 1967 and 1972.

Pre-trends of selected city characteristics



Note: Includes controls for time trends in city baseline characteristics. Bottom row includes time trends in state debt rules. Standard errors clustered at the city level.

Results: Effects of CWA on Local Budget & Water Quality

CWA mandate not funded through crowd-out

	Expenditures Per Capita				
	Total	Wastewater			Other
		Total	Capital	Operating	
Primary'72xPost	326.412	155.215***	115.53**	38.849***	217.011
	(245.763)	(54.806)	(49.069)	(18.527)	(186.408)
Baseline mean	$1,032	$67	$39	$28	$650
Marginal effect	32%	233%	299%	140%	33%

Note: Dependent variables are in 2012 dollars per capita. First stage F statistic is 17.436. Includes 14,866 observations.

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Own-source funding falls mainly on user fees (2x increase)

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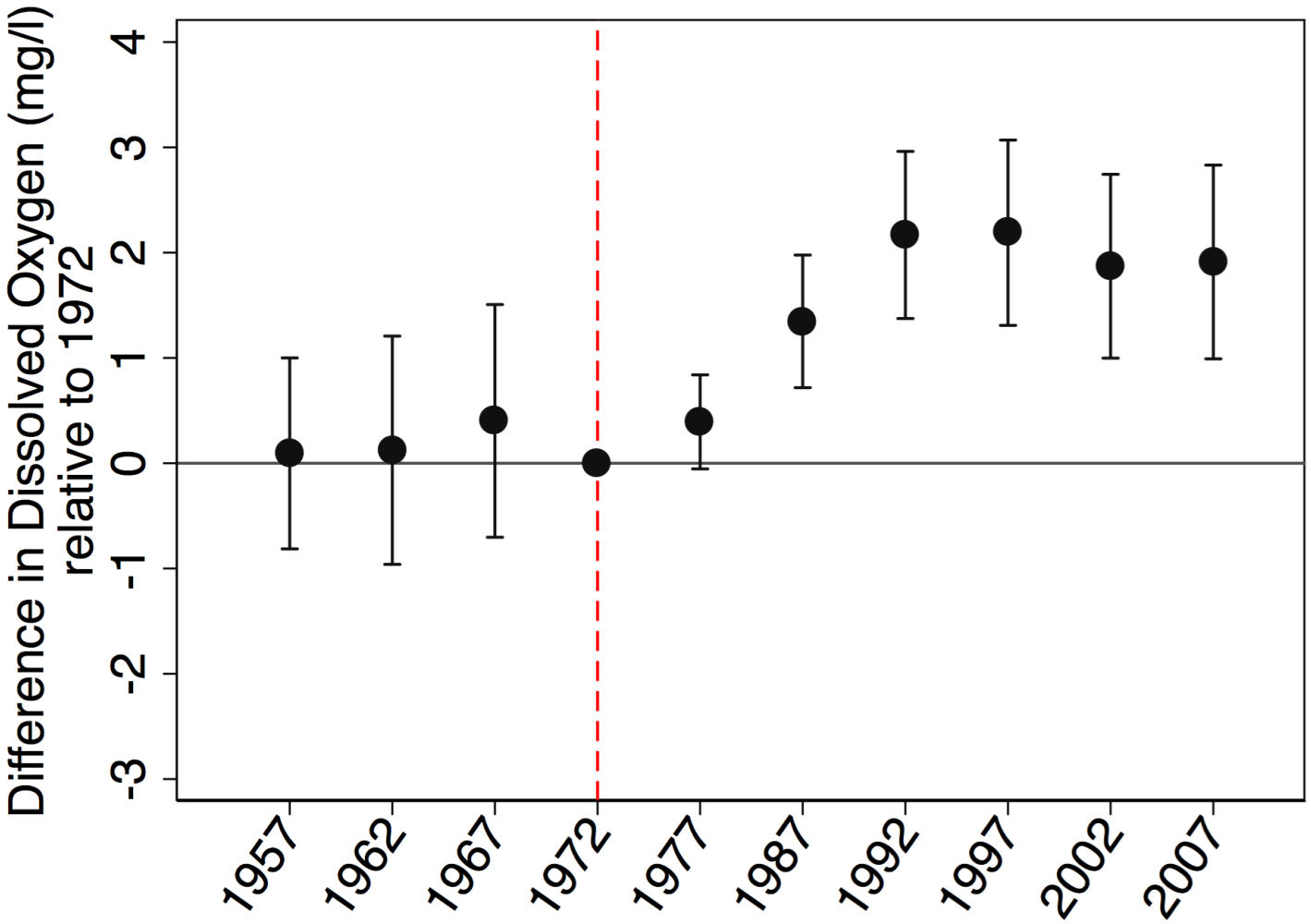
	Revenues Per Capita				
	Total	Federal Grants	User Fees	Taxes	Debt
Primary'72xPost	718.790***	173.506***	38.582**	183.602	1103.274
	(237.872)	(45.065)	(19.742)	(132.225)	(963.795)
Baseline mean	$1019	$29	$31	$340	$1392
Marginal effect	71%	592.255%	124%	47%	79%

Note: Dependent variables are in 2012 dollars per capita. First stage F statistic is 17.436. Includes 14,866 observations.

CWA mandate improves water quality 19%



Note: Regression includes controls for time trends in city baseline financial (intergovernmental grants), industrial mix, and geographic (HUC, region, distance to ocean, river population) characteristics.

Robustness Checks

Address regional (North vs South, interior vs coastal) differences in response to CWA

- Exclude coastal cities
- Exclude hydrologic regions with substantial North-South extent

Address state-level differences

- Control for differences in political climate across states
- Control for differences in state balanced budget rules
- Include StatexYear FE - increases noise, but coefficient magnitudes similar

Sample Selection

- Unbalanced panel of wastewater treatment plants - positive growth outcomes & "crowd-in" larger in magnitude

Results: Effects of CWA on Local Growth

Decomposing Local, Spillover, & GE Effects

$P_{i,j}$ = Primary treatment as of 1972 ("treated")
d_t = Post CWA (1972) dummy

$$y_{it} = \beta(P_i \times d_t) + \mathbf{X_i}\Theta_t + (\gamma_r \times t) + \nu_i + \tau_t + \varepsilon_{it}$$

Decomposing Local, Spillover, & GE Effects

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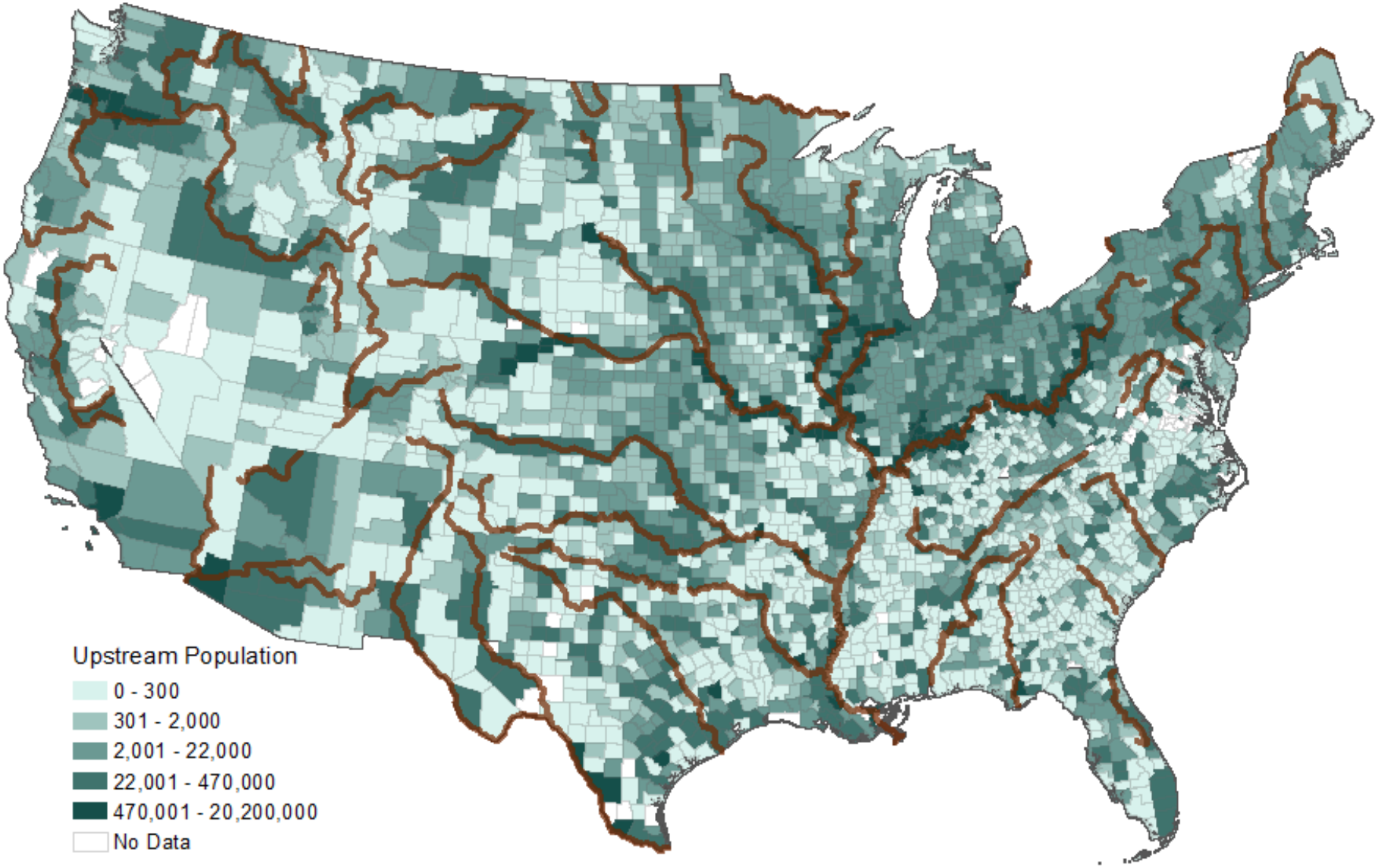
$$y_{it} = \beta(P_i \times d_t) + \mathbf{X_i}\Theta_t + (\gamma_r \times t) + \nu_i + \tau_t + \varepsilon_{it}$$

$$y_{ijt} = \overbrace{\delta_1(P_i \times d_t)}^{\text{Local Effect}} + \overbrace{\delta_2(\textstyle\sum_j \mathbb{1}(P_j)N_{US} \times d_t)}^{\text{GE+Spillover Effect}} + \overbrace{\delta_3(\textstyle\sum_j \mathbb{1}(P_j)N_{50mi} \times d_t)}^{\text{GE Effect}}$$
$$+ \mathbf{Z_i}\Pi_t + (\gamma_r \times t) + \nu_i + \tau_t + \mu_{it}$$

(Includes N_{US}, N_{50mi})

Distribution of *Upstream* population size



Source: USGS, Census, author's calculations.

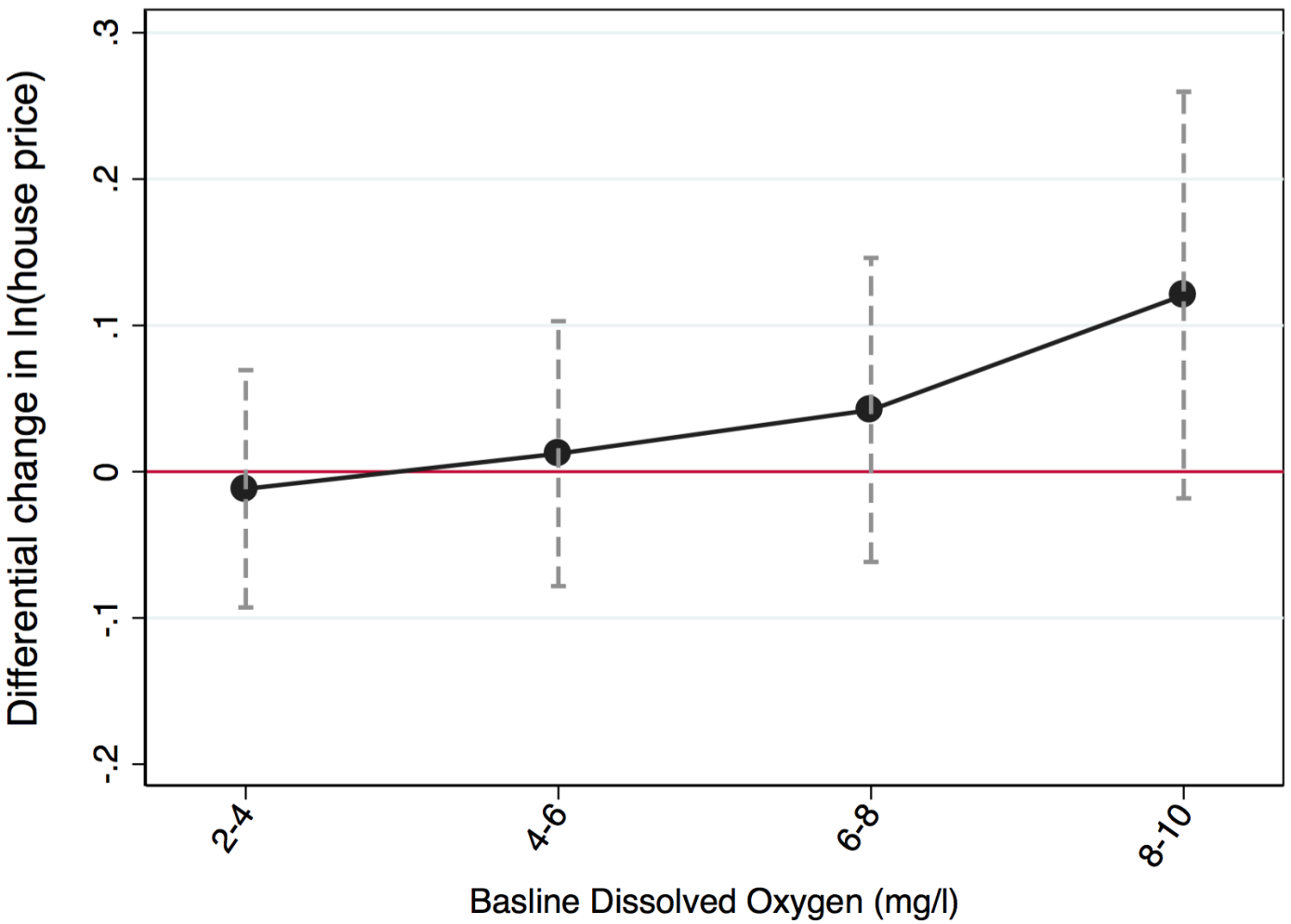
Effect of CWA Mandate on Ln(House Median Price)

	(1)	(2)	(3)
Treated x Post δ_1:	0.106*	0.135**	0.009
(Local Effect)	(0.059)	(0.066)	(0.054)
Upstream Treated Exposure x Post δ_2:		0.039	0.037
(Spillover & General Equilibrium)		(0.026)	(0.026)
Within 50mi Treated Exposure x Post δ_3:		-0.015***	-0.012**
(General Equilibrium)		(0.006)	(0.005)
Local Effects by Base Population Tercile			
Treated x Post (1st tercile)			0.162***
			(0.016)
Treated x Post (2nd tercile)			0.095***
			(0.014)
Spillover (δ_2 - δ_3)		0.054*	0.048*
		(0.028)	(0.027)
F-statistic	16.47	14.09	5.33
Observations	8247	8247	8247

Note: 1st tercile is 1970 population ¡ 2,000. 2nd tercile is 1970 population¡10,000. Includes controls for trends in city baseline characteristics. Standard errors clustered by city.

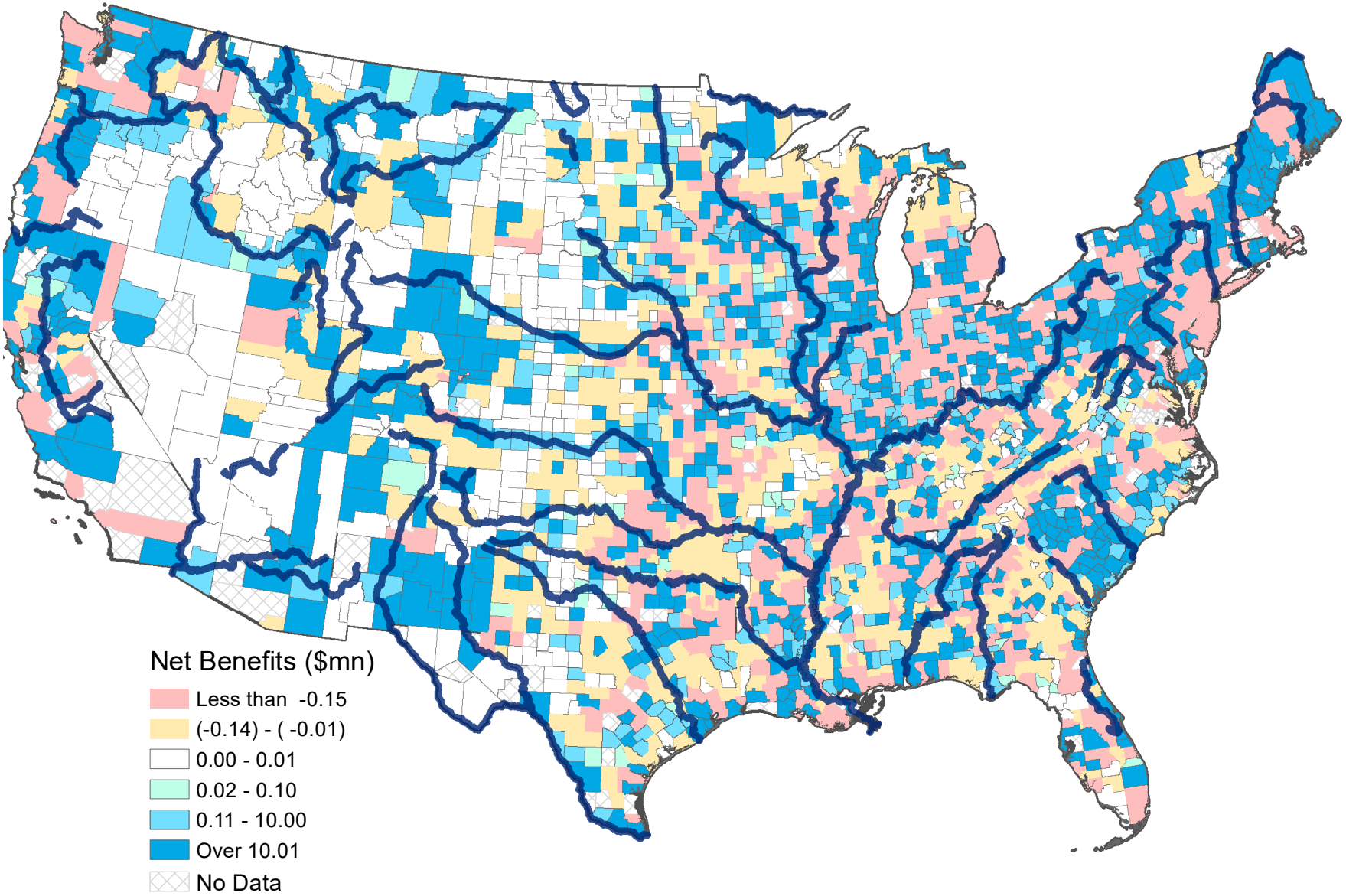
Evidence of Strategic Complementarities:

Local Mandate Benefits *Increasing* in pre-1972 Water Quality



Note: Figure plots estimates of the average change in housing prices following the CWA by 2 mg/l bins of baseline local water quality. Reference bin is baseline water quality less than 2mg/l. Standard errors clustered by city.

Distribution of Net Benefits from CWA mandate



Note: Benefits based on local housing stock value as of 1970.

Back of Envelope Benefit-Cost

Benefits from 1972-1992

- Local: \$320bn ($\delta_1 \times V_i \times \mathbb{1}(P_i\ )$)
- + Spillover: \$36bn ($(\delta_2 - \delta_3) \times V_i \times \sum_j \mathbb{1}(P_j) N_{US}\ )$
- - GE: \$152bn ($\delta_3 \times V_i \times \sum_j \mathbb{1}(P_j) N_{50mi}\ )$
- = **\$204.4 billion** or $\sim$ 11% of change in housing stock from '67-'92

Costs from $\sim$ 1972-1992

(Sources: Keiser & Shapiro (KS) 2019; US Conference of Mayors (CoM) 2010; EPA GICS database (GICS))

- Local + Federal + Industrial costs (KS) = \$940bn: **B/C=0.25**
- Federal + Industrial costs (KS, CoM)= \$464.25bn: **B/C=0.44**
- Federal grants cost (GICS)= \$205.4bn: **B/C=0.99**

Prior works finds B/C ratios of 0.5 on average, median is 0.37.

Note: All values in 2012 dollars.

Summary

Mandates are a large portion of local government budgets - largest mandates are components of environmental law.

How are cities paying for them, and consequences do they have?

- CWA mandate induces 2x increase in user fees, no crowd out
  - Implications for incidence of future infrastructure development
- Local benefits outweigh local costs on average:
  - CWA effect accounts for $\sim 10\%$ overall growth in housing stock value among treated cities
  - B/C ratios higher than prior lit, but < 1. Yet, my estimates exclude any benefits from late adopters, among others.
- Federal mandates can be beneficial *at the local level* if inter-city coordination increases the value of local public goods
  - Water quality may be complementary (as opposed to substitutable) in consumption across jurisdictions

Thank you!

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Determinants of *Ex Ante* CWA Non Compliance

	Cross Section (1972)		Panel	
	(1)	(2)	(3)	(4)
Downstream Population	-0.049***	-0.057***		
	(0.012)	(0.014)		
Dowstream Population x StateShare'72 x Post			-0.704**	-0.593*
			(0.322)	(0.330)
Dowstream Population x Post			-0.003	-0.011
			(0.019)	(0.019)
StateShare'72 x Post			-2.066***	-2.345***
			(0.347)	(0.372)
Baseline mean	0.75	0.75	0.75	0.75
Pct δ in y for 1 SD increase DSpop	-6.58%	-7.56%	-3.20%	-2.70%
Pct δ in y for 1% increase StateShare			-2.77%	-2.93%
River FE	Y	Y		
Geography Controls		Y		
City Controls		Y		
Year & City FE			Y	Y
RiverPopulation x YearFE			Y	Y
All Other Controls				Y
F-statistic			19.22	20.11
Over-identification P-value			0.84	0.44
Observations	2151	2151	14866	14866

Results