Municipal Bond Insurance & the U.S. Drinking Water Crisis

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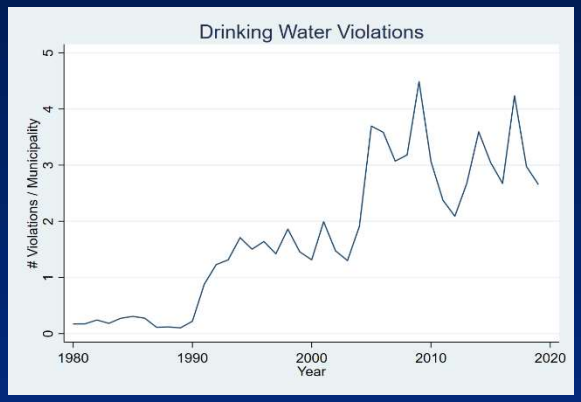
Motivation

- U.S. Drinking Water Crisis

Flint, Michigan

Water Pollution (EPA)



Amer. Society of Civil Eng.

- Common Explanation
  - Local govt's face tight budgets → cheaper, but worse, water infrastructure

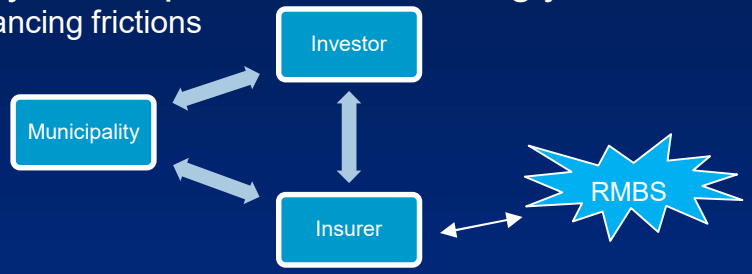
- However…
  - Tight budgets are a universal problem: why are some cities—but not others–still able to provide clean water?
  - We have a poor understanding of the ***root causes*** of drinking water pollution

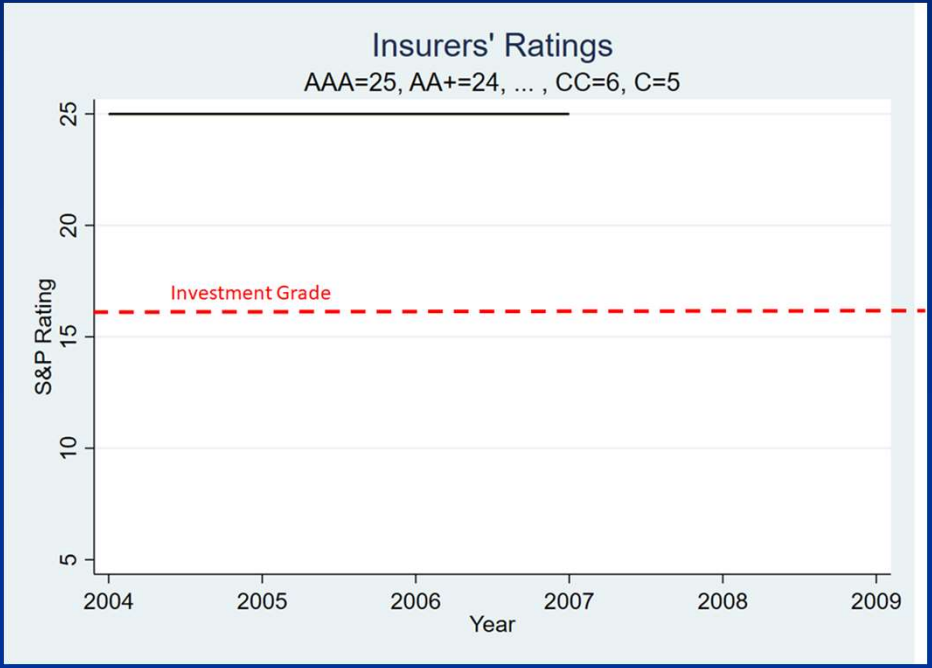
Hypothesis

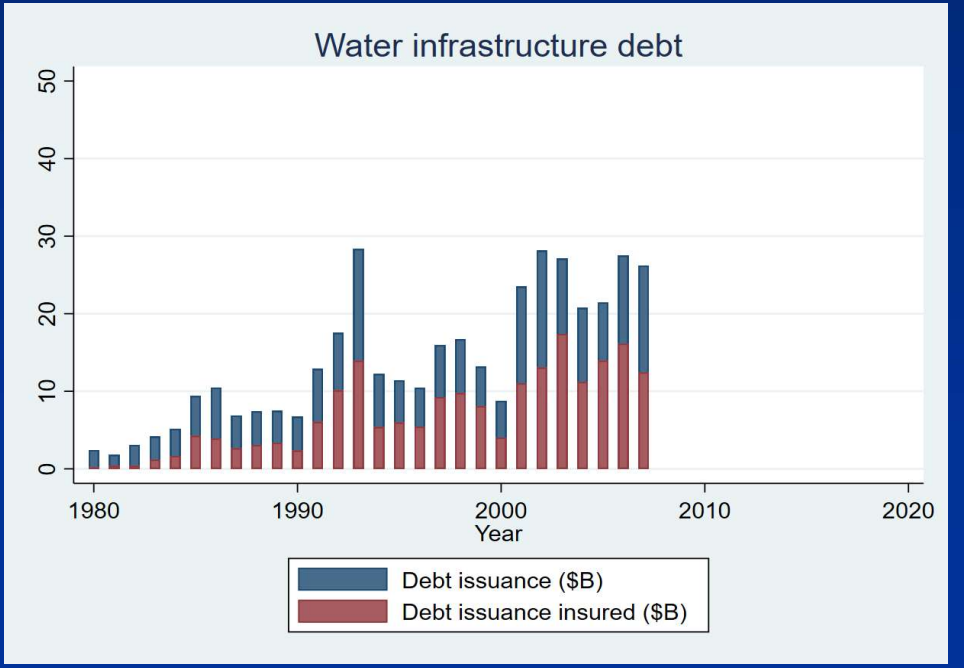
- U.S. drinking water crisis can be partly traced back to the collapse of municipal bond insurance

Part 1 of 3: Public water infrastructure financed by municipal debt, increasingly insured

- Small number of AAA-rated insurers, mitigate muni financing frictions
- 1990's: some–but not all—insurers back securitized financial products (e.g. RMBS), unrelated to muni bonds







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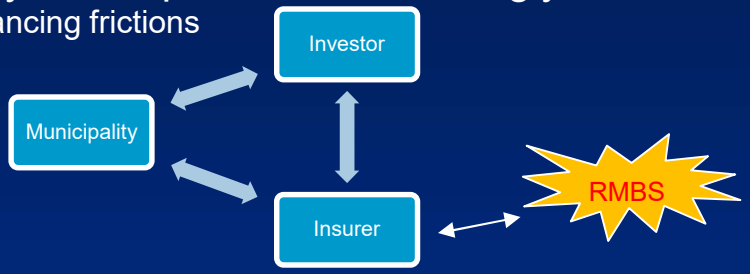
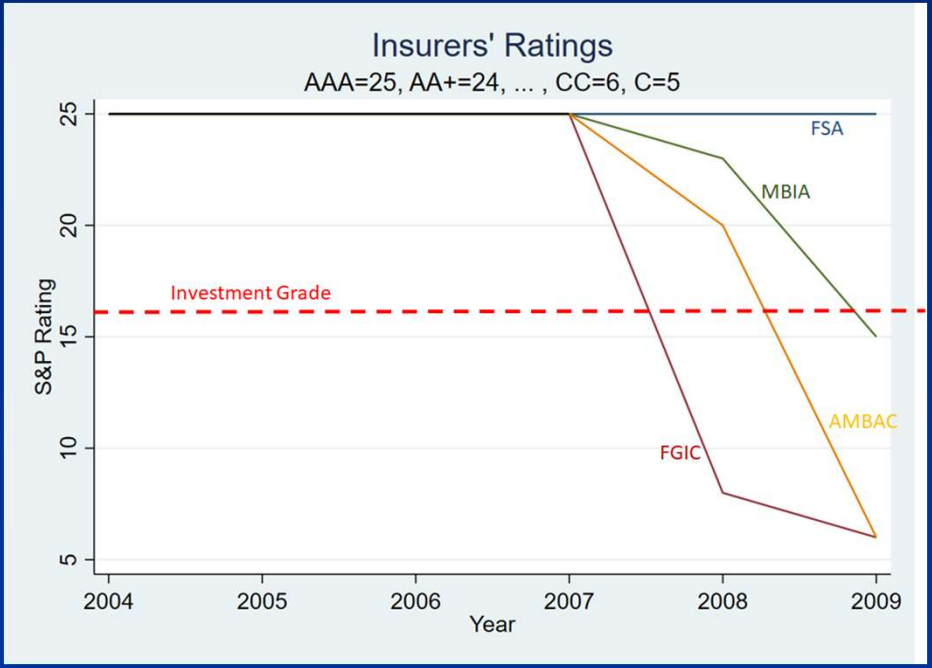
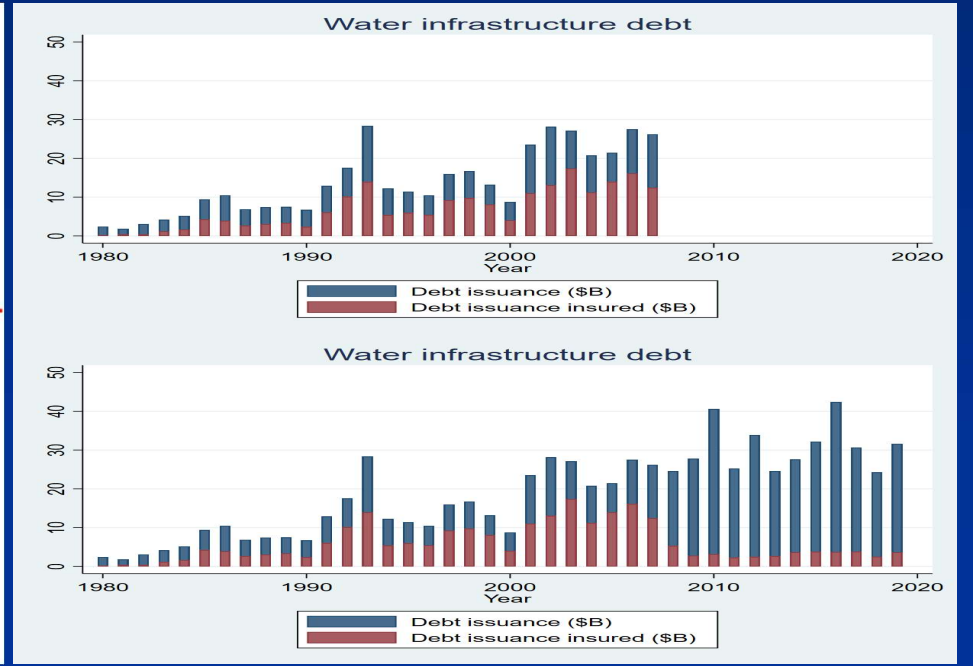
- 2007 crash -> shock to municipal insurers







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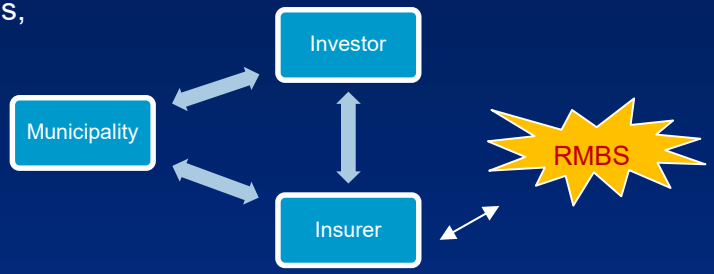
- U.S. drinking water crisis can be partly traced back to the collapse of municipal bond insurance in 2007

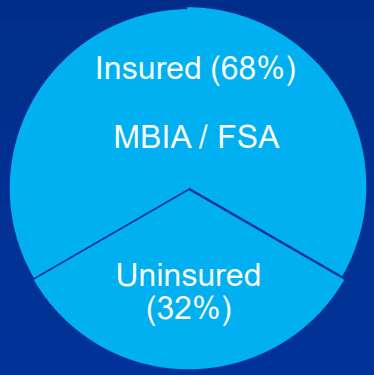
Part 2 of 3: Negative shocks to insurers worsen municipal financing frictions

- Heterogeneous effects across municipalities, depending on insurers

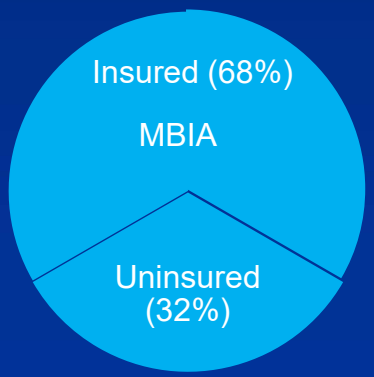


★ Identification: Exploit pre-2007 variation in insurers across municipalities

Saline County (Kansas)



Geary County (Kansas)



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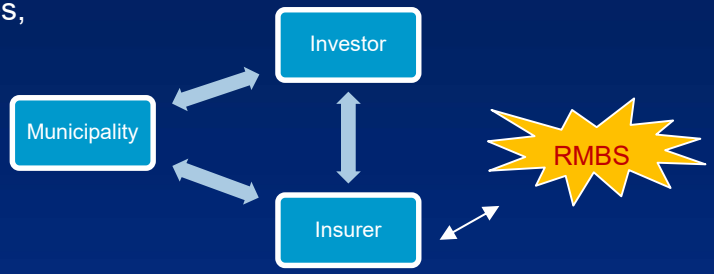

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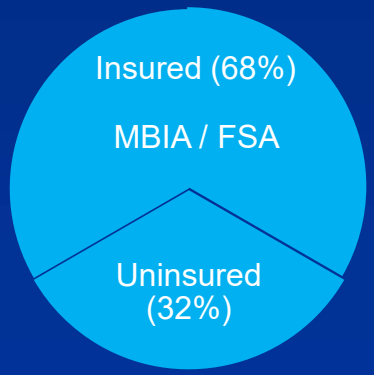
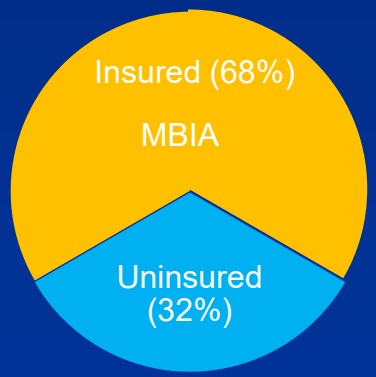


"control"

Geary County (Kansas)

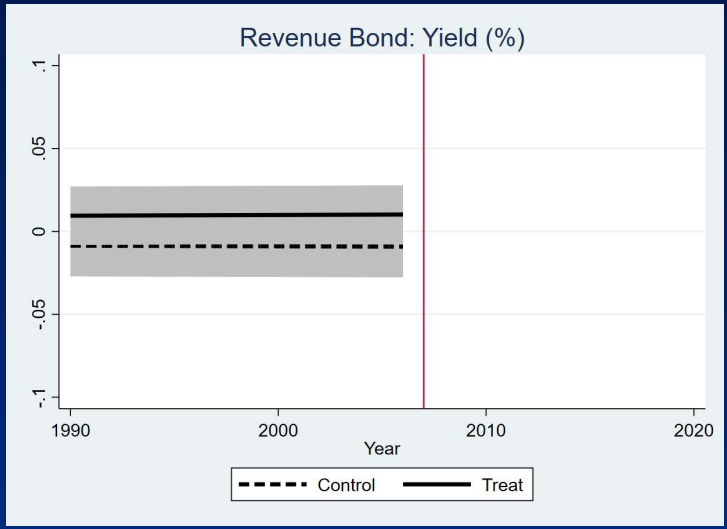


"treatment"

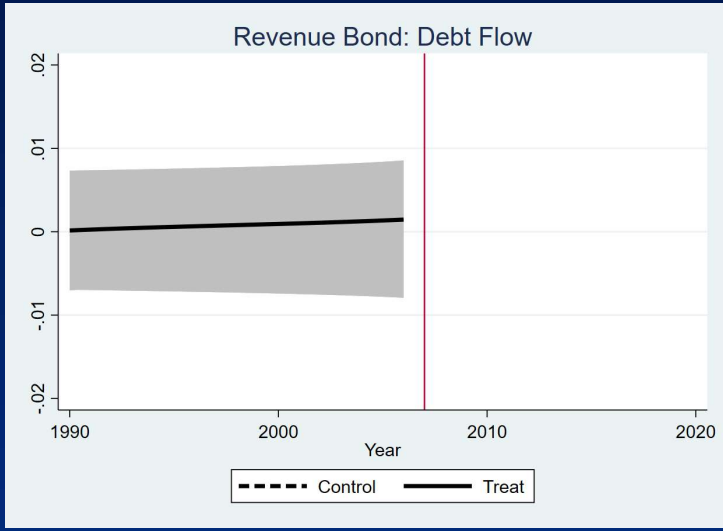
Findings

Part 3 of 3: More negative shock to insurers → municipal…

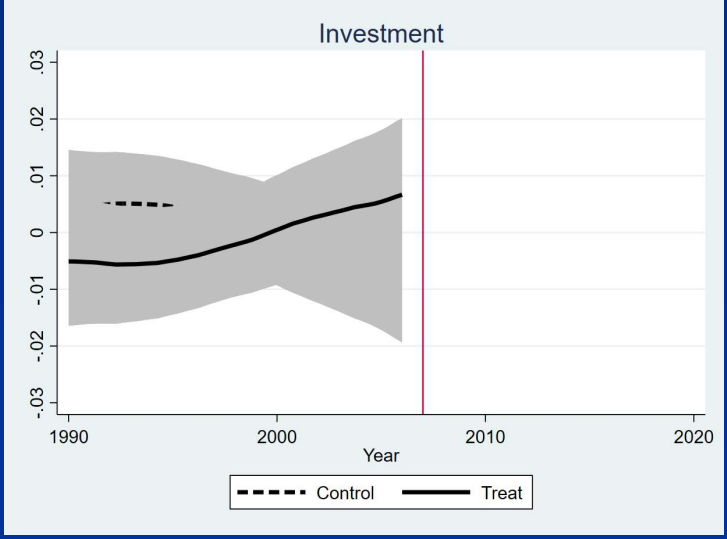
Borrowing Costs



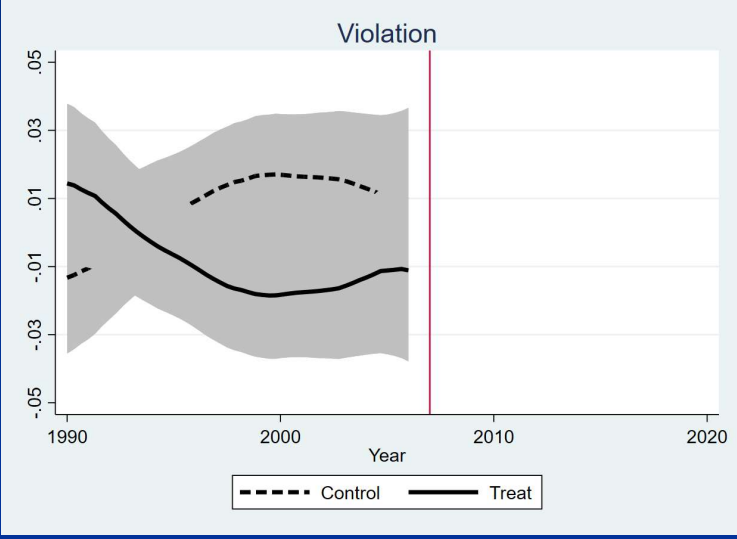
Debt Amounts



Infrastructure Investment



Water Pollution



Findings

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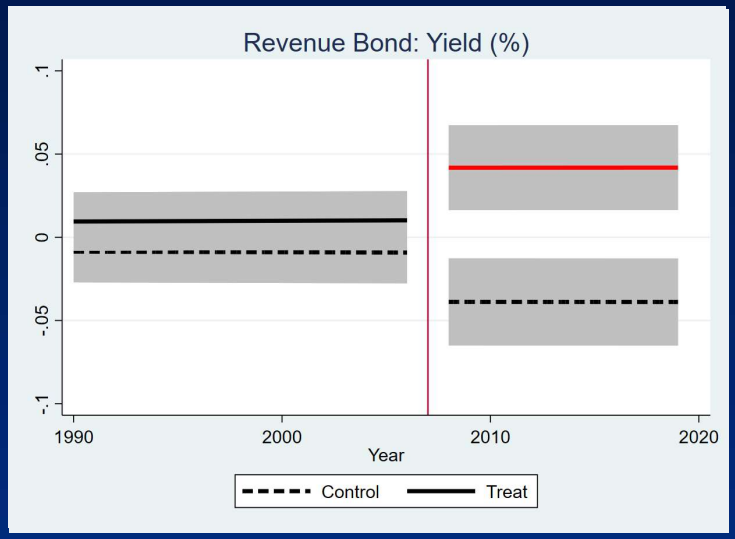
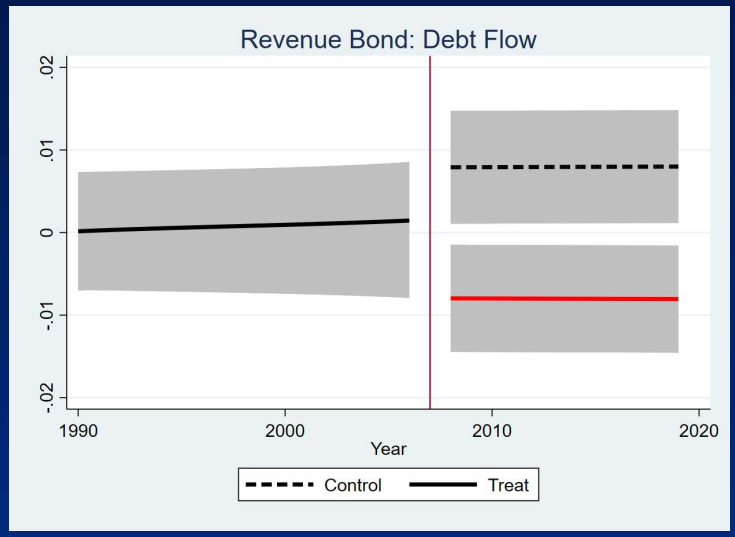
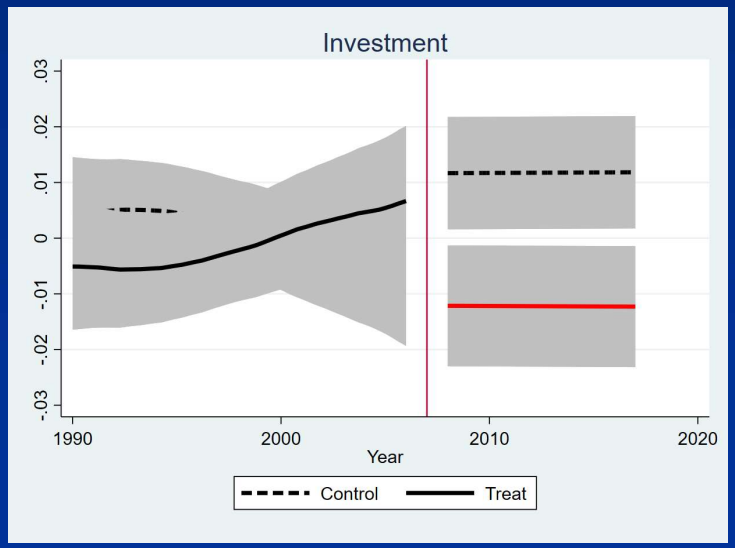
Higher Borrowing Costs



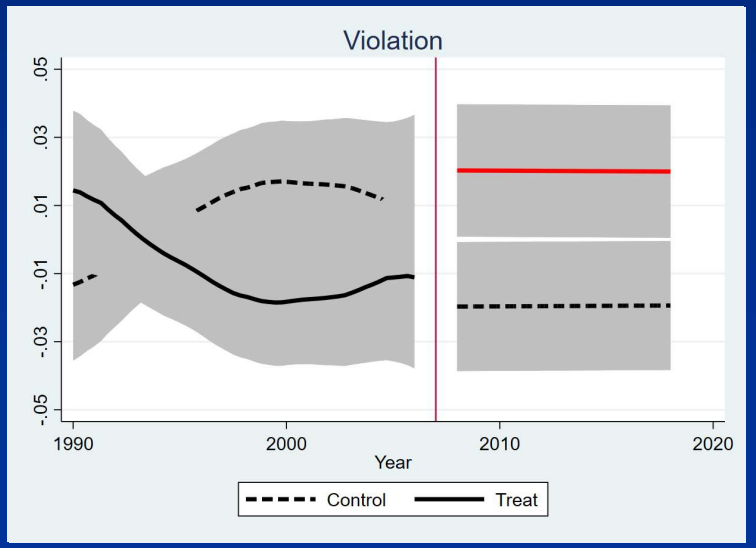
Lower Debt Amounts



Lower Infrastructure Investment



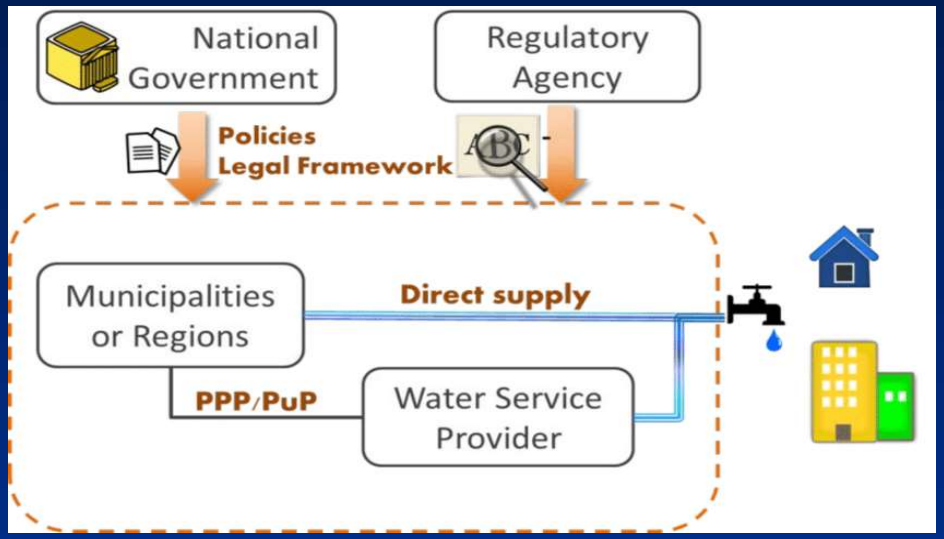
Greater Water Pollution



→ shows how water pollution can be traced back to financial market failures

Background

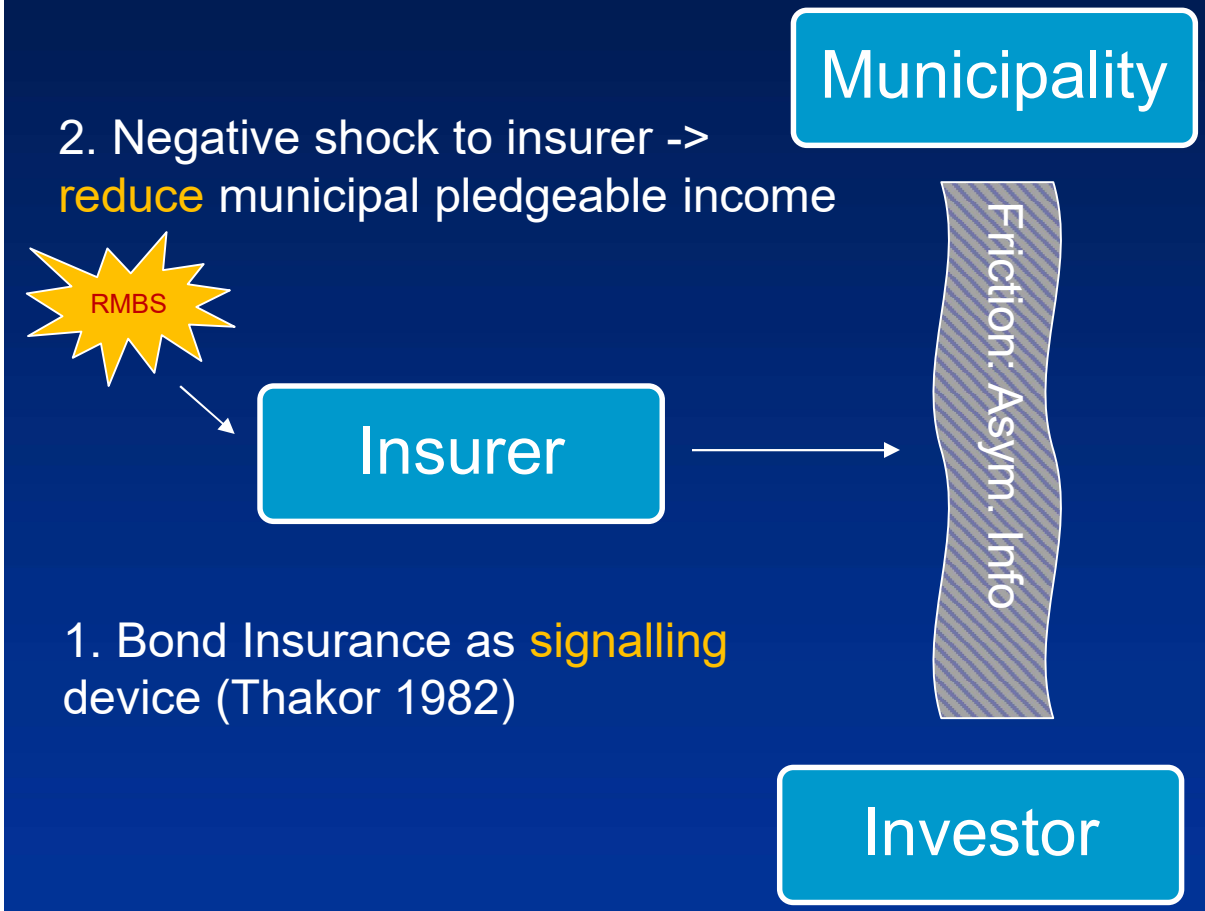
- Public drinking water supplied by local government, and governed by federal law: EPA 1974 Safe Drinking Water Act



- Infrastructure financing sources: municipal debt (86% revenue bonds), tax revenues, water service fees
  - Revenue bonds restricted to projects
  - General obligation bonds can be spread across projects

Theory

3. No perfect substitute for insurance
   Credit ratings x
   Disclosure rules x
   Insurance requires expertise and capital x



4. Municipal limits to internal capital reallocation: revenue vs. general obligation bonds

1. Bond Insurance as signalling device (Thakor 1982)

5. Gov't public good objective function sensitive to financing frictions

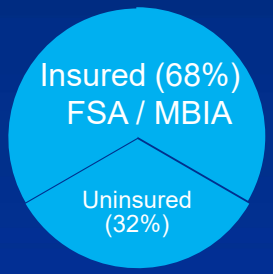
Empirics

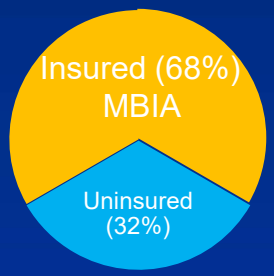
Empirical Predictions: Negative shock to insurers → municipalities

Identification:

- 9 insurers downgraded after 2007 (e.g. MBIA); 2 firms remain AAA (e.g. FSA)
- Exploit heterogeneity in pre-2007 municipality-insurer pairs
- Assumption: Insurance shock exogenous to municipal characteristics
- Compare municipalities with above vs. below median (53%) exposure to downgraded insurers

Saline County "control"





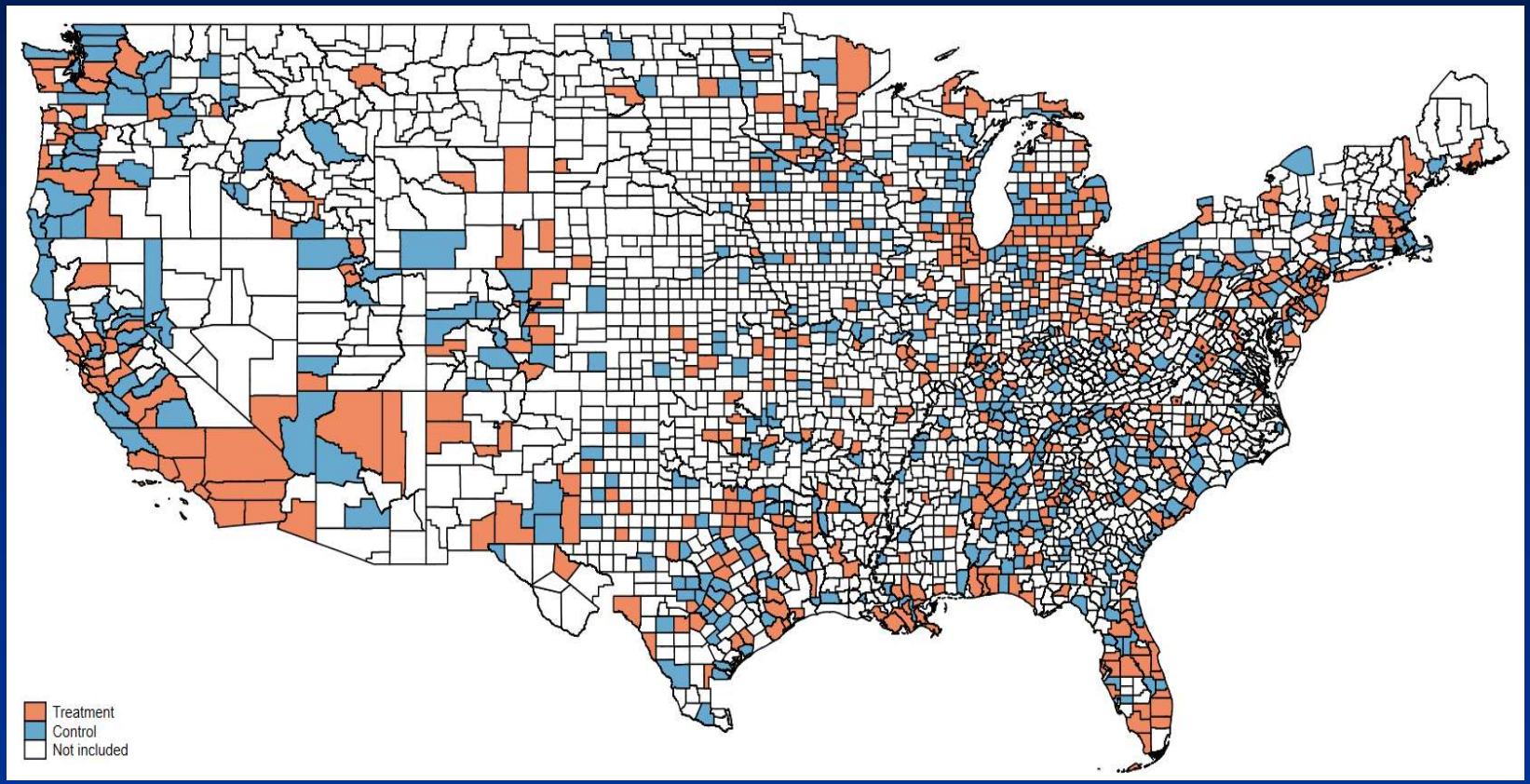
Geary County "treatment"

Outcome = β*Treatment + Controls + e ("Diff-in-Diff")

Null Hypothesis: Municipal borrowing costs & investment unaffected by bond insurance shocks

- Theoretically compelling: muni market may be frictionless in practice, and muni default is rare!

“Treatment vs. Control”



Treatment vs. Control Statistics

	Control			Treatment			T-test
	N	mean	sd	N	mean	sd	Control−Treatment
Water revenue (M)	389	12.53	12.78	376	13.65	12.68	−1.22
Water interest expense (M)	389	1.257	1.685	376	1.380	1.642	−1.02
Water investment (M)	389	8.362	8.412	376	9.165	8.562	−1.31
Population (K)	389	259.8	256.0	376	264.8	263.7	−0.27
Property tax (M)	389	135.2	128.0	376	135.7	130.6	−0.05
Debt outstanding (M)	507	63.11	81.33	507	66.66	82.89	−0.69
Rev debt outstanding (M)	507	59.88	91.46	507	63.94	91.38	-0.71
Debt insured (M)	507	137.7	634.1	507	133.6	413.9	0.12
Debt issuance (M)	507	2.837	4.577	507	3.087	4.871	−0.84
Offering yield	507	0.0516	0.00796	507	0.0520	0.00721	−0.84
# SWDA Violations	506	2.688	3.210	504	2.274	2.934	2.14
# SWDA Viol. pop wgt (K)	506	7.465	10.91	504	6.623	10.55	1.25

Finding 1: Borrowing Costs

Interest Rate (weighted) = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.137**	0.137**	0.136**	0.136**	0.136**	0.140**
	(0.0641)	(0.0640)	(0.0639)	(0.0637)	(0.0638)	(0.0626)
Maturity	0.0313	0.0315	0.0309	0.0331	0.0333	0.0245
	(0.0241)	(0.0241)	(0.0241)	(0.0243)	(0.0242)	(0.0238)
Debt issuance	−0.146***	−0.145***	−0.147***	−0.148***	−0.148***	−0.160***
	(0.0310)	(0.0310)	(0.0311)	(0.0316)	(0.0317)	(0.0306)
Lag log violation		0.0102	0.0105	0.0104	0.0105	0.0103
		(0.0137)	(0.0136)	(0.0136)	(0.0136)	(0.0136)
Lag log water revenue			0.0504	0.0381	0.0418	0.0483
			(0.0402)	(0.0388)	(0.0358)	(0.0352)
Lag log debt out'				0.0326	0.0341	0.0218
				(0.0331)	(0.0319)	(0.0312)
Lag log property tax					−0.0117	0.0249
					(0.0496)	(0.0558)
Lag log population						−0.0665
						(0.0450)
Total insurance frac						0.276***
						(0.0850)
Observations	9,513	9,513	9,513	9,513	9,513	9,513
County FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Municipalites in our sample face higher borrowing costs: **5.16% to 5.3%**

Finding 2: Debt Issuance

Log(Debt Issuance Size) = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	−0.0208*	−0.0211*	−0.0209*	−0.0216*	−0.0219**	−0.0250**
	(0.0106)	(0.0107)	(0.0107)	(0.0107)	(0.0107)	(0.0113)
Lag log revenue debt out'	0.921***	0.921***	0.920***	0.890***	0.890***	0.889***
	(0.00969)	(0.00970)	(0.00989)	(0.0112)	(0.0112)	(0.0120)
Lag log violation		0.00368	0.00369	0.00459	0.00453	0.00412
		(0.00365)	(0.00365)	(0.00358)	(0.00357)	(0.00344)
Lag log water revenue			0.0103**	0.00644	0.00341	0.00447
			(0.00497)	(0.00526)	(0.00522)	(0.00550)
Lag log debt out'				0.0407***	0.0400***	0.0314***
				(0.00910)	(0.00912)	(0.00922)
Lag log property tax					0.0106	0.0120
					(0.00669)	(0.00758)
Lag log population						−0.00128
						(0.00539)
Total insurance frac						0.137***
						(0.0367)
Observations	27,583	27,583	27,583	27,583	27,583	27,566
County FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Municipalites in our sample raise **$1.5 billion less** per year

Finding 3: Water Infrastructure Investment

Log(Investment) = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	−0.0365	−0.0373	−0.0271*	−0.0270*	−0.0322**	−0.0329**
	(0.0277)	(0.0277)	(0.0156)	(0.0157)	(0.0155)	(0.0155)
Lag log violation		0.0148**	0.0124**	0.0127**	0.0123**	0.0129**
		(0.00684)	(0.00539)	(0.00542)	(0.00536)	(0.00544)
Lag log water revenue			0.453***	0.441***	0.405***	0.410***
			(0.0515)	(0.0525)	(0.0538)	(0.0524)
Lag log debt out'				0.0378***	0.0288***	0.0282***
				(0.00772)	(0.00690)	(0.00681)
Lag log property tax					0.115***	0.138***
					(0.0250)	(0.0309)
Lag log population						−0.0388**
						(0.0169)
Total insurance frac						0.00363
						(0.0184)
Observations	27,505	27,505	27,505	27,505	27,505	27,469
County FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Municipalites in our sample invest **$274 million less** per year on water infrastructure

Finding 4: Water Pollution

Log EPA Health Violations = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.0728**	0.0610**	0.0610**	0.0610**	0.0600**	0.0588**
	(0.0333)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)
Lag log violation		0.244***	0.244***	0.244***	0.244***	0.243***
		(0.0258)	(0.0257)	(0.0257)	(0.0256)	(0.0255)
Lag log water revenue			0.00271	0.00440	−0.00268	−0.00384
			(0.0165)	(0.0164)	(0.0168)	(0.0172)
Lag log debt out'				−0.00509	−0.00693	−0.00818
				(0.00868)	(0.00869)	(0.00867)
Lag log property tax					0.0242	0.0159
					(0.0162)	(0.0224)
Lag log population						0.0137
						(0.0212)
Total insurance frac						0.0273
						(0.0238)
Observations	30,543	30,543	30,543	30,543	30,543	30,506
County FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Municipalites in our sample face **165 more** water violations per year
Equivalently, **458,433 more** people are exposed to an additional violation

Alternative Explanations

Causality: Results driven by general economic decline (i.e. recession)?

1. Prior to shock, control & treatment share similar characteristics / trajectories
2. After the shock, similar general outcomes:
   Population growth, property taxes, & drinking water service revenues
3. Results for revenue bonds, *not* general obligation bonds
   G.O. bonds more reflective of general economic conditions

→ **General decline across *both* treatment and control; cannot explain findings**

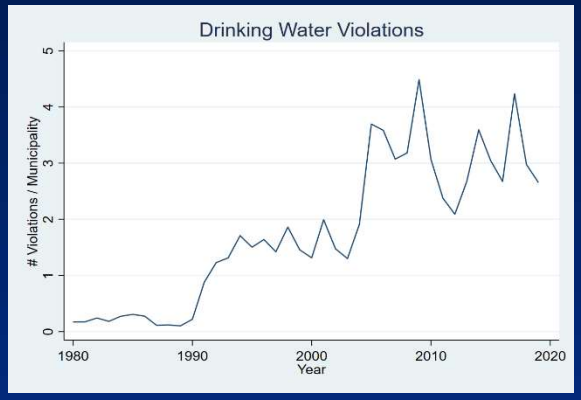
Mechanism/Friction: Bond insurance also has tax and/or regulatory benefits?

4. Taxes – Mixed evidence (similar for long vs. short maturity bonds)
5. Regulation – Mutual funds, insurance companies don't change muni holdings (Bergstresser et al. 2010)

→ **Evidence most strongly supportive of asymmetric information frictions**

Conclusion

- Question: What are the root causes of the U.S. drinking water crisis?



- Answer: Collapse of municipal bond insurance a leading cause

- Takeaways:
  - Real consequences to bond insurance shocks / financing frictions
  - Public good provision traced back to financial market failures
  - More research examining municipal balance sheets

Alternative Explanations

Log Population = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)
Treatment	0.0245	0.0239	0.0282	0.0284	0.0164
	(0.0243)	(0.0242)	(0.0229)	(0.0226)	(0.0204)
Lag log violation		0.0123	0.0110	0.0114	0.0106
		(0.00802)	(0.00726)	(0.00727)	(0.00667)
Lag log water revenue			0.192***	0.178***	0.0658***
			(0.0343)	(0.0336)	(0.0227)
Lag log debt out'				0.0411***	0.0176
				(0.00989)	(0.0109)
Lag log property tax					0.355***
					(0.0639)
Total insurance frac					−0.0766***
					(0.0278)
Observations	28,272	28,272	28,272	28,272	28,237
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Back

Alternative Explanations

Log Property Taxes = β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)
Treatment	0.0360	0.0359	0.0422	0.0425	0.0350
	(0.0308)	(0.0307)	(0.0276)	(0.0270)	(0.0252)
Lag log violation		0.00333	0.00155	0.00220	−0.00188
		(0.00716)	(0.00647)	(0.00620)	(0.00587)
Lag log water revenue			0.278***	0.250***	0.170***
			(0.0369)	(0.0331)	(0.0263)
Lag log debt out'				0.0823***	0.0760***
				(0.0110)	(0.0104)
Lag log population					0.252***
					(0.0536)
Total insurance frac					0.0260
					(0.0247)
Observations	28,272	28,272	28,272	28,272	28,237
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Alternative Explanations

Log Revenues= β*Downgrade + Controls + Year FE + County FE + e

	(1)	(2)	(3)	(4)	(5)
Treatment	−0.0104	−0.0112	−0.00979	−0.0180	−0.0183
	(0.0282)	(0.0283)	(0.0271)	(0.0248)	(0.0250)
Lag log violation		0.0173**	0.0178**	0.0156**	0.0151**
		(0.00808)	(0.00762)	(0.00713)	(0.00709)
Lag log debt out'			0.112***	0.0840***	0.0852***
			(0.0113)	(0.00913)	(0.00948)
Lag log property tax				0.250***	0.234***
				(0.0349)	(0.0387)
Lag log population					0.0243
					(0.0311)
Total insurance frac					−0.000181
					(0.0233)
Observations	25,279	25,279	25,279	25,279	25,244
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Alternative Explanations

GO Bonds (Yield regression)

Yield (in %) for general obligation bonds						
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.119	0.117	0.118	0.117	0.117	0.121
	(0.0843)	(0.0843)	(0.0842)	(0.0843)	(0.0848)	(0.0836)
Maturity	0.102***	0.103***	0.103***	0.103***	0.104***	0.0943***
	(0.0194)	(0.0194)	(0.0194)	(0.0194)	(0.0192)	(0.0192)
Debt issuance	−0.329***	−0.329***	−0.327***	−0.326***	−0.325***	−0.325***
	(0.0497)	(0.0496)	(0.0499)	(0.0497)	(0.0501)	(0.0494)
Lag log violation		0.0177	0.0187	0.0152	0.0150	0.0150
		(0.0199)	(0.0200)	(0.0193)	(0.0192)	(0.0187)
Lag log water revenue			−0.101*	−0.0835*	−0.0592	−0.0634
			(0.0505)	(0.0477)	(0.0448)	(0.0451)
Lag log debt out'				−0.0761*	−0.0689	−0.0880*
				(0.0448)	(0.0428)	(0.0429)
Lag log property tax					−0.0699	−0.0663
					(0.0613)	(0.0758)
Lag log population						0.00410
						(0.0622)
Total insurance frac						0.366***
						(0.113)
Observations	5,679	5,679	5,679	5,679	5,679	5,679
County FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

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Mechanism: Signaling Quality (per-capita property tax)

High quality: Above-median per-capita property tax					
	Borrowing costs	Financing expenses	Borrowing amounts	Municipal investments	Water pollution
Treatment	0.00241***	0.118***	-0.0321**	-0.0409*	0.0773**
	(0.000792)	(0.0403)	(0.0149)	(0.0223)	(0.0376)
Observations	5,643	6,830	15,650	15,306	17,550
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Low quality: Below-median per-capita property tax					
	Borrowing costs	Financing expenses	Borrowing amounts	Municipal investments	Water pollution
Treatment	-0.0001	0.0771*	-0.0165	-0.0331	0.0328
	(0.00108)	(0.0413)	(0.0158)	(0.0210)	(0.0367)
Observations	3,859	4,748	11,877	12,126	12,918
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Suggestive evidence in support of signaling theory (Thakor 1982)

Mechanism: Tax benefit (years to maturity)

Low tax benefit: Below-median years to maturity					
	Borrowing costs	Financing expenses	Borrowing amounts	Municipal investments	Water pollution
Treatment	0.00181*	0.0327	-0.0597***	-0.0257	0.0903**
	(0.000968)	(0.0481)	(0.0170)	(0.0208)	(0.0349)
Observations	3,624	4,914	13,254	13,377	14,964
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
High tax benefit: Above-median years to maturity					
	Borrowing costs	Financing expenses	Borrowing amounts	Municipal investments	Water pollution
Treatment	0.00131	0.125***	0.00290	-0.0440*	0.0267
	(0.000784)	(0.0398)	(0.0142)	(0.0220)	(0.0365)
Observations	5,889	6,675	14,312	14,092	15,542
County FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Mixed evidence for tax channel (Nanda and Singh 2004)