Supplementary Appendix for: Is the Policy Enough? Adoption and Impacts of Tiered Water Pricing in Utah, 1980 - 2022

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Appendix A: Senate Bill 28: *Water System Conservation Pricing*

WATER SYSTEM CONSERVATION PRICING

2016 GENERAL SESSION

STATE OF UTAH

Chief Sponsor: Scott K. Jenkins

House Sponsor: Lee B. Perry

LONG TITLE

General Description:

This bill requires retail water providers to establish an increasing rate structure for culinary water.

Highlighted Provisions:

This bill:

- requires retail water providers to establish an increasing rate structure for culinary water and provide certain information to customers.

Money Appropriated in this Bill:

None

Other Special Clauses:

None

Utah Code Sections Affected:

ENACTS:

73-10-32.5, Utah Code Annotated 1953

Be it enacted by the Legislature of the state of Utah:

Section 1. Section **73-10-32.5** is enacted to read:

73-10-32.5. Culinary water pricing structure.

A retail water provider, as defined in Section 73-10-32, shall:

(1) establish a culinary water rate structure that:

(a) incorporates increasing block units of water used; and

(b) provides for an increase in the rate charged for additional block units of water used as usage increases from one block unit to the next;

(2) provide in customer billing notices, or in a notice that is distributed to customers at least annually, block unit rates and the customer's billing cycle; and

(3) include individual customer water usage in customer billing notices.

Appendix B: Utah Culinary Water Pricing Survey

Utah Culinary Water Pricing Survey

* Indicates required question

1. What city/municipality do you represent? *

2. To the best of your knowledge, does your municipality provide the majority of culinary water used by residents that live within the boundaries of your municipality? i.e., all households get the majority of their water through your municipality. *

Mark only one oval.

- yes *Skip to question 4*
- no *Skip to question 3*
- unsure *Skip to question 3*

3. What entity provides the majority of culinary water to residents that live within the boundaries of your municipality? *

Skip to question 21

4. Do residents in your municipality have access to secondary water (i.e., water strictly used for outdoor irrigation) from a third party entity?

Mark only one oval.

- yes
- no
- unsure

5. For the municipality you represent, approximately what percentage of residential culinary water customers have access to secondary water? *

Mark only one oval.

- 0%
- 1 - 10%
- 11 - 20%
- 21 - 30%
- 31 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%
- 91 - 100%

6. How often are culinary water customers in your municipality billed for their water use?

Mark only one oval.

- weekly
- monthly
- quarterly
- every six months
- annually
- unsure

Skip to question 7

7. Does your municipality bill culinary water use with an increasing block rate price structure (also known as tiered pricing)? *

Mark only one oval.

- yes *Skip to question 12*
- no *Skip to question 9*
- unsure *Skip to question 8*

8. You've indicated that you are unsure if your municipality is using an increasing block rate price structure for culinary water use. We therefore assume your municipality is likely using a flat rate (i.e., fixed price) structure to price culinary water use. Is this correct? *

Mark only one oval.

- yes *Skip to question 11*
- no *Skip to question 10*
- unsure *Skip to question 21*

9. You've indicated that your municipality does not use an increasing block rate price structure for culinary water use. We therefore assume your municipality is likely using a flat rate (i.e., fixed price) structure to price culinary water use. Is this correct? *

Mark only one oval.

- yes *Skip to question 11*
- no *Skip to question 10*
- unsure *Skip to question 21*

10. Please briefly describe the water pricing policy that is used for culinary water customers in your municipality. *

____

Skip to question 21

11. Please enter the current flat rate (fixed price in US dollars) that is currently used by your municipality to bill culinary water use. *

Skip to question 21

12. To the best of your knowledge, please indicate the specific year that the municipality you represent switched from using a flat (or uniform) rate to using an increasing block/tiered rate for culinary water use. *

Mark only one oval.

- 2024
- 2023
- 2022
- 2021
- 2020
- 2019
- 2018
- 2017
- 2016
- 2015
- 2014
- 2013
- 2012
- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002
- 2001
- 2000
- 1999
- 1998
- 1997

- 1996
- 1995
- 1994
- 1993
- 1992
- 1991
- 1990
- 1989
- 1988
- 1987
- 1986
- 1985
- 1984
- 1983
- 1982
- 1981
- 1980

13. To the best of your knowledge, please indicate what the flat (or uniform) rate was for culinary water use (i.e., fixed price in US dollars) before your municipality switched to an increasing block rate structure. Please enter "NA" if unsure. *

14. To the best of your knowledge, what was the motivation for your municipality to adopt an increasing block rate price structure for culinary water use? Select all that apply.

Check all that apply.

- [ ] To raise revenue
- [ ] To accommodate for anticipated changes in municipal population
- [ ] To comply with a mandate from the Utah legislature for culinary water pricing (i.e. Senate Bill 28, 2016)
- [ ] To fund water infrastructure maintenance and/or upgrades
- [ ] To address drought conditions
- [ ] To encourage water conservation efforts
- [ ] Other (please concisely list other motivating factors as applicable)
- [ ] Other: ______________________

15. To the best of your knowledge, has your municipality had more than one unique increasing block rate structure for culinary water use since this water pricing policy was adopted? By "unique" we mean: changes in prices, the number of tiers, and/or the size of each tier (in gallons). *

Mark only one oval.

- ( ) yes *Skip to question 16*
- ( ) no *Skip to question 20*
- ( ) unsure *Skip to question 20*

16. To the best of your knowledge, how many changes has your municipality made to **prices within tiers**? For example, if your municipality has not changed the **prices within any tiers** since adopting tiered pricing, the correct answer would be "0". *

Mark only one oval.

- unsure
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26

- 27
- 28
- 29
- 30
- 31
- 32
- 33
- 34
- 35
- 36
- 37
- 38
- 39
- 40+

17. To the best of your knowledge, how many changes has your municipality made to the **number of tiers**? For example, if your municipality has not changed the **number of tiers** since adopting tiered pricing, the correct answer would be "0". *

Mark only one oval.

- unsure
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20+

18. To the best of your knowledge, how many changes has your municipality made to the **size of tiers (in gallons)**? For example, if your municipality has not changed the **size of any tier (in gallons)** since adopting tiered pricing, the correct answer would be "0". *

Mark only one oval.

- unsure
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20+

19. Would you be willing to answer follow-up questions about how your municipal water pricing structure has changed over time? *

Mark only one oval.

- yes
- no

20. To the best of your knowledge, what year did your municipality implement its current increasing block rate price structure (i.e., current tiered pricing rate) for culinary water use? *

Mark only one oval.

- 2024
- 2023
- 2022
- 2021
- 2020
- 2019
- 2018
- 2017
- 2016
- 2015
- 2014
- 2013
- 2012
- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005
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- 2003
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- 1999
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- 1997

- 1996
- 1995
- 1994
- 1993
- 1992
- 1991
- 1990
- 1989
- 1988
- 1987
- 1986
- 1985
- 1984
- 1983
- 1982
- 1981
- 1980

Skip to question 21

21. Thank you for taking the time to complete this survey -- your input is greatly appreciated! In the event that we have follow-up questions regarding culinary water pricing in your municipality, please provide your preferred contact information (your phone number and/or email address). *

Table B.1: Municipalities that responded to the *Utah Culinary Water Pricing Survey* (n = 97) by county ($n = 26$ of 29)and their self-reported tiered pricing adoption status and year of adoption as of 2024.

Beaver County

- Milford (adopted; 2002)
- Minersville (adopted; 2010)

Box Elder County

- Corinne (adopted; 1980)
- Deweyville (adopted; 2009)
- Garland (not yet adopted)
- Howell (adopted; 1990)
- Perry (adopted; 2012)
- Snowville (adopted; 2005)
- Tremonton (adopted; 2017)

Cache County

- Clarkston (not yet adopted)
- Hyrum (not yet adopted)
- Logan (adopted; 2003)
- Nibley (adopted; 2018)
- Paradise (adopted; 1995)
- Providence (adopted; 1990)
- Wellsville (adopted; 1980)

Carbon County

- East Carbon (adopted; adoption year not reported)

Davis County

- Bountiful (adopted; 2018)
- Centerville (adopted; 2014)
- Farmington (adopted; 1995)
- Fruit Heights (adopted; 2003)
- Layton (adopted; 2019)
- North Salt Lake (adopted; 2010)
- Sunset (adopted; 2017)
- Syracuse (adopted; 2000)
- West Bountiful (adopted; 2008)
- Woods Cross (adopted; 2015)

Duchesne County

- Duchesne (not yet adopted)

Emery County

- Castledale (adopted; 2000)
- Ferron (adopted; 2021)
- Huntington (adopted; 1980)

Garfield County

- Hatch (adopted; 2018)
- Henrieville (adopted; 2021)
- Tropic (adopted; 2021)

Grand County

- Castle Valley (not yet adopted)

Iron County

- Enoch (adopted; 2010)
- Kanarraville (adopted; 2004)

Kane County

- Big Water (adopted; adoption year not reported)
- Glendale (not yet adopted)

Millard County

- Hinckley (adopted; 1980)
- Holden (adopted; 2015)
- Lynndyl (adopted; 2007)
- Meadow (adopted; 2012)
- Oak City (adopted; 1999)

Morgan County

- Morgan (not yet adopted)

Piute County

- Kingston (adopted; 2000)

Rich County

- Randolph (not yet adopted)

Salt Lake County

- Bluffdale (adopted; 2000)
- Brighton (no information on adoption)
- Draper (no information on adoption)
- Midvale (adopted; adoption year not reported)
- Murray (adopted; 2018)
- Salt Lake City (adopted; 1998)
- Sandy (adopted; 2016)
- South Jordan (adopted; 2000)
- Taylorsville (adopted; 2015)

San Juan

- Blanding (adopted; 2018)
- Monticello (adopted; 2005)

San Pete

- Ephraim (adopted; 1980)
- Fairview (adopted; 2003)
- Fayette (adopted; 2016)
- Manti (adopted; 2003)
- Mayfield (adopted; 2012)
- Spring City (adopted; 2000)
- Wales (not yet adopted)

Sevier

- Annabella (adopted; 2010)
- Elsinore (adopted; 1987)
- Glenwood (not yet adopted)
- Joseph (adopted; 2017)

Summit

- Kamas (not yet adopted)

Toole

- Grantsville (adopted; 2019)
- Lake Point (adopted; 1999)

Uintah

- Ballard (adopted; 2008)
- Naples (adopted; 1983)

Utah

- Elk Ridge (adopted; 2008)
- Fairfield (not yet adopted)
- Highland (adopted; 2011)
- Lehi (adopted; 2006)
- Mapleton (adopted; 2014)
- Orem (adopted; 2016)
- Payson (adopted; 2016)
- Salem (adopted; 1995)
- Woodland Hills (adopted; 2000)

Washington

- Hurricane (adopted; 2008)
- Ivins (adopted; 2003)
- Leeds (not yet adopted)
- Rockville (adopted; 2005)
- Santa Clara (adopted; 1990)
- St. George (adopted; 1995)
- Toquerville (adopted; 2021)
- Washington (adopted; 1999)

Wayne

- Bicknell (adopted; 1992)

Weber

- Farr West (no information on adoption)
- Huntsville (adopted; 2000)
- Marriott-Slaterville (adopted; 2011)
- North Ogden (adopted; 2010)
- Ogden (adopted; 2002)
- West Haven (no information on adoption)

Appendix C: Summary Statistics

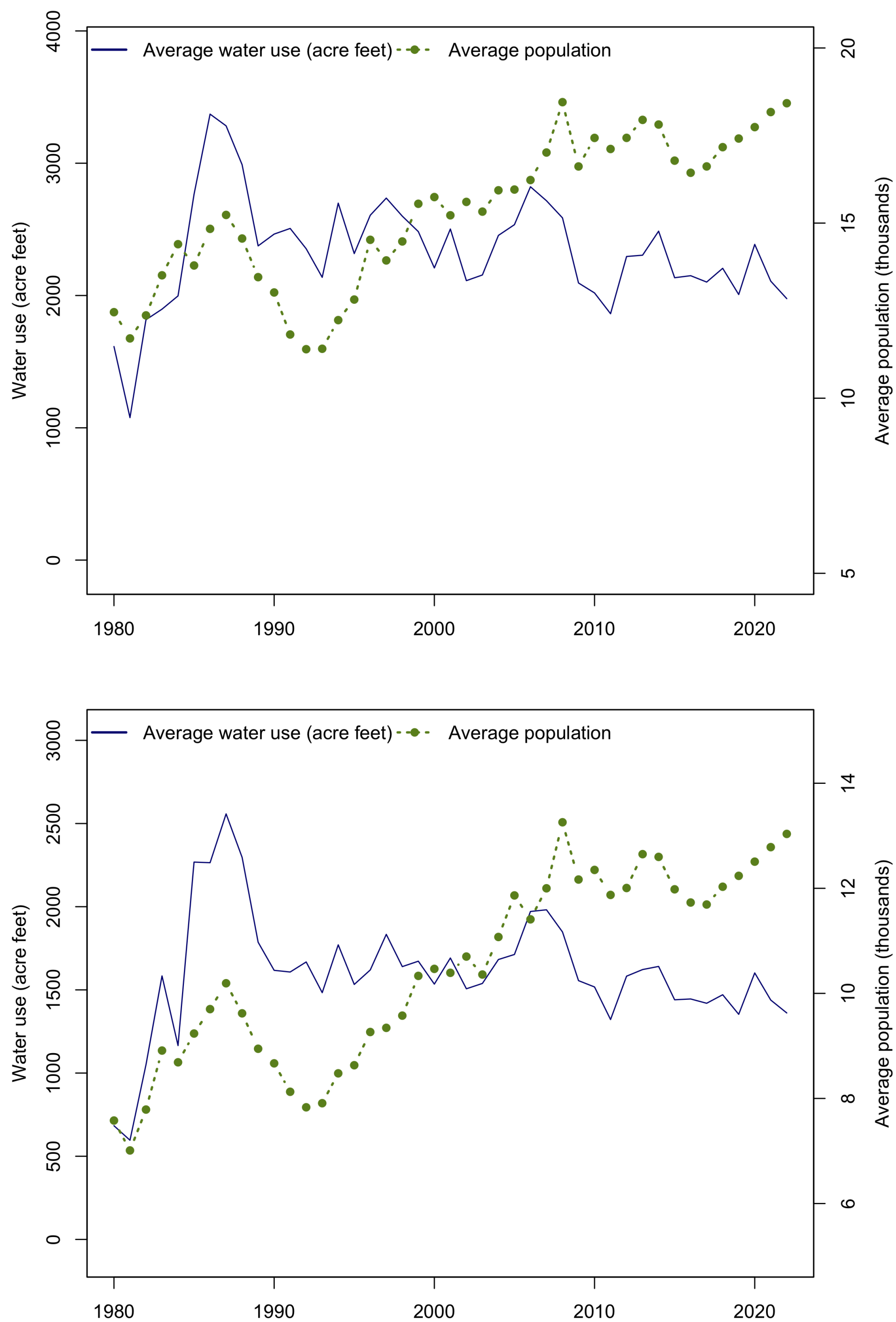

Figure C.1: Trends in average residential culinary water consumption and average population from 1980 - 2022. Top panel: the distribution among municipalities captured in the in *Utah Culinary Water Pricing Survey*. Bottom panel: the distribution among the 242 unique municipalities captured in the available UDWR-WR data.

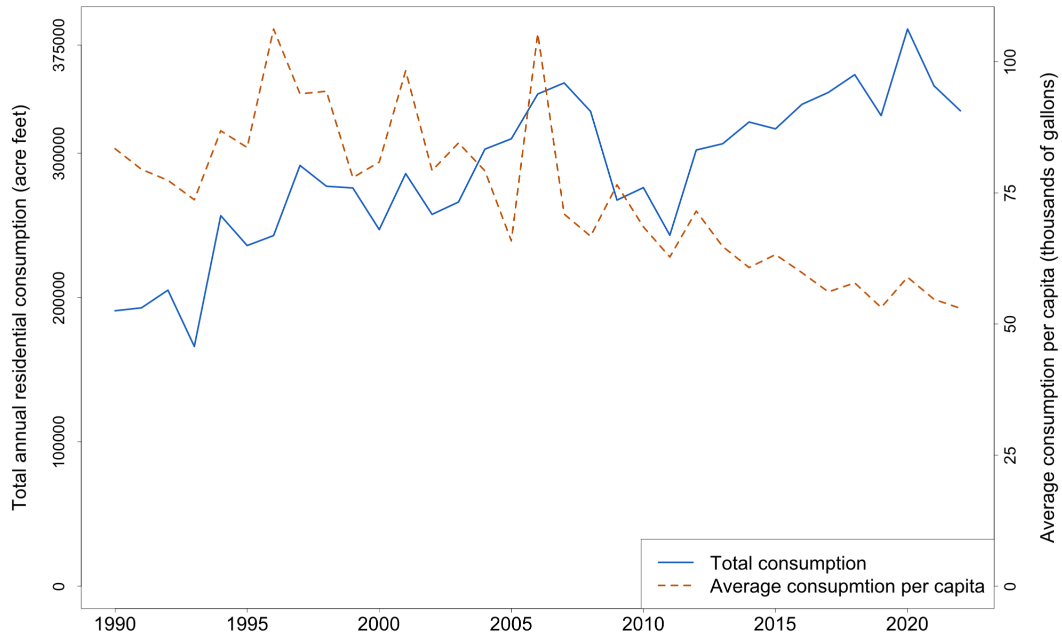

Figure C.2: Trends over 1990 - 2022 in total residential culinary water consumption (acre feet) juxtaposed against the trend in average consumption per capita (thousands of gallons) across the full sample of available UDWR-WR data.

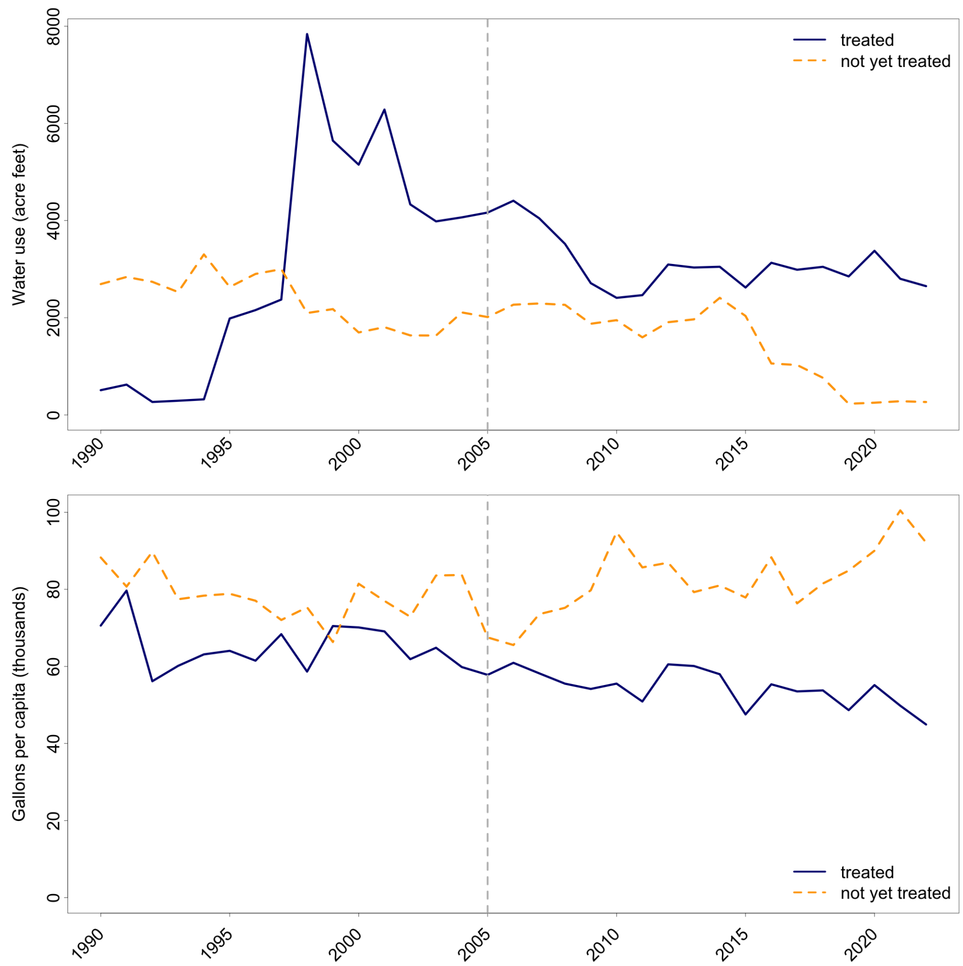

Figure C.3: Trends in average municipal water consumption, conditional on adopting tiered water pricing, from 1990-2020. The vertical line at 2005 captures the average year of adoption according to responses from the *Utah Culinary Water Pricing Survey* (see Table B.2). Top panel: Trends in average annual consumption (acre-feet) conditional on having a tiered pricing policy (dark blue) versus the trend in average annual consumption (acre-feet) conditional on *not* having a tiered pricing policy (orange). Bottom panel: Trends in average annual consumption per capita (thousands of gallons) conditional on having a tiered pricing policy (dark blue) versus the trend in average annual consumption per capita (thousands of gallons) conditional on *not* having a tiered pricing policy (orange).

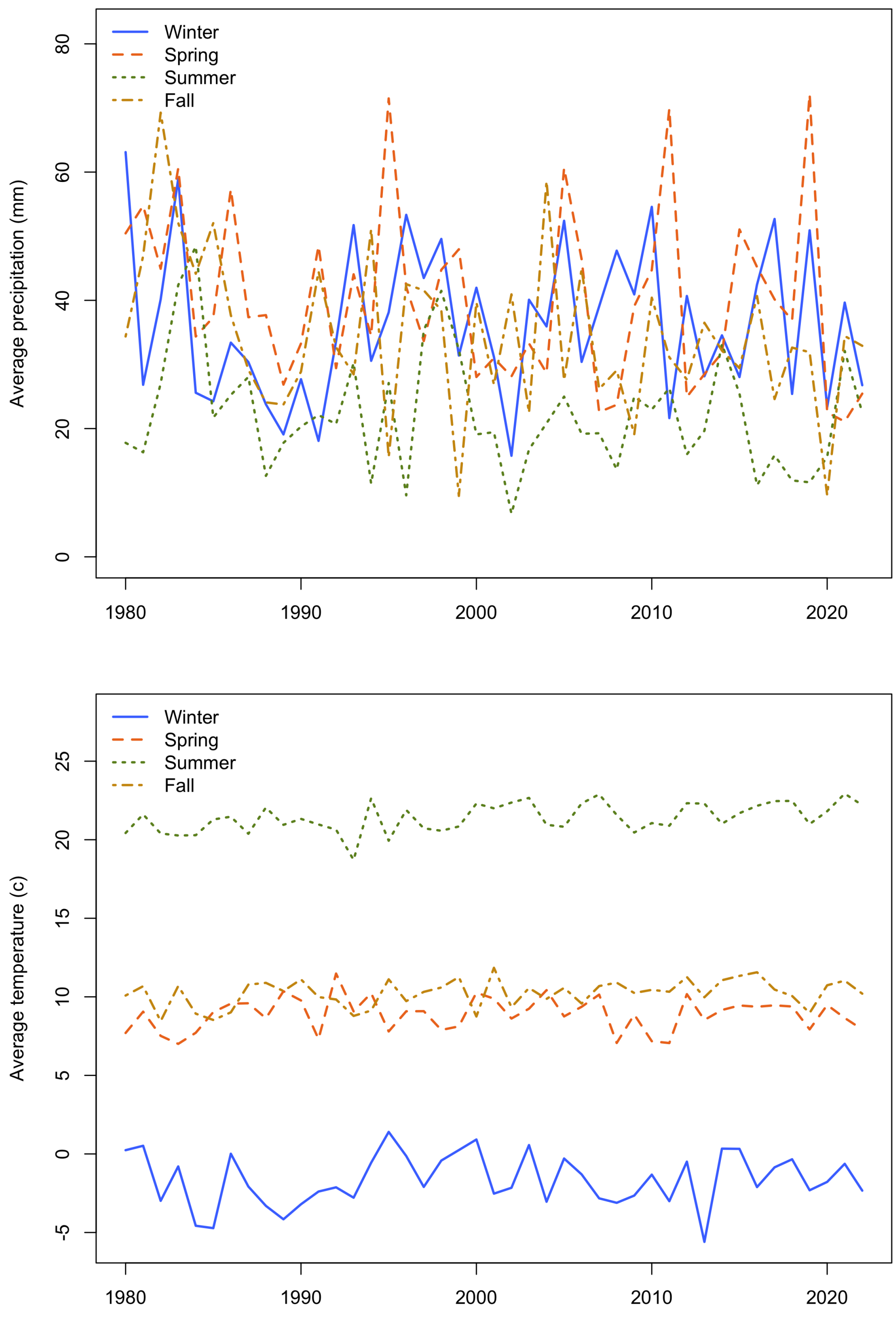

Figure C.4: Top panel: Seasonal average precipitation across all municipalities 1980 - 2022. Bottom panel: Seasonal average temperature across all municipalities 1980 - 2022.

Table C.1: Summary statistics for water use data and municipal culinary water pricing structures as of 2022.

Variable	Mean in 2022
Total water use (acre-feet)	1361.31 (3492.26) [242]
Water use per capita (thousands of gallons)	52.98 (60.97) [242]
Number of residential connections	3289.61 (7014.63) [242]
Population	13035.55 (32452.02) [242]
Number of tiers	4.96 (2.21) [191]
Base price (real USD)	25.27 (12.64) [192]
Base size (gallons)	6620.41 (9421.21) [191]

Note. Summary statistics reflect means as of 2022 for important variables from UDWR-WR water use data and data gathered from municipality websites capturing culinary pricing structures. Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets.

Table C.2: Summary statistics from the *Utah Culinary Water Pricing Survey* of municipal water managers.

Variable	Mean
Increasing tiered rate policy (dummy)	0.88 (0.32) [94]
First year tiered rate	2005.09 (11.63) [79]
Current year tiered rate	2016.24 (8.49) [79]
Prior rate (real USD)	26.49 (13.2) [25]
Secondary water access (dummy)	0.68 (0.47) [92]
Multiple tiers (dummy)	0.75 (0.44) [68]
Price of tiers change (dummy)	3.55 (3.11) [47]
Number of tiers change (dummy)	1.11 (1.05) [47]
Size of tier change (dummy)	1 (1.1) [47]

Note. Summary statistics are for responses to the *Utah Culinary Water Pricing Survey* (2024). Below the means for each variable, standard deviations are in parentheses and sample sizes are in square brackets. Sample sizes may differ from respective number of observations for a given variable because a municipality representative did not answer the question, or the question was not applicable.

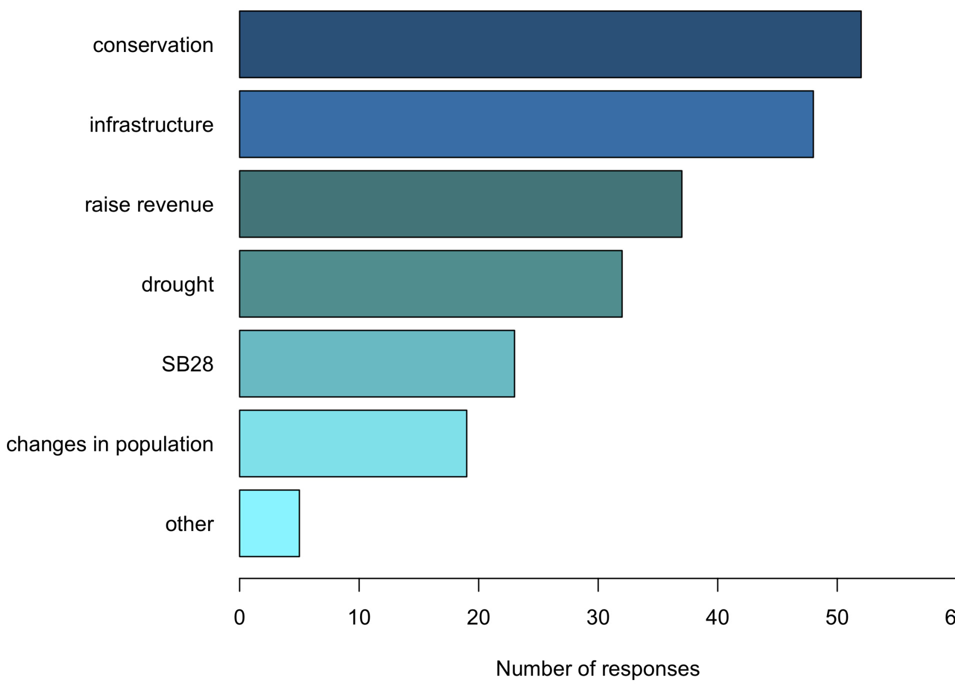

Figure C.5: Barplot of the distribution of motivations behind adopting increasing tiered block rate structures according to responses from the *Utah Culinary Water Pricing Survey*.

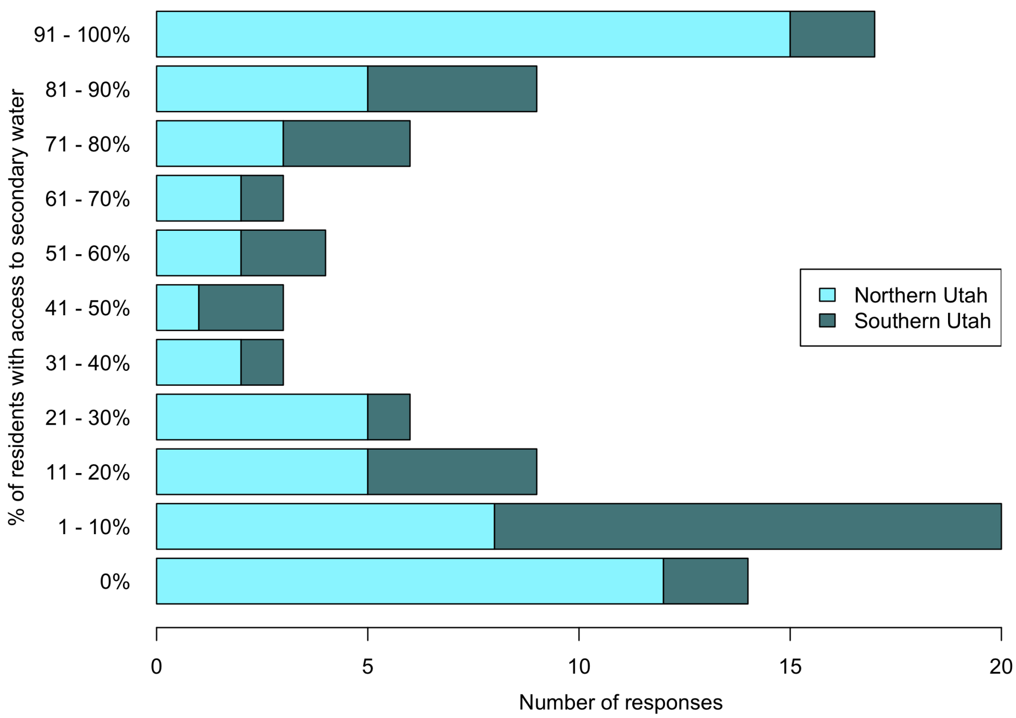

Figure C.6: Barplot of the distribution of the percentage of residents with secondary water access according to responses from the *Utah Culinary Water Pricing Survey*. Percentages reflect the municipal water manager's best estimate of residents with access to secondary water.

Appendix D: Supplementary Results

Table D.1: First stage results for Table 1, columns 2-4, estimated on the untreated observations over 1990-2022 with dependent variable 'Total water use (acre feet)'.

	Dependent variable: Total water use (acre-feet)			
	(2)	(3)	(4)	(5)
June avg. temperature (C)	132.40	94.666	205.73	253.06
	(219.26)	(242.55)	(181.50)	(190.35)
June avg. precipitation (mm)	-13.622*	-12.048	-11.852	-14.178*
	(7.2820)	(7.9892)	(7.4171)	(7.7701)
July avg. temperature (C)	-131.66	-120.73	-211.14	-240.39
	(302.47)	(302.67)	(327.59)	(303.44)
July avg. precipitation (mm)	-5.1547	-1.3110	-3.7612	-2.5482
	(17.465)	(17.061)	(17.879)	(18.938)
August avg. temperature (C)	496.23	293.53	414.83	407.57
	(387.35)	(318.46)	(363.78)	(349.63)
August avg. precipitation (mm)	5.2237	2.4754	4.6174	5.1549
	(12.035)	(11.320)	(11.149)	(11.595)
September avg. temperature (C)		-117.64	-103.48	-48.353
		(251.58)	(245.12)	(215.17)
September avg. precipitation (mm)		-4.2932	-3.6946	-2.4597
		(6.1624)	(6.7095)	(6.2366)
October avg. temperature (C)		473.89*	523.97*	566.30*
		(262.04)	(291.52)	(323.62)
October avg. precipitation (mm)		-1.3192	-4.7340	-4.1882
		(9.4889)	(8.0082)	(7.8830)
November avg. temperature (C)		281.94	411.70	449.83
		(675.42)	(762.46)	(752.33)
November avg. precipitation (mm)		17.982	15.463	16.472
		(12.595)	(12.634)	(13.363)
March avg. temperature (C)			-238.64	-231.28
			(188.96)	(197.09)
March avg. precipitation (mm)			-16.636**	-17.392**
			(7.5326)	(8.0520)
April avg. temperature (C)			-415.47	-471.22
			(379.22)	(422.48)
April avg. precipitation (mm)			-2.2057	-2.3849
			(10.256)	(10.426)
May avg. temperature (C)			45.321	38.516
			(306.93)	(322.90)
May avg. precipitation (mm)			-13.356**	-13.127**
			(6.0494)	(5.7937)
December avg. temperature (C)				-187.84
				(238.94)
December avg. precipitation (mm)				-5.1672
				(4.3320)
January avg. temperature (C)				20.152
				(137.15)
January avg. precipitation (mm)				-1.1020
				(6.2943)
February avg. temperature (C)				1.9949
				(100.11)
February avg. precipitation (mm)				8.7764
				(9.3288)
Unit FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Summer weather	Y	Y	Y	Y
Fall weather	N	Y	Y	Y
Spring weather	N	N	Y	Y
Winter weather	N	N	N	Y
# Observations	1,160	1,160	1,160	1,160
Adjusted R^2	0.992	0.992	0.992	0.992

Notes: Estimations are weighted by population. Standard errors are clustered at the municipality level. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.2: First stage results for Table 1, columns 2-4, estimated on the untreated observations over 1990-2022 with dependent variable 'Water use per capita (thousands of gallons)'.

	Dependent variable: Water water use per capita (thousands of gallons)			
	(2)	(3)	(4)	(5)
June avg. temperature (C)	6.2203**	6.3945**	6.4778**	6.2117**
	(2.5903)	(2.6157)	(2.7563)	(2.7442)
June avg. precipitation (mm)	0.15050*	0.12913	0.10620	0.10045
	(0.08421)	(0.08178)	(0.08328)	(0.08353)
July avg. temperature (C)	-2.5448	-3.4512	-3.4879	-3.8431
	(3.9623)	(4.1829)	(4.2951)	(4.4623)
July avg. precipitation (mm)	-0.11179	-0.10136	-0.07345	-0.07585
	(0.11592)	(0.12316)	(0.12394)	(0.13033)
August avg. temperature (C)	-0.73841	-2.0231	-1.7803	-1.0512
	(2.7386)	(2.6450)	(2.7242)	(2.9280)
August avg. precipitation (mm)	-0.12179	-0.11588	-0.10968	-0.10042
	(0.08006)	(0.08480)	(0.08465)	(0.09120)
September avg. temperature (C)		4.7269*	3.7545	4.2428
		(2.8264)	(2.9296)	(3.1087)
September avg. precipitation (mm)		-0.00492	-0.01931	-0.01500
		(0.09197)	(0.10359)	(0.11048)
October avg. temperature (C)		-2.7960	-2.4393	-2.7476
		(3.5904)	(3.6566)	(3.6137)
October avg. precipitation (mm)		-0.06425	-0.06684	-0.08492
		(0.08612)	(0.09185)	(0.09550)
November avg. temperature (C)		0.43473	0.76044	0.33958
		(2.5131)	(2.5829)	(2.5542)
November avg. precipitation (mm)		0.08647	0.09774	0.07230
		(0.08155)	(0.09059)	(0.08309)
March avg. temperature (C)			-1.2951	-1.6267
			(2.2474)	(2.2174)
March avg. precipitation (mm)			0.09104	0.08054
			(0.07877)	(0.07129)
April avg. temperature (C)			2.9964	3.3862
			(2.9649)	(2.8829)
April avg. precipitation (mm)			0.08738	0.10390
			(0.11685)	(0.12081)
May avg. temperature (C)			-0.61094	-0.90083
			(2.1901)	(2.1188)
May avg. precipitation (mm)			-0.05167	-0.03891
			(0.07072)	(0.07175)
December avg. temperature (C)				2.2960
				(1.4348)
December avg. precipitation (mm)				0.03741
				(0.07434)
January avg. temperature (C)				0.69558
				(1.5137)
January avg. precipitation (mm)				-0.08835
				(0.09141)
February avg. temperature (C)				-0.74075
				(1.3464)
February avg. precipitation (mm)				0.10661
				(0.10340)
Unit FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Summer weather	Y	Y	Y	Y
Fall weather	N	Y	Y	Y
Spring weather	N	N	Y	Y
Winter weather	N	N	N	Y
# Observations	1,160	1,160	1,160	1,160
Adjusted R^2	0.784	0.784	0.783	0.783

Notes: Estimations are not weighted by population. Standard errors are clustered at the municipality level. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.3: Example two-way fixed effects regressions focused on the relationship between monthly average weather and water use over 1990-2022.

	TTL-W	TTL-NW	WCAP-W	WCAP-NW
June avg. temperature (C)	71.602	8.165	1.342	5.491
	(374.840)	(32.051)	(1.189)	(5.533)
June avg. precipitation (mm)	−4.321	0.019	−0.009	0.057
	(8.796)	(0.863)	(0.032)	(0.095)
July avg. temperature (C)	−711.309***	−51.793	0.009	0.938
	(259.235)	(34.824)	(1.163)	(5.776)
July avg. precipitation (mm)	3.384	−1.299	−0.105**	−0.016
	(14.053)	(1.113)	(0.043)	(0.173)
August avg. temperature (C)	85.036	2.244	−0.598	−1.024
	(372.747)	(39.445)	(1.408)	(4.833)
August avg. precipitation (mm)	−8.848	−0.729	−0.038	−0.051
	(7.957)	(0.639)	(0.029)	(0.066)
September avg. temperature (C)	−48.104	−2.089	1.329	−2.121
	(202.507)	(17.615)	(0.958)	(2.946)
September avg. precipitation (mm)	−6.610	−0.955	−0.038	−0.198
	(6.465)	(0.633)	(0.025)	(0.158)
October avg. temperature (C)	−223.244	−20.302	−0.755	0.649
	(232.509)	(18.425)	(1.085)	(4.713)
October avg. precipitation (mm)	13.423	0.546	0.011	0.016
	(8.604)	(0.781)	(0.025)	(0.159)
November avg. temperature (C)	−190.153	−13.618	−2.164*	−3.436
	(353.131)	(27.038)	(1.153)	(4.403)
November avg. precipitation (mm)	27.574	1.535	−0.056	−0.174**
	(27.816)	(2.367)	(0.048)	(0.084)
March avg. temperature (C)	−250.399	0.019	1.639**	−3.668
	(246.936)	(19.893)	(0.792)	(4.374)
March avg. precipitation (mm)	−5.114	−1.298	−0.020	−0.122
	(6.283)	(0.832)	(0.025)	(0.103)
April avg. temperature (C)	341.365	48.001*	0.036	1.164
	(225.956)	(27.812)	(0.896)	(2.511)
April avg. precipitation (mm)	1.175	0.522	0.003	0.055
	(8.451)	(0.794)	(0.022)	(0.077)
May avg. temperature (C)	118.342	3.203	0.962	−3.697
	(241.632)	(25.681)	(1.080)	(4.393)
May avg. precipitation (mm)	−5.895	−1.405	0.011	0.006
	(9.302)	(1.021)	(0.023)	(0.076)
December avg. temperature (C)	−12.705	−26.323*	−1.648**	−4.884*
	(188.152)	(13.401)	(0.787)	(2.892)
December avg. precipitation (mm)	−20.297***	−2.043**	−0.063**	−0.010
	(7.671)	(0.874)	(0.028)	(0.151)
January avg. temperature (C)	63.827	8.227	0.190	−0.840
	(138.361)	(10.489)	(0.682)	(1.120)
January avg. precipitation (mm)	6.613	−0.030	−0.031	−0.033
	(7.356)	(0.839)	(0.019)	(0.084)
February avg. temperature (C)	−320.947	−19.060**	−0.563	1.270
	(207.159)	(9.024)	(0.695)	(2.186)
February avg. precipitation (mm)	−0.049	−0.001	−0.023	−0.071
	(3.538)	(0.582)	(0.023)	(0.160)
Municipality FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
# Observations	5865	5989	5865	5865
Adjusted R^2	0.971	0.956	0.491	0.303

Notes: Four models are presented above. The corresponding specifications are the same with the exception of the dependent variable and weighting approach, which varies by column as follows: TTL-W = total water use (acre feet) weighted by population; TTL-NW = total water use (acre feet) not weighted by population; WCAP-W = water use per capita (thousands of gallons) weighted by population. WCAP-NW = water use per capita (thousands of gallons) not weighted by population. Standard errors are clustered at the municipality level. Differences in the number of observations are due to more missing instances of population than water use. Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.4: Two-way fixed effects differences-in-differences estimation of the extensive margin effect of having a tiered culinary water pricing policy over 1990-2022.

	Dependent variable: Total water use (acre feet)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	434.111	476.218	429.238	429.741	361.258
	(722.838)	(658.377)	(602.803)	(561.659)	(587.935)
Adjusted R^2	0.971	0.971	0.973	0.973	0.973
	Dependent variable: Water use per capita (thousands of gallons)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	−6.199	−6.223	−6.473	−6.465	−6.568
	(5.246)	(5.163)	(5.275)	(5.255)	(5.181)
Adjusted R^2	0.753	0.754	0.754	0.754	0.754
# Observations	1985	1985	1985	1985	1985
Municipality FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Summer covariates	N	Y	Y	Y	Y
Fall covariates	N	N	Y	Y	Y
Spring covariates	N	N	N	Y	Y
Winter covariates	N	N	N	N	Y

Notes: Notes: Results for two dependent variables are presented above with two different weighting strategies: 'Total water use (acre feet)' is weighted by population; 'Water use per capita (thousands of gallons)' is not weighted. Standard errors are in parentheses and clustered at the municipality level ($n = 77$ unique units). Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.5: Overall ATT of extensive margin effect of having a tiered culinary water pricing policy over 1990-2022 estimated via two-stage DiD (Gardner et al., 2025) (alternative weighting).

	Dependent variable: Total water use (acre feet)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	190.82	184.35	194.57	191.89	185.80
	(347.58)	(348.91)	(346.47)	(346.66)	(345.35)
Adjusted R^2	0.002	0.002	0.002	0.002	0.002
# Observations	2,011	2,011	2,011	2,011	2,011
	Dependent variable: Water use per capita (thousands of gallons)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	5.8779	5.6290	5.6675	5.6785	5.4037
	(4.3033)	(4.2792)	(4.3078)	(4.3203)	(4.1674)
Adjusted R^2	0.037	0.034	0.035	0.035	0.032
# Observations	1,985	1,985	1,985	1,985	1,985
First stage specification parameters					
Municipality FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Summer covariates	N	Y	Y	Y	Y
Fall covariates	N	N	Y	Y	Y
Spring covariates	N	N	N	Y	Y
Winter covariates	N	N	N	N	Y

Notes: Results for two dependent variables are presented above with two different weighting strategies: 'Total water use (acre feet)' is not weighted by population; 'Water use per capita (thousands of gallons)' is weighted by population. Observations differ due to there being more missing observations for municipal population than total water use. Standard errors are in parentheses and clustered at the municipality level ($n = 77$ unique units). Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.6: Overall ATT of extensive margin effect of having a tiered culinary water pricing policy over 1990-2022 estimated via two-stage DiD (Gardner et al., 2025) using data from UDWR (no imputations, observations of zero set to missing).

	Dependent variable: Total water use (acre feet)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	-498.35	-461.46	-627.11	-1,071.5	-876.54
	(1,803.0)	(1,683.4)	(1,829.9)	(2,028.7)	(2,069.5)
Adjusted R^2	0.0004	0.0003	0.0010	0.004	0.002
# Observations	1,882	1,882	1,882	1,882	1,882
	Dependent variable: Water use per capita (thousands of gallons)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	-3.3873	-2.0713	-1.8722	-1.5845	-1.2034
	(8.5876)	(8.4091)	(8.4846)	(8.5190)	(8.5344)
Adjusted R^2	-0.0003	-0.0004	-0.0005	-0.0005	-0.0005
# Observations	1,882	1,882	1,882	1,882	1,882
First stage specification parameters					
Municipality FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Summer covariates	N	Y	Y	Y	Y
Fall covariates	N	N	Y	Y	Y
Spring covariates	N	N	N	Y	Y
Winter covariates	N	N	N	N	Y

Notes: Notes: Results for two dependent variables are presented above with two different weighting strategies: 'Total water use (acre feet)' is weighted by population; 'Water use per capita (thousands of gallons)' is not weighted. Standard errors are in parentheses and clustered at the municipality level ($n = 77$ unique units). Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.7: Overall ATT of extensive margin effect of having a tiered culinary water pricing policy over 1980-2022 estimated via two-stage DiD (Gardner et al., 2025).

	Dependent variable: Total water use (acre feet)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	-2,003.3	-2,052.2	-2,099.6	-2,078.0	-2,173.8
	(2,356.9)	(2,385.8)	(2,384.3)	(2,439.8)	(2,408.3)
Adjusted R^2	0.036	0.038	0.039	0.036	0.040
# Observations	2,228	2,228	2,228	2,228	2,228
	Dependent variable: Water use per capita (thousands of gallons)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	-0.34456	0.07108	0.01704	-0.06387	-0.58109
	(6.6809)	(6.3927)	(6.4680)	(6.4929)	(6.4579)
Adjusted R^2	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
# Observations	2,228	2,228	2,228	2,228	2,228
First stage specification parameters					
Municipality FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Summer covariates	N	Y	Y	Y	Y
Fall covariates	N	N	Y	Y	Y
Spring covariates	N	N	N	Y	Y
Winter covariates	N	N	N	N	Y

Notes: Results for two dependent variables are presented above with two different weighting strategies: ‘Total water use (acre feet)’ is weighted by population; ‘Water use per capita (thousands of gallons)’ is not weighted. Standard errors are in parentheses and clustered at the municipality level ($n = 79$ unique units). Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

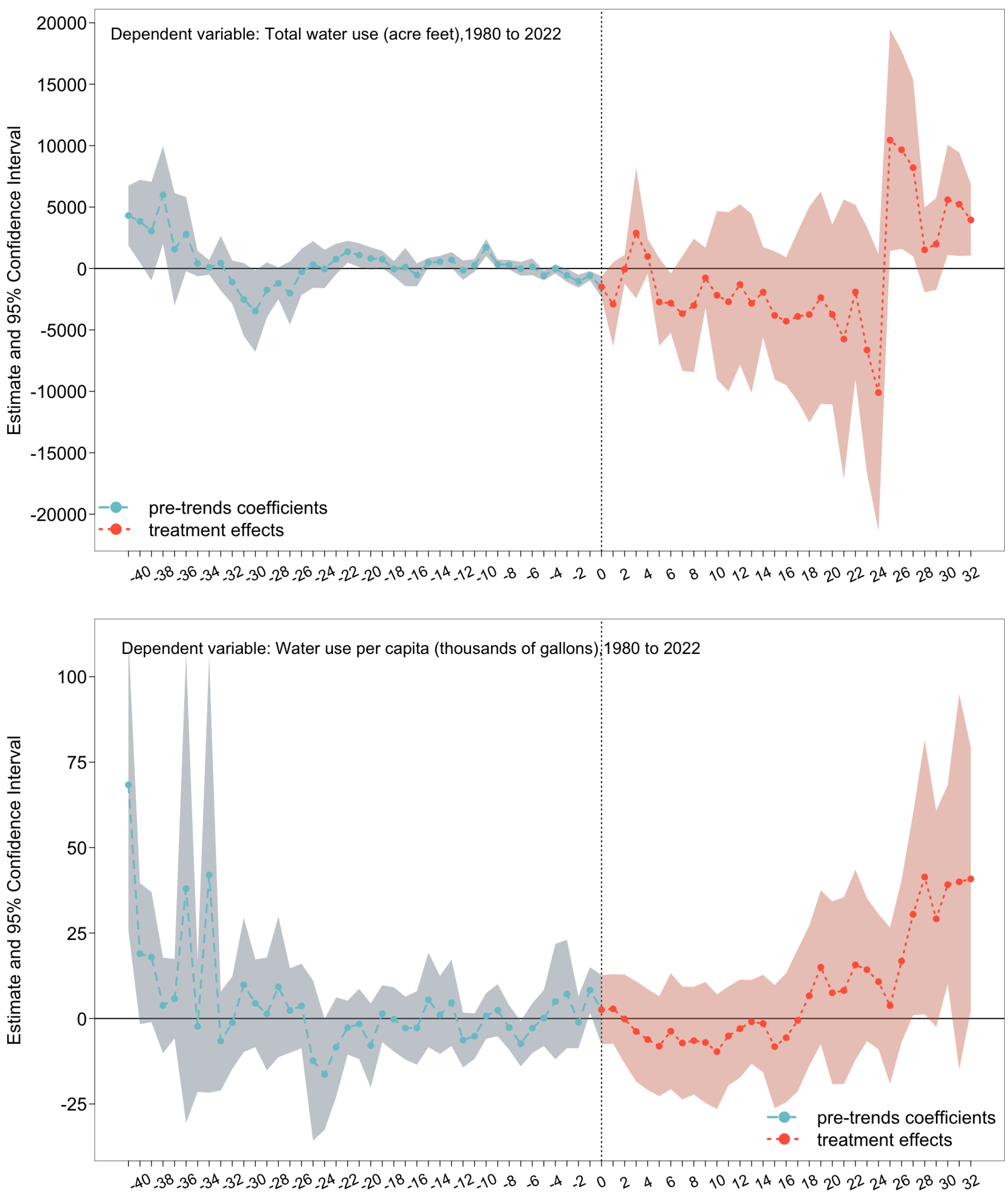

Figure D.1: Event studies via Gardner et al. (2025) of the extensive margin effect of adopting tiered water pricing. Top panel: Event study for total water use (acre feet) over 1980-2022 (population-weighted). Bottom panel: Event study for water use per capita (thousands of gallons) over 1980-2022 (not weighted).

Table D.8: Overall ATT of extensive margin effect of having a tiered culinary water pricing policy over 1980-2022 estimated via two-stage DiD (Gardner et al., 2025) using data from UDWR (no imputations, observations of zero set to missing).

	Dependent variable: Total water use (acre feet)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	-1,636.4	-1,755.4	-1,944.9	-2,174.7	-1,990.1
	(2,198.4)	(2,149.1)	(2,308.8)	(2,400.6)	(2,465.1)
Adjusted R^2	0.011	0.013	0.016	0.019	0.015
# Observations	2,108	2,108	2,108	2,108	2,108
	Dependent variable: Water use per capita (thousands of gallons)				
	(1)	(2)	(3)	(4)	(5)
Tiered pricing dummy (extensive margin)	1.2043	2.9390	3.1141	3.1587	3.1696
	(8.3482)	(8.0622)	(8.1012)	(8.1287)	(8.1820)
Adjusted R^2	-0.0004	-0.0003	-0.0002	-0.0002	-0.0002
# Observations	2,108	2,108	2,108	2,108	2,108
First stage specification parameters					
Municipality FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Summer covariates	N	Y	Y	Y	Y
Fall covariates	N	N	Y	Y	Y
Spring covariates	N	N	N	Y	Y
Winter covariates	N	N	N	N	Y

Notes: Notes: Results for two dependent variables are presented above with two different weighting strategies: 'Total water use (acre feet)' is weighted by population; 'Water use per capita (thousands of gallons)' is not weighted. Standard errors are in parentheses and clustered at the municipality level ($n = 79$ unique units). Significance codes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

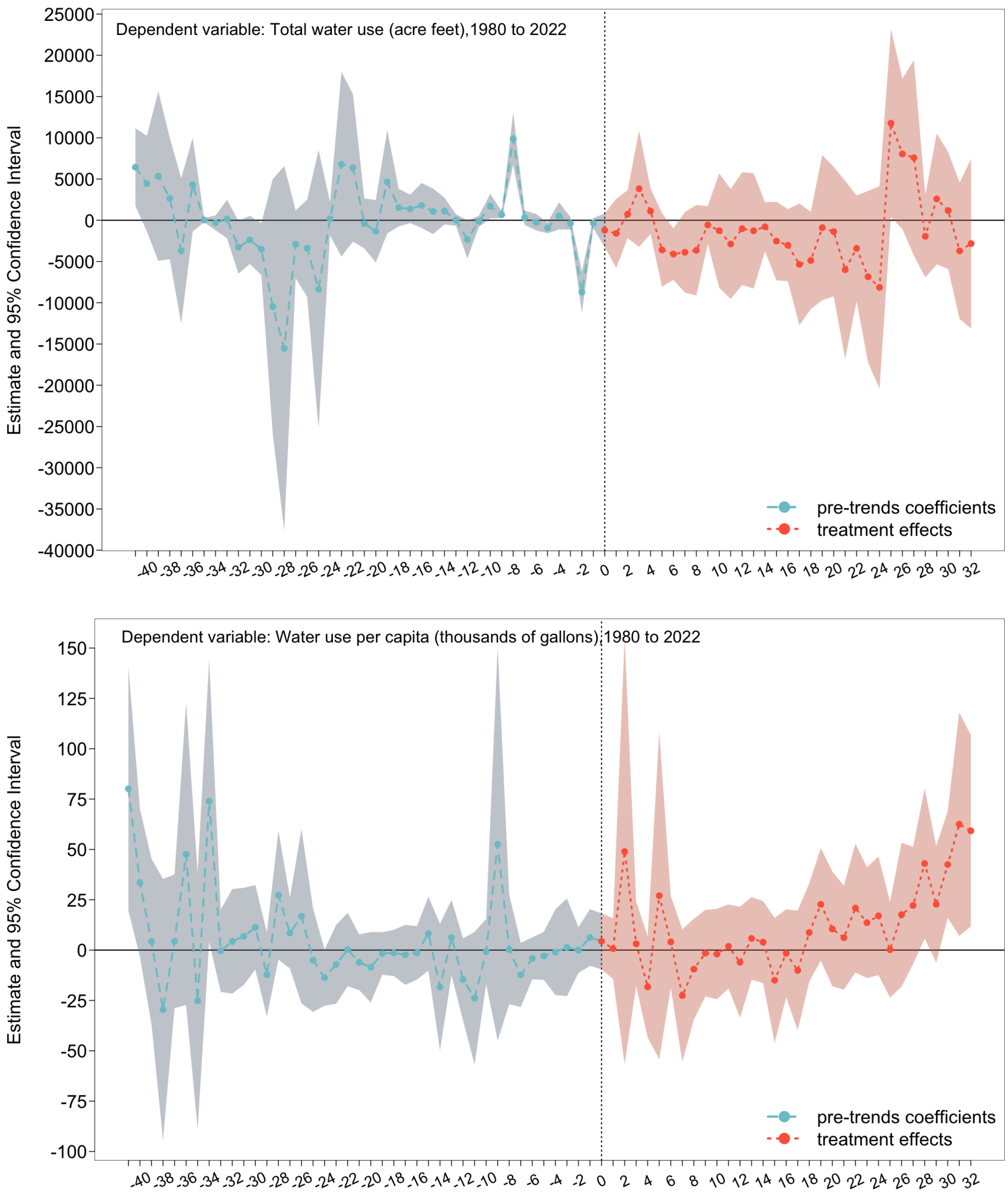

Figure D.2: Event studies via Gardner et al. (2025) of the extensive margin effect of adopting tiered water pricing UDWR-WR data (no imputations, observations of zero set to missing). Top panel: Event study for total water use (acre feet) over 1980-2022 (population-weighted). Bottom panel: Event study for water use per capita (thousands of gallons) over 1980-2022 (not weighted).

Figure D.3: 95% confidences intervals (CIs) following Rambachan and Roth (2023) for the extensive margin effect of tiered water pricing on total culinary water use (acre feet, population weighted effects). The y-axis captures post-treatment event time period CIs. Blue CIs are the original CIs estimated via Gardner et al. (2025) and the pink CIs vary based on the proportion (x-axis) of the maximum M pre-treatment violation of parallel trends that is applied to bound maximum potential post-treatment violations of parallel trends.

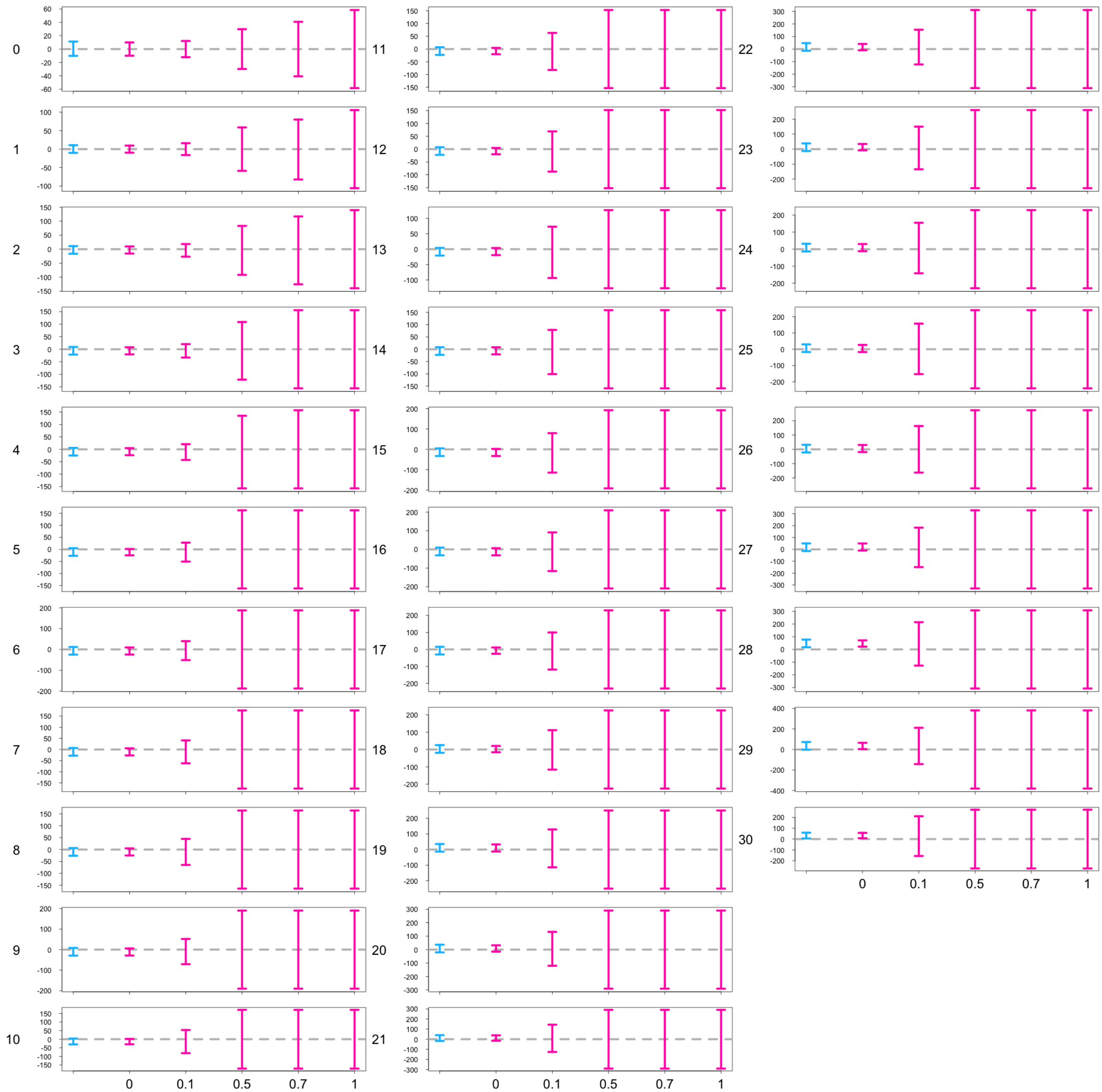

Figure D.4: 95% confidences intervals (CIs) following Rambachan and Roth (2023) for the extensive margin effect of tiered water pricing on total water use per capita (thousands of gallons, not weighted). The y-axis captures post-treatment event time period CIs. Blue CIs are the original CIs estimated via Gardner et al. (2025) and the pink CIs vary based on the proportion (x-axis) of the maximum M pre-treatment violation of parallel trends that is applied to bound maximum potential post-treatment violations of parallel trends.

References

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