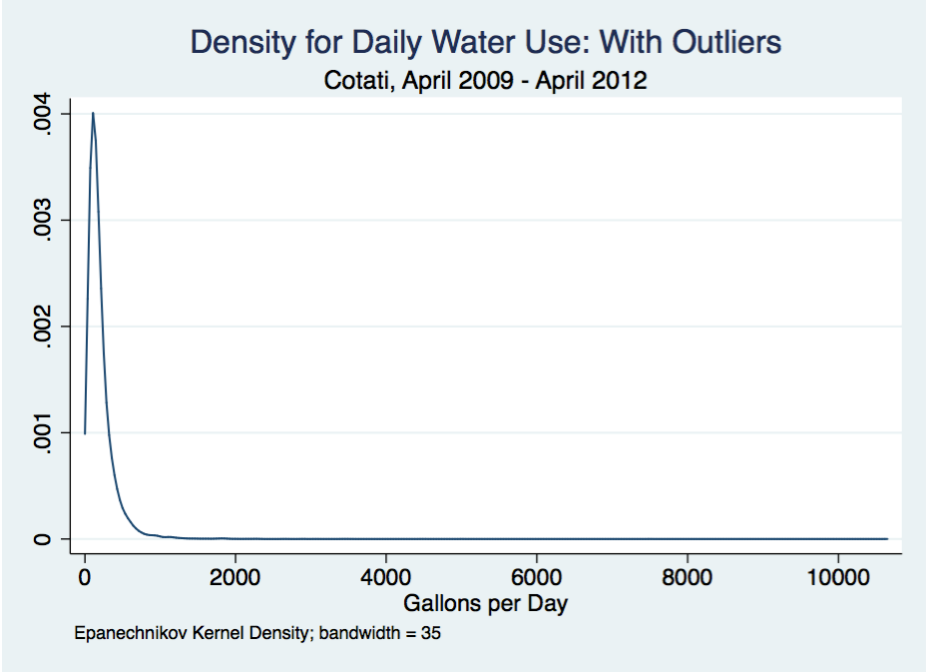
Analyzing WaterSmart's Conservation Program

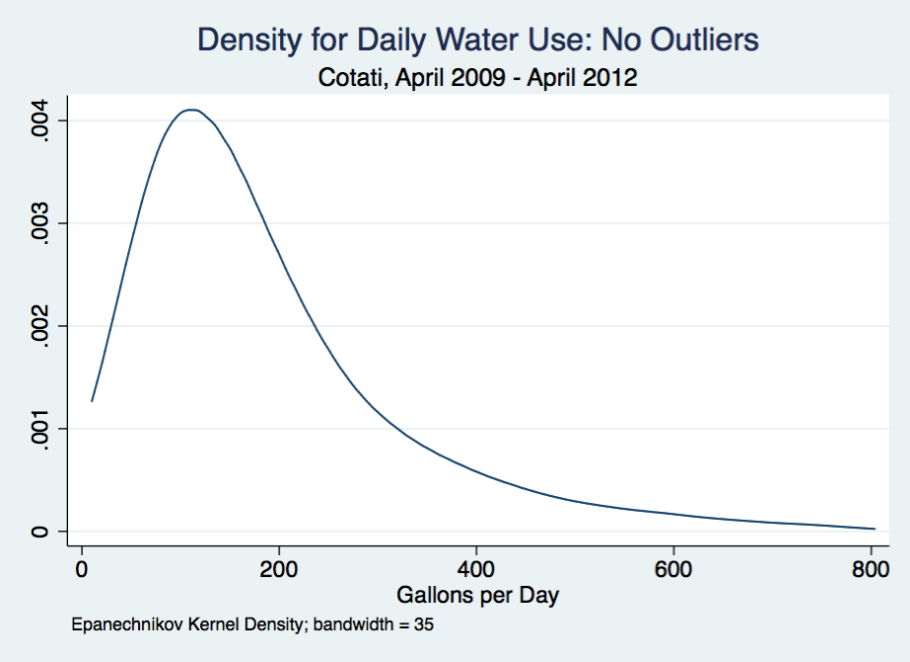
Danny Brent

Outline

1. Basic treatment effects
2. Robustness checks
3. Exploring heterogeneity
4. Opportunities for further work

Data

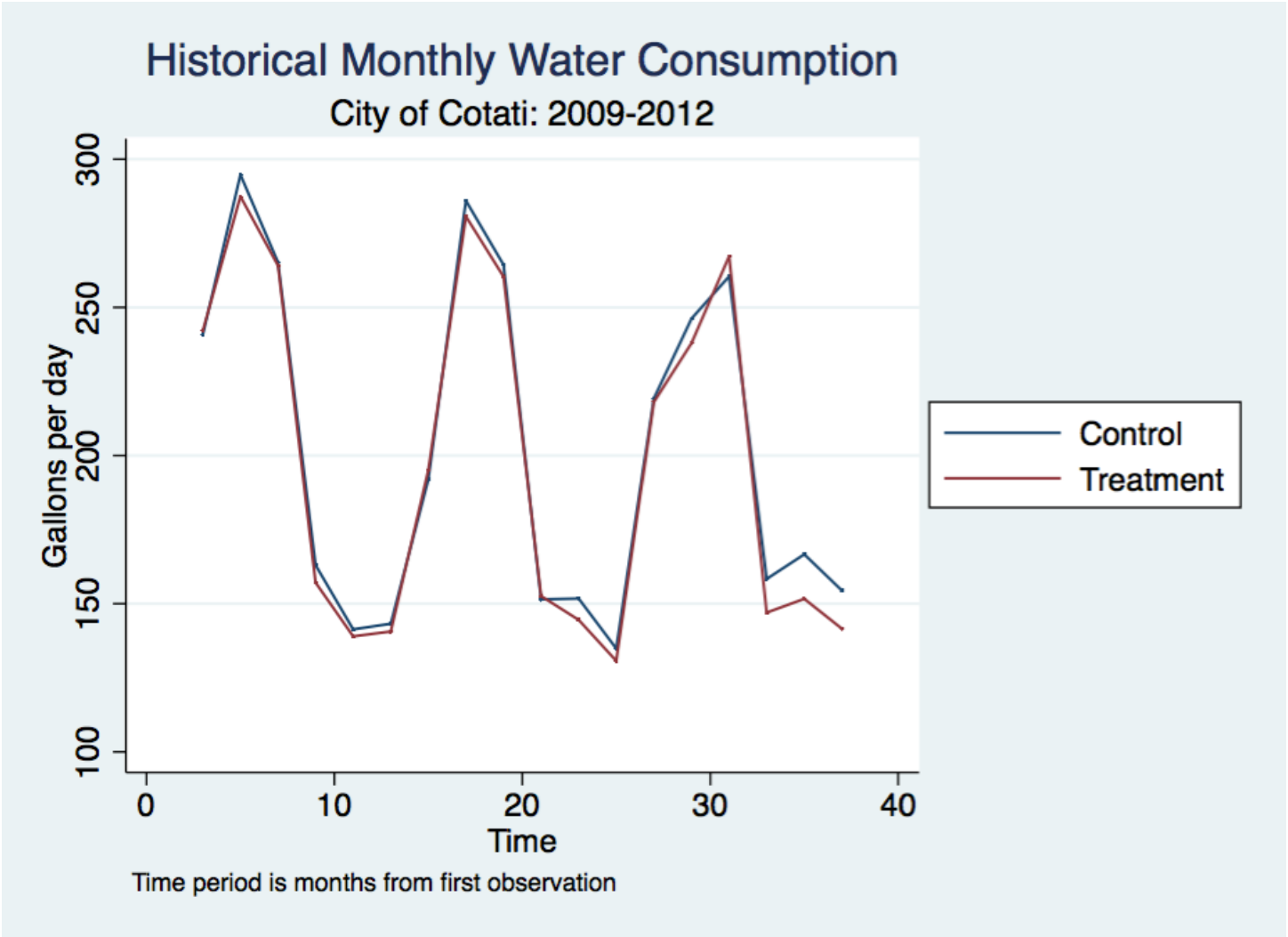

Density for Daily Water Use: With Outliers
Cotati, April 2009 - April 2012
0
.001
.002
.003
.004
0
2000
4000
6000
8000
10000
Gallons per Day
Epanechnikov Kernel Density; bandwidth = 35


Density for Daily Water Use: No Outliers
Cotati, April 2009 - April 2012
0
.001
.002
.003
.004
0
200
400
600
800
Gallons per Day
Epanechnikov Kernel Density; bandwidth = 35

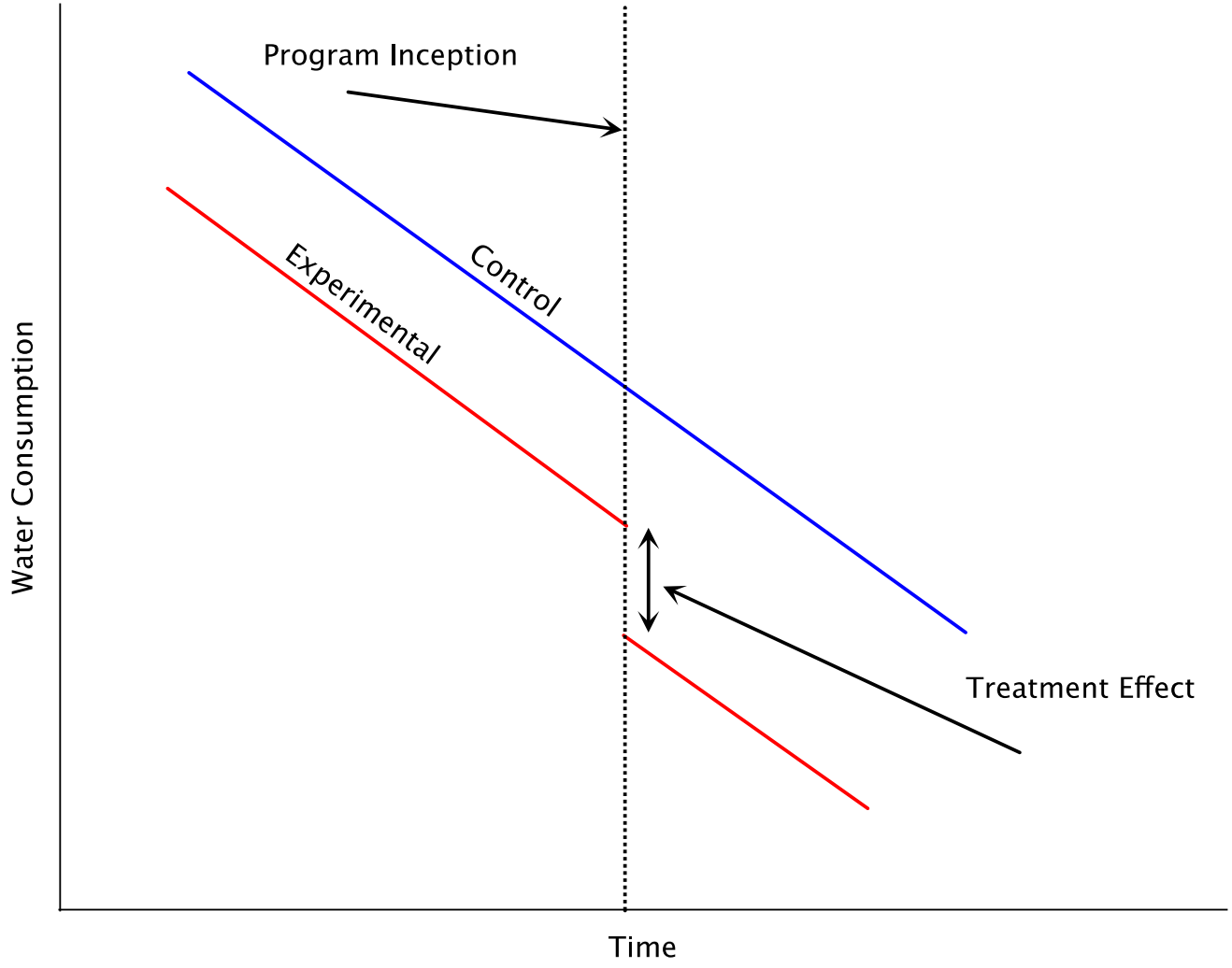
Data

- Convert data to gallons per day
- Remove outliers
  - Over three (under two) standard deviations from the sample average
  - Over three (under two) standard deviations from individual average

Changes over time



Difference-in-Difference



Base Results

VARIABLES	(1) Base - Levels
Experimental Group	
Treatment Period	
Treatment Effect	
Sq Ft	0.0708***
Lot Size	0.000199***
Year Built	-0.0375
Bathrooms	18.56***
Rainy Days	-2.562***
Total Precipitation	0.00255
Cooling Degree Days	0.0213***
Time Trend	-0.197**
Summer	56.12***
Constant	105.4
Observations	25,771
Adj. R-squared	0.245

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

Base Results

VARIABLES	(1) Base - Levels	(2) Base - Logs
Experimental Group		
Treatment Period		
Treatment Effect		
Sq Ft	0.0708***	0.000345***
Lot Size	0.000199***	7.56e-07**
Year Built	-0.0375	-0.000245
Bathrooms	18.56***	0.152***
Rainy Days	-2.562***	-0.0107***
Total Precipitation	0.00255	-4.55e-07
Cooling Degree Days	0.0213***	8.24e-05***
Time Trend	-0.197**	-0.000602
Summer	56.12***	0.270***
Constant	105.4	4.576***
Observations	25,771	25,771
Adj. R-squared	0.245	0.219

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

Base Results

VARIABLES	(1) Base - Levels	(2) Base - Logs	(3) DID - Levels
Experimental Group			6.393***
Treatment Period			-8.504**
Treatment Effect			-10.39***
Sq Ft	0.0708***	0.000345***	0.0707***
Lot Size	0.000199***	7.56e-07**	0.000199***
Year Built	-0.0375	-0.000245	-0.0379
Bathrooms	18.56***	0.152***	18.71***
Rainy Days	-2.562***	-0.0107***	-3.183***
Total Precipitation	0.00255	-4.55e-07	0.00431**
Cooling Degree Days	0.0213***	8.24e-05***	0.0204***
Time Trend	-0.197**	-0.000602	0.0141
Summer	56.12***	0.270***	49.92***
Constant	105.4	4.576***	107.9
Observations	25,771	25,771	25,771
Adj. R-squared	0.245	0.219	0.246

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Base Results

VARIABLES	(1) Base - Levels	(2) Base - Logs	(3) DID - Levels	(4) DID - Logs
Experimental Group			6.393***	0.0377***
Treatment Period			-8.504**	-0.0184
Treatment Effect			-10.39***	-0.0493**
Sq Ft	0.0708***	0.000345***	0.0707***	0.000345***
Lot Size	0.000199***	7.56e-07**	0.000199***	7.63e-07**
Year Built	-0.0375	-0.000245	-0.0379	-0.000247
Bathrooms	18.56***	0.152***	18.71***	0.153***
Rainy Days	-2.562***	-0.0107***	-3.183***	-0.0127***
Total Precipitation	0.00255	-4.55e-07	0.00431**	5.12e-06
Cooling Degree Days	0.0213***	8.24e-05***	0.0204***	7.97e-05***
Time Trend	-0.197**	-0.000602	0.0141	4.67e-05
Summer	56.12***	0.270***	49.92***	0.250***
Constant	105.4	4.576***	107.9	4.577***
Observations	25,771	25,771	25,771	25,771
Adj. R-squared	0.245	0.219	0.246	0.219

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Sensitivity Checks

	Treatment Effect	
Methodology	**Levels**	**Logs**
Monthly Dummies	-10.36***	-0.0492**
Only SFH	-12.20***	-0.0510**
No SFH	-4.505	-0.0405
Fixed Effects	-6.906*	-0.0368**
All Outliers	-10.28*	-0.0673***
Remove only low	-11.55***	-0.0691***
Remove only high	-8.985	-0.0475**

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

Interpretation

- Program has an effect of reducing daily demand by ~10 GPD
  - Reduction of approximately 5% of
- Savings is mainly from single family homes
- Results are robust to different methodologies

Subgroup Analysis

VARIABLES	(1) Levels	(2) Logs
Group A	2.048	0.0123
	(2.336)	(0.0129)
Group B	4.944**	0.0369***
	(2.361)	(0.0124)
Group C	12.29***	0.0641***
	(2.433)	(0.0127)
Treatment Effect A	-11.78***	-0.0830**
	(4.538)	(0.0323)
Treatment Effect C	-9.885**	-0.0380
	(4.542)	(0.0296)
Treatment Effect C	-9.732**	-0.0287
	(4.817)	(0.0299)

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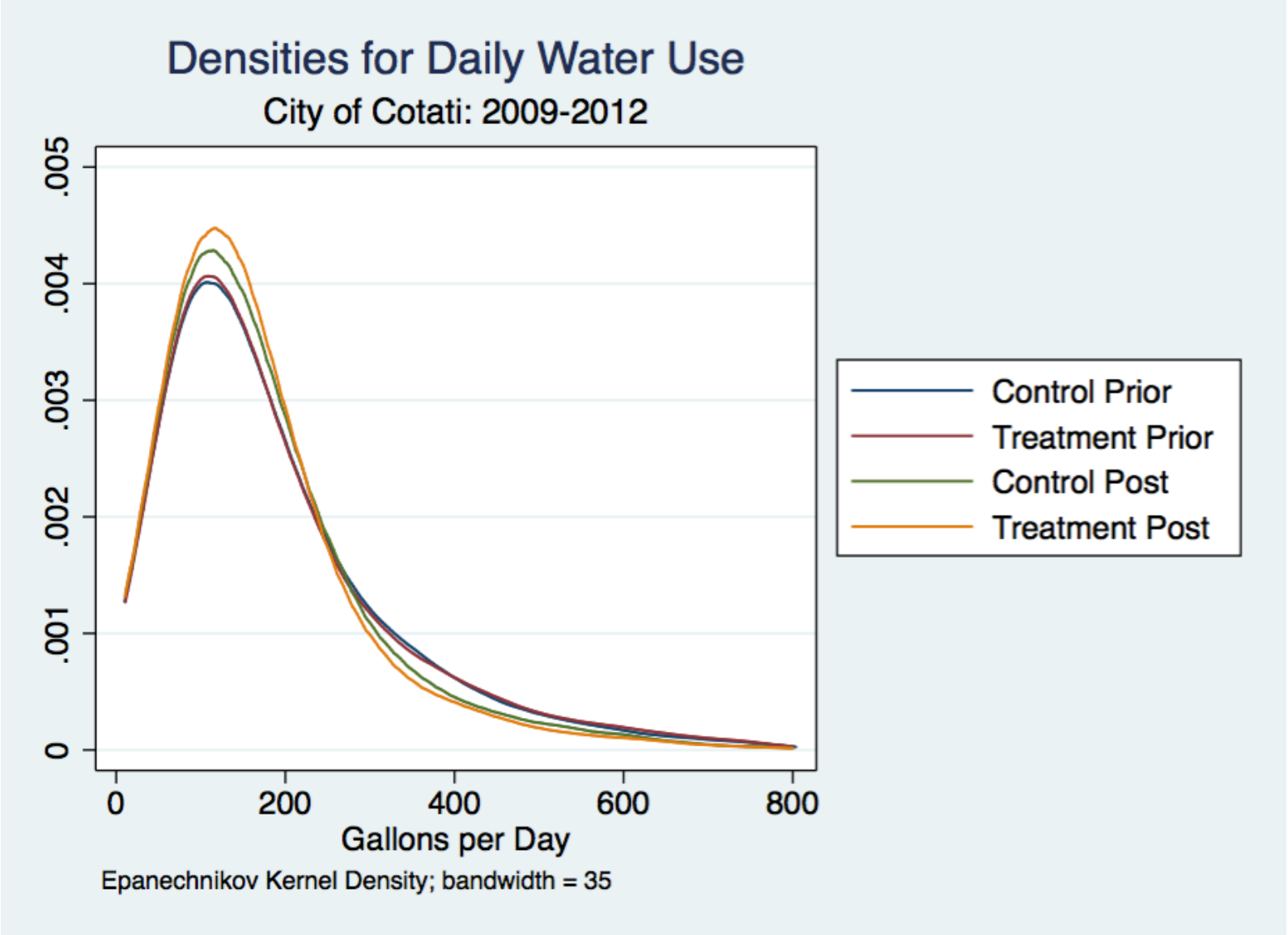
Interpretation

- Differences in baseline water consumption
  - A < B < C
- Difference responses to program
  - A > B = C
  - Differential in responses are not significant
  - More profound in logs than levels

Distribution of Savings



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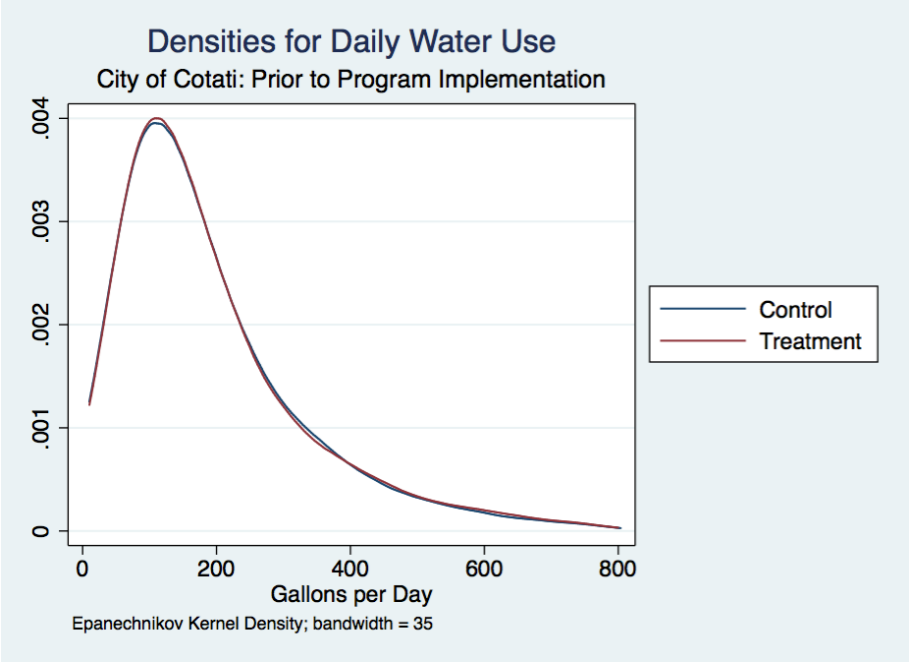

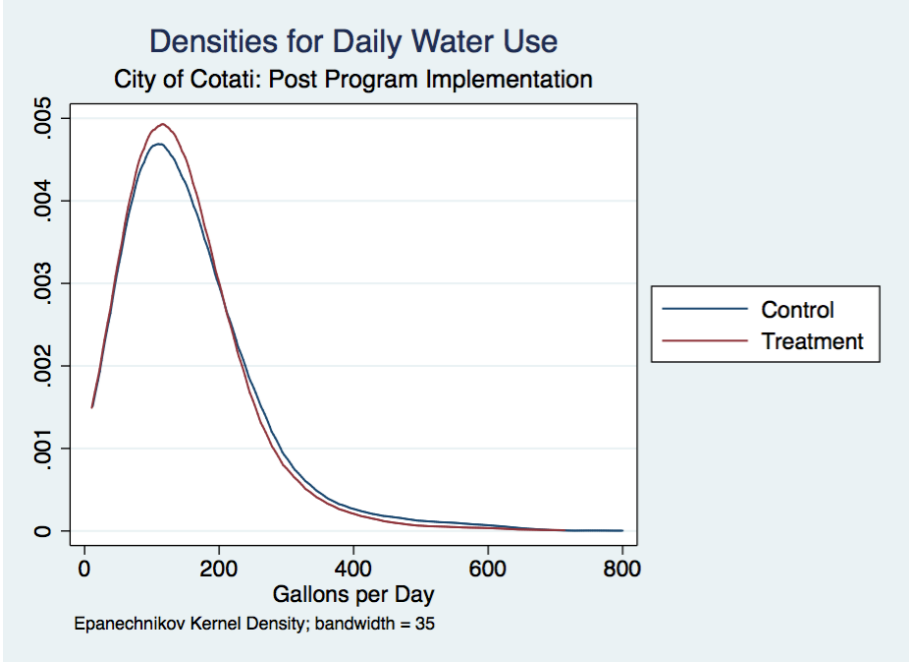

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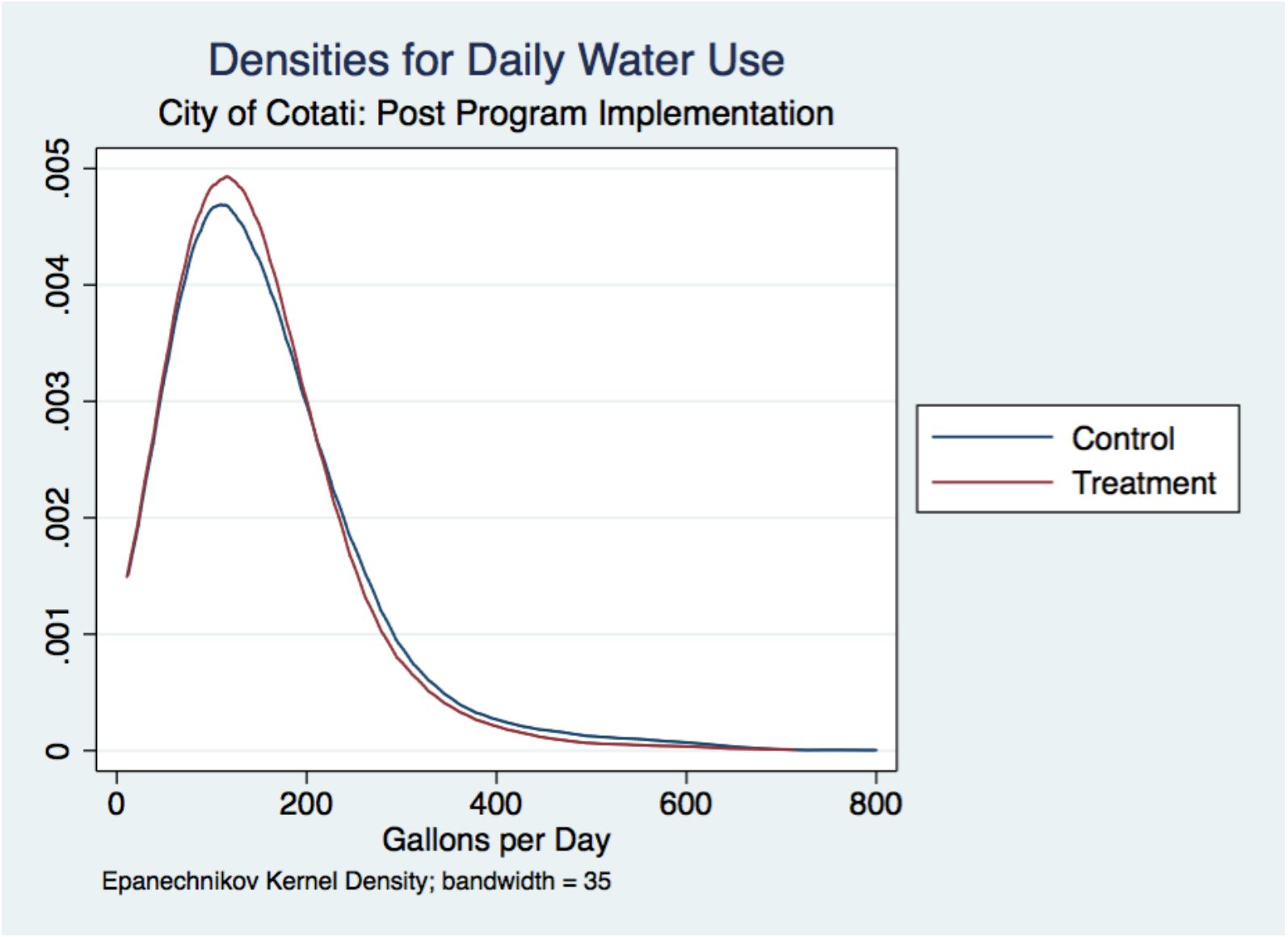
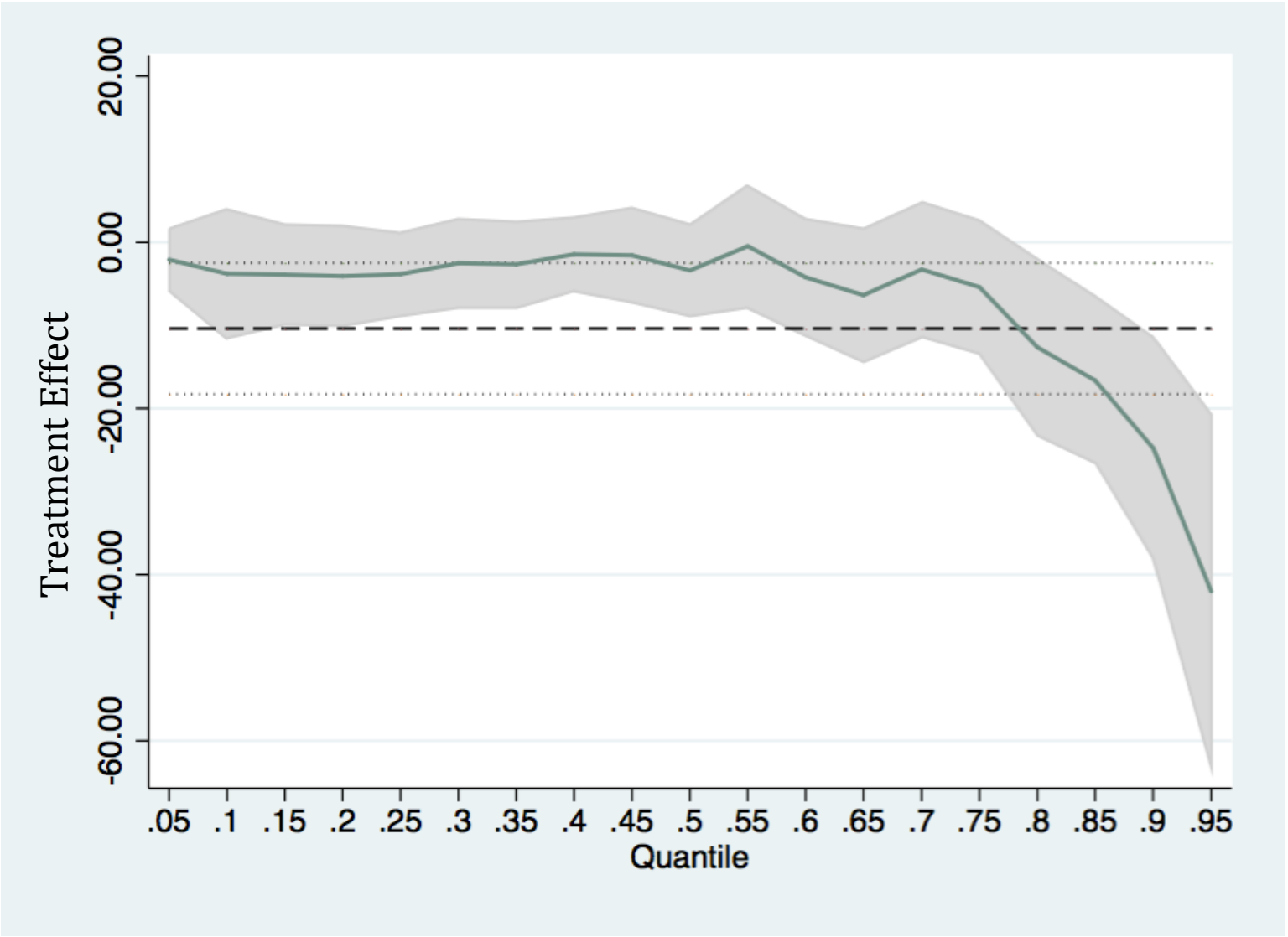
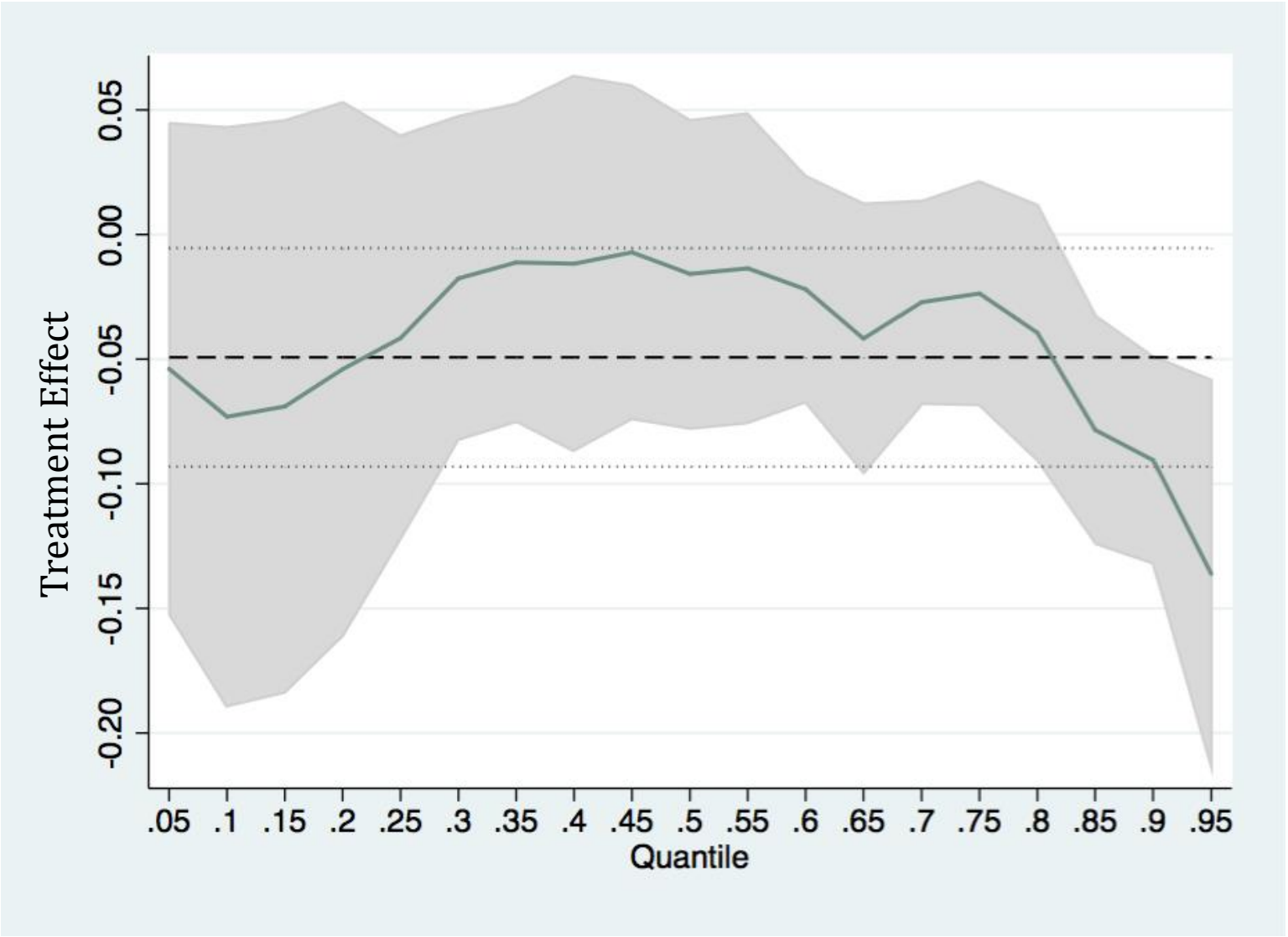


Quantile Regression - Levels



Quantile Regression - Logs



Interpretation

- In absolute reductions (levels) the high users are driving the results
- Proportionally high and low users are more responsive than the middle
  - High users have more potential to reduce
  - Low users are more cost/environmentally conscious

Survey Data

- Not enough data for statistical analysis of the program
  - Treatment effect disappears running exact same regressions for the survey sample
- Qualitative results of treatment effect: small sample size
  - Prior retrofit decreases response
  - Presence of irrigation increases response
  - Owner occupied home decreases response (odd)

Further Work

- Persistence
  - Initial results are significant for individual monthly treatments
  - Savings occur from the first treatment
- Outdoor water use
- Mechanism of water savings
- Effect of online account
- Comparison to other pilots

Messaging

- Learn from how subgroups respond to different types of messaging
- Example
  - Subgroup A: information about behavior
  - Subgroup B: information about retrofits
  - Subgroup C: information about both
- How do different type of households respond to different messages

Questions

- How can we measure if an individual household saved water?
  - Weather normalization
  - Creating bins, propensity score
  - This is the big one
  - Rolling 12 month average or median
- Where are the savings coming from?