Enduring effects of changes in billing frequency: Evidence from urban water use

> Casey J. Wichman Resources for the Future

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RESOURCES

Casey J. Wichman

Enduring effects of billing frequency

Motivation

For environmental policy, how robust is information provision as a regulatory instrument?

- Increasing reliance on non-pecuniary mechanisms for conservation
- Varying degrees of persistence

Previous work:

- One-time social norm treatments can have lasting implications (Bernedo, Ferraro, & Price, 2014)
- The impact of sustained treatments decline (slowly) over time (Allcott and Rogers, 2014)
- Moral suasion and economic incentives have diverging long-run implications (Ito et al., 2015)
- More frequent billing (pre-paid metering) may relax credit constraints (Jack and Smith, 2015)

Casey J. Wichman

This talk

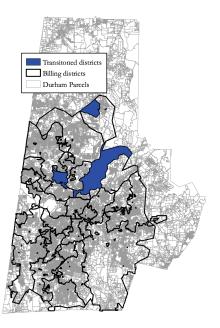
I exploit a natural experiment in water demand in which residential customers were transitioned from bi-monthly to monthly billing

- Water customers *increase* consumption 3-5% in response to more frequent billing
- Can be reconciled in model of misperceived consumption costs, where more frequent information allows consumers to optimize "better"
- Dynamic treatment effects suggest that responses persist, but decline slowly over time
- Lowest users increase by the largest percentage
- No evidence of heterogeneous responses by income class

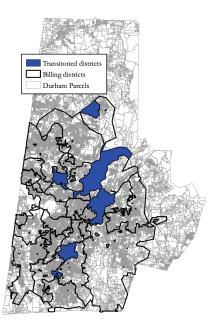
Data & empirical setting

Experimental setting in Durham, NC:

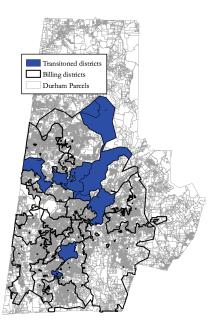
- Starting in Dec. 2011, water billing districts were individually transitioned from bi-monthly to monthly billing
 - Primary motivation: Delinquent payments, leak detection
 - Meter replacement
- By Sep. 2014, all of Durham's 17 billing districts were transitioned to monthly billing.



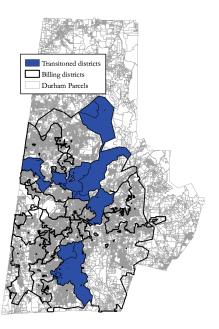
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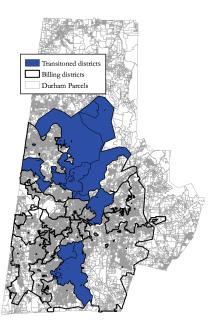
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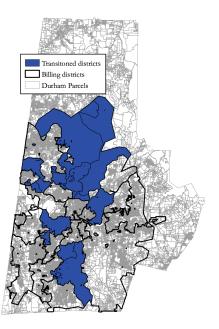
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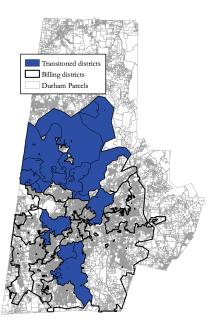
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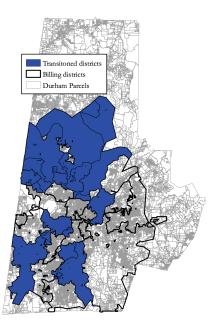
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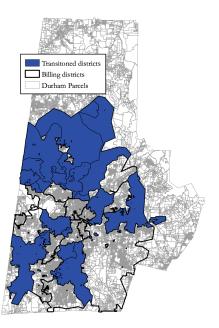
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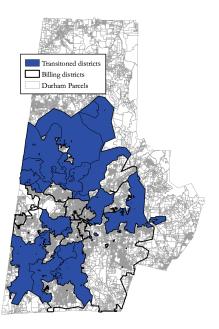
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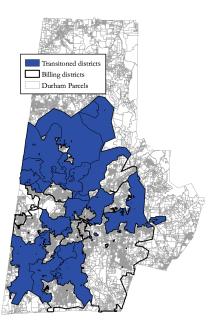
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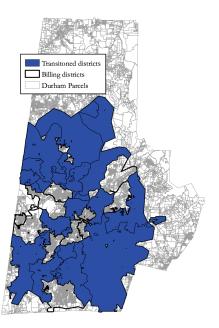
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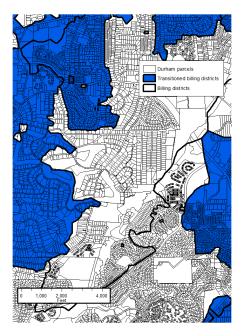
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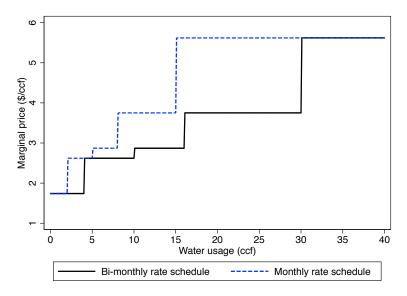
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Enduring effects of billing frequency

Account	Customer Name		Ser	vice Location	Apt/Unit	Bill Date 04/14/20
						04/14/20
WATER USAGE WATER SERVIC SEWER USAGE SEWER SERVIC	4/09/2014 UGHT FORWARD INSIDE CITY ZE FEE 5/8" MTR INSIDE CITY	\$80.91 \$80.91CR \$0.00 \$0.00 \$0.31 \$6.15 \$16.79 \$7.02 \$1.80	USAGE 2392 1914 1435 957 478 0 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	CONSUMPTION CONSUMPTION PER PER PER PER PER PER PER PER	IDD Iule remains in effect. Jurham OneCall at	
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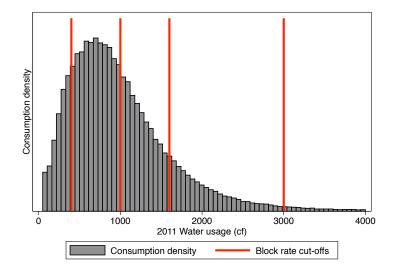
Enduring effects of billing frequency

Tiered rate schedule under (bi-)monthly billing



Casey J. Wichman

Bunching at kink points?



Casey J. Wichman

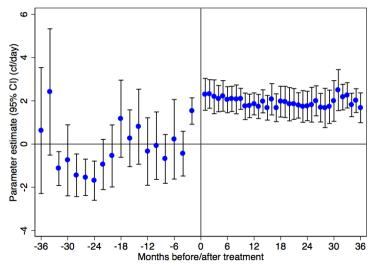
Enduring effects of billing frequency

Data & empirical setting

Residential water billing data:

- ${\sim}5.5$ years of billing records in Durham, North Carolina
 - Feb 2009 June 2015
 - \sim 59,000 households
- Matched with tax assessor data at parcel level
 - Assessed value of home, lot size, age, square footage
- 2010 Census block group demographics
 - Percent renters, racial composition, household size
- Weather variables from the NC State Climate Office
 - Daily maximum temperature, total rainfall

Event study



(Conditional on weather, and time and route fixed effects)

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Empirical framework

Spatial regression discontinuity, exploiting district boundaries, over time,

$$w_{ijt} = \alpha_i + \beta BF_{jt} + \gamma_D f(Dist_i) + \mathbf{X}'\gamma_1 + \mathbf{W}'\gamma_2 + \tau_t + \varepsilon_{ijt}$$

- w_{ijt} is daily water use at the household level $\implies \beta$ is a local average treatment effect (LATE) of increases in billing frequency on daily water consumption
- Avoids concerns of non-random selection into treatment
- Controls for unobserved changes in "neighborhood" characteristics over time
- Bandwidth of 500 feet from district boundary

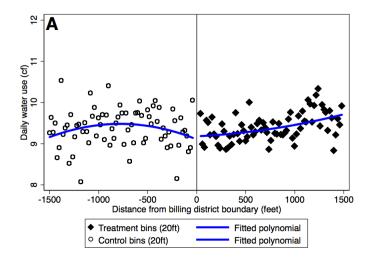
Re-estimate to obtain "dynamic" LATE,

$$\sum_{S=0}^{30} \beta_S \cdot \mathbb{1}(BF_{jt-S})$$

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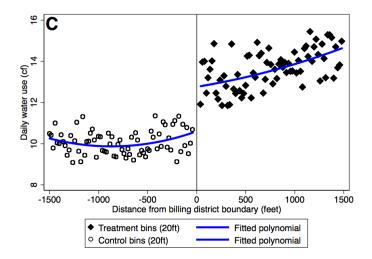
RD design (1 year before treatment)



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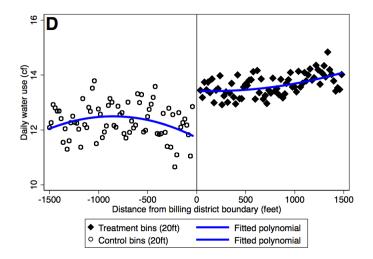
RD design (year after treatment)



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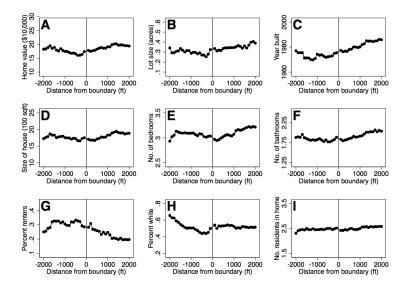
RD design (2 & 3 years after treatment)



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RD design (observables)

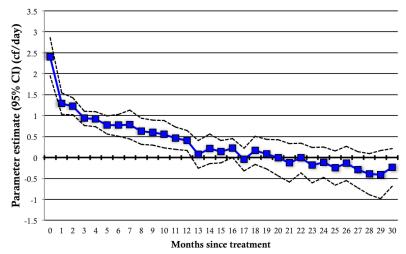


Main regression results

		<u> </u>	Spatial RD	
	Full sample	$<\!\!2000 {\rm ~ft}$	<1000 ft	${<}500~{\rm ft}$
BF_{ijt}	0.685^{**} (0.239)	0.581^{**} (0.237)	0.555^{**} (0.223)	0.541^{**} (0.213)
Household fixed effects?	Y	Y	Y	Y
Time fixed effects?	Υ	Υ	Υ	Υ
Weather covariates?	Υ	Υ	Υ	Υ
Observations	2,086,488	$1,\!642,\!061$	1,003,800	$539,\!601$
R-squared	0.030	0.030	0.029	0.028
Number of households	58,780	46,496	$28,\!535$	$15,\!412$

Dependent variable is daily water consumption in cubic feet. Robust standard errors in parentheses clustered at billing district level. *** p<0.01, ** p<0.05, * p<0.1.

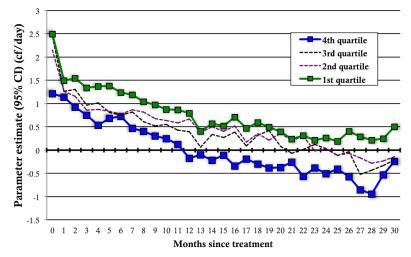
Dynamic average treatment effects



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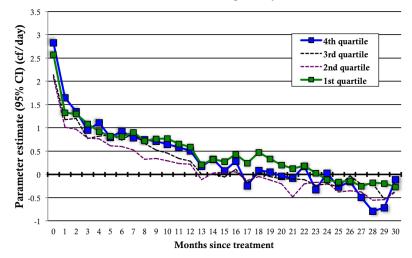
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Consumption heterogeneity



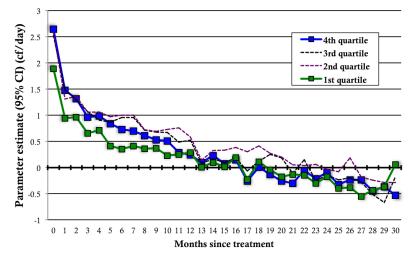
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"Wealth" heterogeneity



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Lot size heterogeneity



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Summary and implications

Main results:

- The average treatment effect masks important dynamic behavior.
- Dynamic treatment effects decrease over ${\sim}2$ years
- Consumers in the lowest quartile of consumption increase usage by the highest percentage.
 - \implies consumers responding to something other than price?
- No evidence of heterogeneity among proxies for wealth.
 - Little support that more frequent billing helps smooth consumption month to month.

Questions?



Thank you

wichman@rff.org

Casey J. Wichman

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