Environmental Externalities and Intrahousehold Inefficiencies

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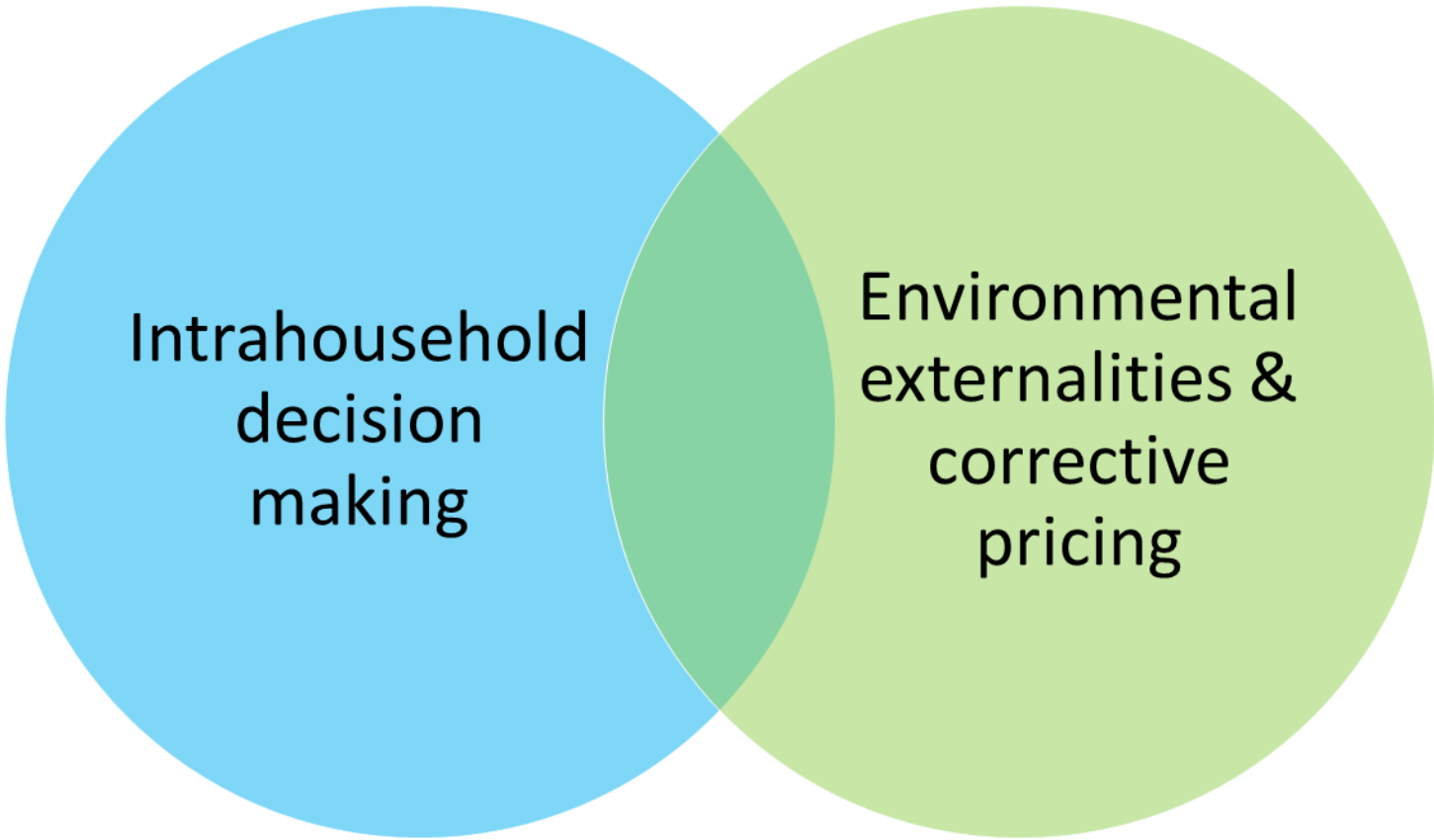
This paper = Chiappori + Pigou



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- Specific context: HHs in urban Zambia with piped water connections

Intrahousehold inefficiency

- Household achieves Pareto efficient outcomes in collective model
- But households might have limited information or limited enforcement, leading to inefficiency
- Our work fits into this part of literature
- Household cannot achieve optimal outcome even for themselves, and this exacerbates negative externality on the environment

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- Implication: More inefficient households are less price sensitive
  - Inefficient = internalizes less of externality due to (a) less observability (b) weaker enforcement (c) less altruism

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- For home water and electricity use, the price is applied to household consumption
- Pigouvian tax needs to correct for 2 externalities: (1) intrahh problem causes household to consume more than its first best (2) household's first best exceeds societally optimal consumption

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- Thus, the person who consumes most of the water has very weak incentives to conserve

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- Two other interventions
  - Information about price of water
  - Information on how water utility measures quantity and sets bills

Preview of results

- Consumption responds to price incentives: average short run price elasticity is -0.3
- Consumption response is larger among more efficient households:
  - Elasticity is 3 times as large for HHs with above-median efficiency compared to below median
- Price incentives are more effective if they target spouse that is not usually the residual claimant

Outline of rest of talk

- **Model of household decision making about water**
- Setting, study design, and data
- Empirical specification and results
- Next steps and conclusions

Model setup

- Non-cooperative decision: Nash equilibrium
- Individual i chooses own water use w_i, taking spouse's water use w_{-i} as given
- w_{-i} is not observable
- Water utility observes and bills for household consumption, $W = w_A + w_B$, and charges the household pW

Individual decision problem

- Bargaining weight λ_i
- Division of after-bill income: $\lambda_i(Y - pW)$
- Individual utility from water use and income for other consumption

$$v_i = f(w_i) + c = f(w_i) + \lambda_i(Y - pW)$$

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- α_i could also reflect contract enforcement (which we do not model)
- First order condition: $f'(w_i^*) = p(\lambda_i + \alpha_i \lambda_{-i})$
- Consume less water if
  - Larger residual claim on after-water income
  - More altruistic toward spouse

Effects of a price change

- Response to a change in p depends on α_i and λ_i
- **Result 1:** $\left|\frac{\partial w_i^*}{\partial p}\right|$ is increasing in α_i
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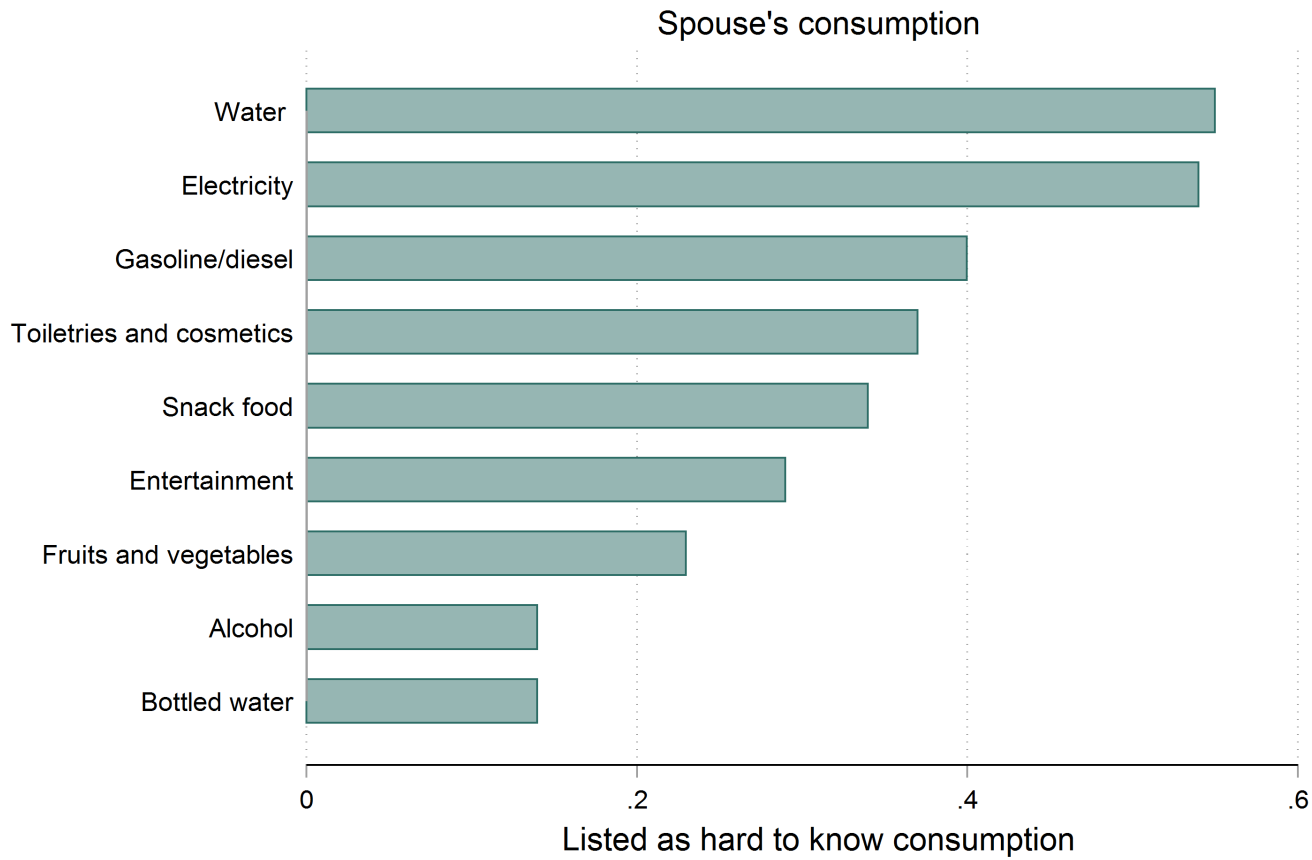
- There are also predictions on interactive effects (e.g., HH is more price sensitive if large water user is primary residual claimant)

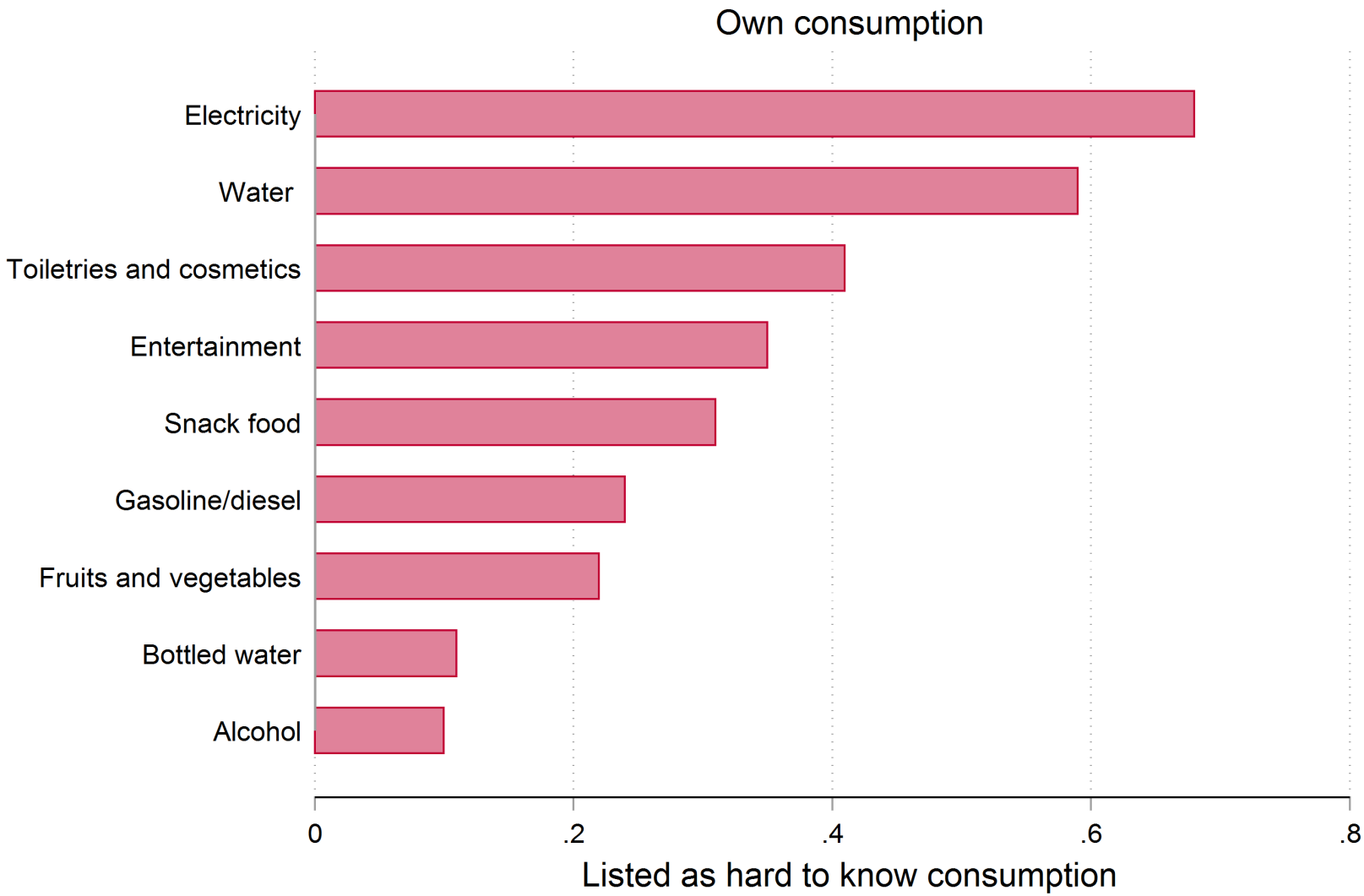
What's special about water?

Spouse's water consumption is difficult to observe

- mTurk survey of US couples (we are replicating it in Zambia)
- "Suppose you were trying to estimate your spouse/partner's consumption. Among the following categories, which 3 would you be LEAST confident in your estimate of the $ value for his or her consumption in a typical week?"



Own water consumption is also difficult to observe



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Study setting

- Study location: Livingstone, Zambia
- Collaborated with regional water utility, Southern Water and Sewerage Company (SWSC)
- Use their account data for sampling and outcome measure (water use)
- Water bill $\sim$5% monthly household expenditure for our sample, about 10 USD
  - US EPA's affordability threshold is 2% and UNDP's is 3%
- Water shortages during dry season

Sampling

- Used data as of April 2015
- Obtained monthly billing and payment records for all metered residential customers in Livingstone since 2012 (N=9800)
- Excluded households with suggestive evidence of meter tampering, very low or high users, those with large debts (N=7425)
- Screening visits to restrict sample to: (a) married couples, (b) tenancy $>$ 6 months, (c) non-shared meter (N=2051)
- Return visit to survey household; surveyed 1282 households
  - Include all screened households in analysis to improve precision $\rightarrow$ 6594 hh in analysis

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- Measure of intrahousehold altruism/efficiency: Dictator game with sharing multiplier between spouses

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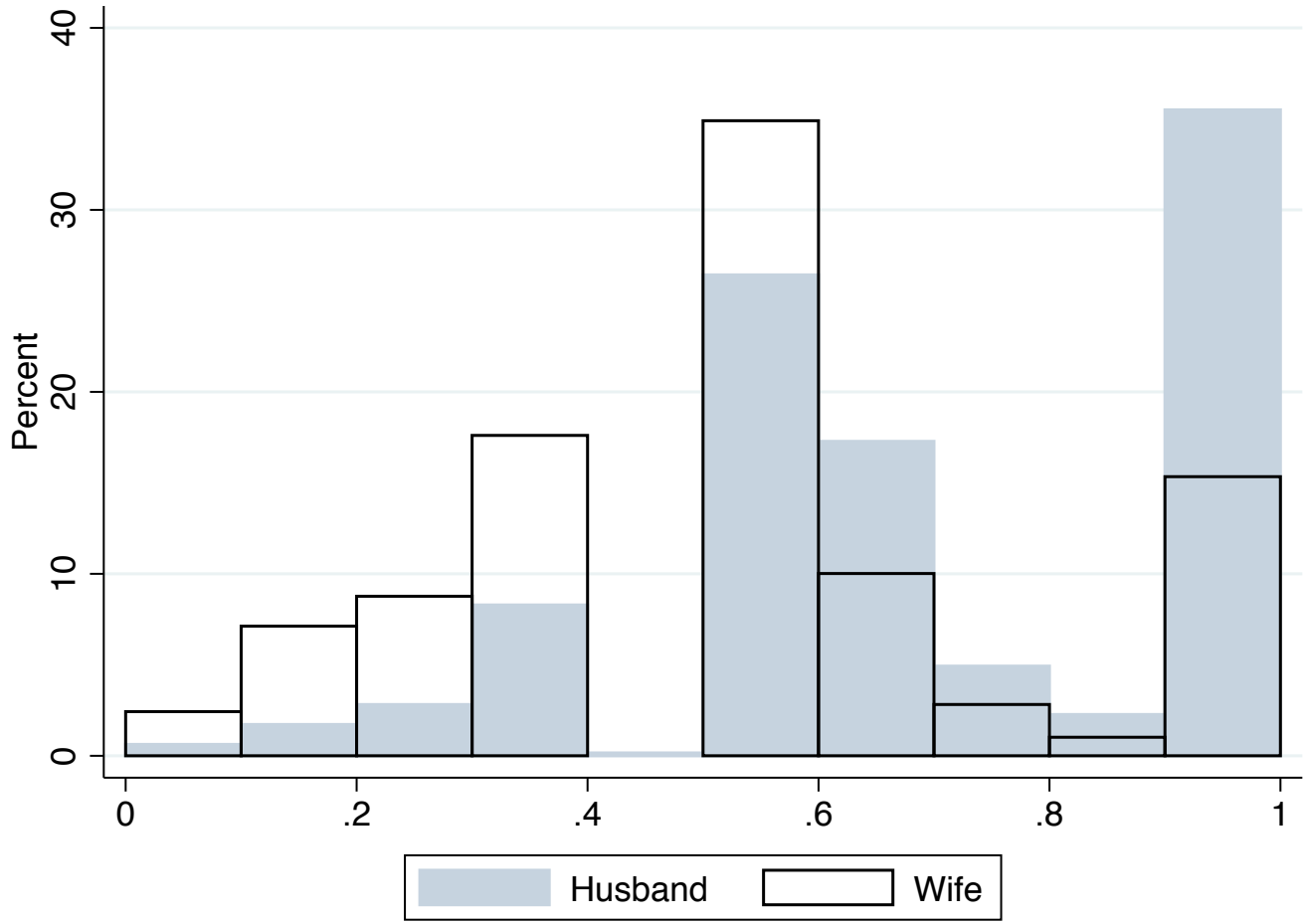
- Interpret share of endowment sent to spouse as a measure of α_i

Amount shared in dictator game



- Considerable variation in how much is sent
- Husbands send more on average than wives

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- Individual treatment: $v_i = f(w_i) + \lambda_i(Y - pW) + \underbrace{R \times \mathbf{1}(W < \overline{W})}_{\text{not multiplied by } \lambda_i}$

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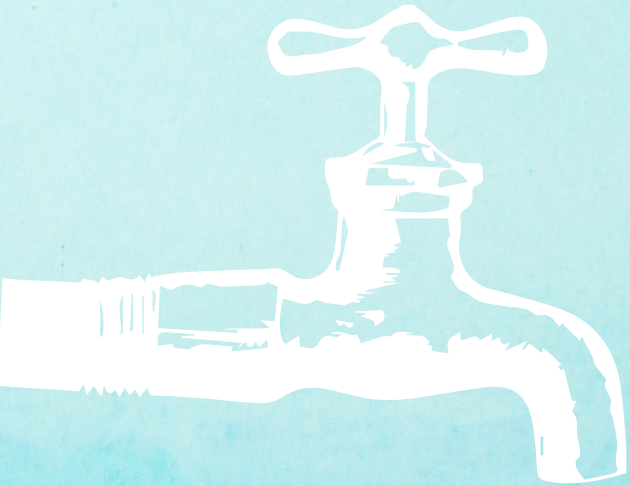
- All households that received price incentive also received price information (but not vice versa)
- Brought couple together at end and gave them this information



WANT TO SAVE MONEY ON YOUR MONTHLY WATER BILL?

NANGA MUFUNA KUCHEPESA NDALAMA ZIMENE MUMA LIPILA BILL YANU YA MANZI YAPA MWEZI?

TURN OFF THE TAP!
VALANI POPI YANU!

Save 10 Kwacha per month with 10 minutes less tap use per day.

Sungani K10 pamwezi paku chepesako 10 minetisi yosebenzesa tap yamanzi pa siku imodzi.

Save 20 Kwacha per month with 20 minutes less tap use per day.

Sungani K20 pamwezi paku chepesako 20 minetisi yosebenzesa tap yamanzi pa siku imodzi.

These reductions are for your entire household, not any particular individual. These are typical savings. Depending on your water pressure, your situation may be slightly different.

Uku kuchepesa nikwa nyumba yanu yonse osati muntu umodzi. Aka kachepesedwe nikapindu. Kulingana na mphamvu yakachokedwe ka manzi yanu, mbali yanu ingakale yosianako.

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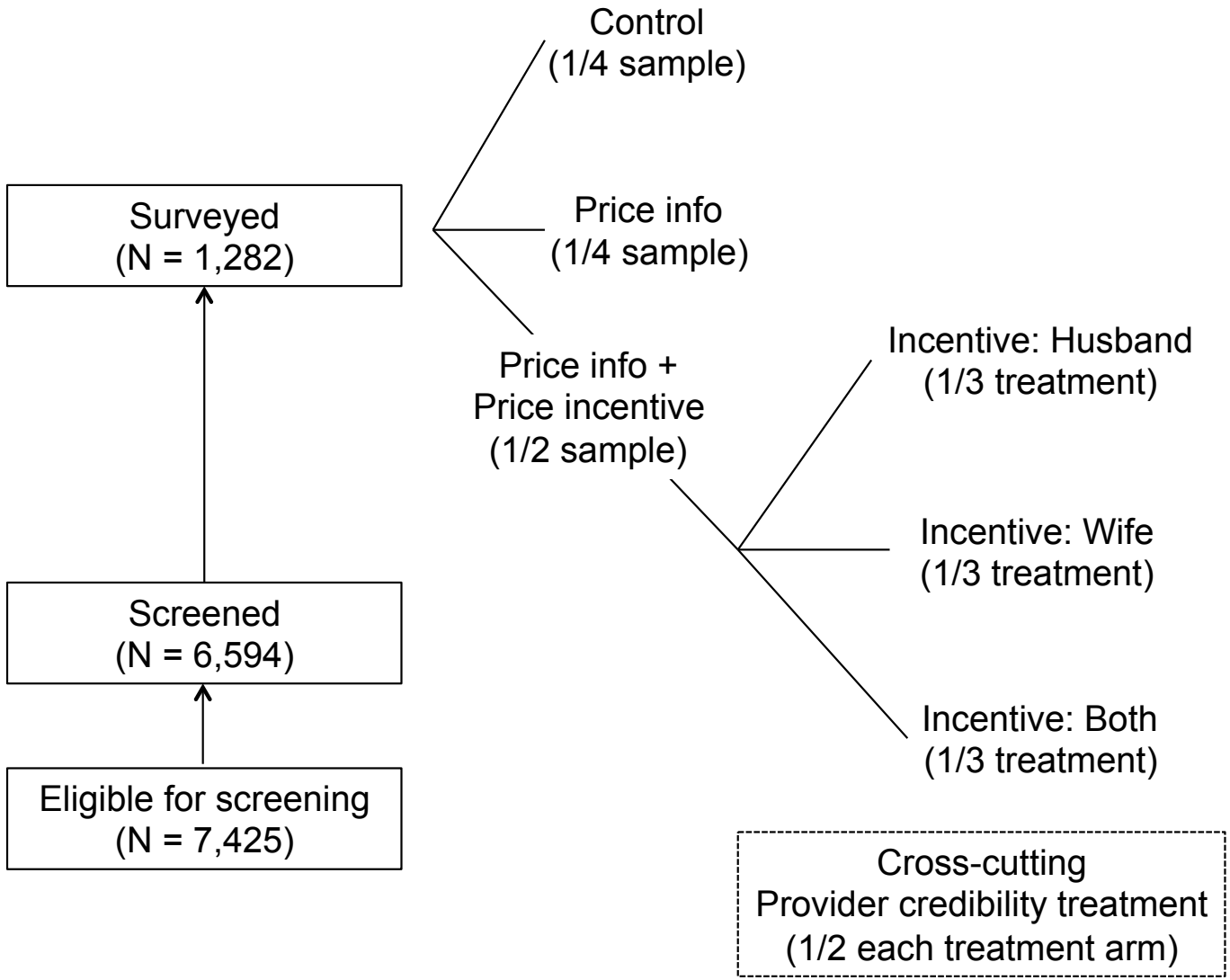
- Interesting hypothesis but intervention had no effect (cheap talk?)

Summary of study design



Outcome data

- Monthly water consumption in cubic meters from SWSC bills
- Household average usage is 20 cubic meters/month
- Based on physical water meter readings collected monthly between the 20th and 25th of each calendar month
- Keep only successful meter readings (i.e., drop months in which meter reading is estimated or meter reported as broken)
- Data from January 2012 through September 2016

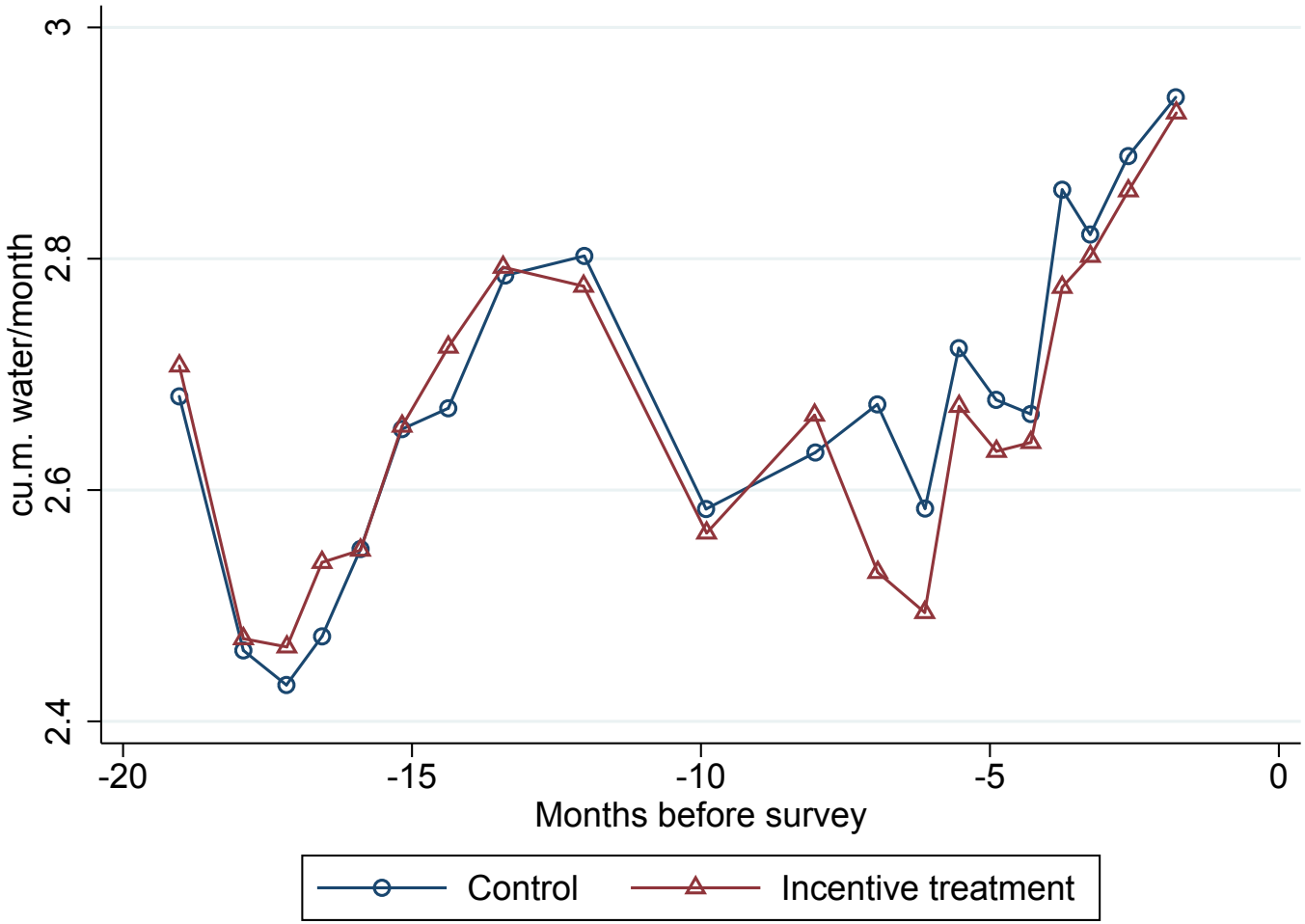
Sample characteristics

	Only screened HHs (1)	No incentive HHs (2)	Incentive HHs (3)	P-val (2)=(3) (4)
Quantity consumed	20.940	18.995	18.247	0.239
	(14.525)	(12.097)	(10.515)	
Any payment	0.738	0.764	0.769	0.566
	(0.195)	(0.166)	(0.166)	
Missing meter reading	0.137	0.100	0.112	0.210
	(0.188)	(0.157)	(0.170)	
Total monthly bill	99.848	92.925	87.309	0.124
	(88.152)	(69.044)	(60.949)	
Households	5312	664	618	

Sample characteristics

	No incentive HHs (1)	Incentive HHs (2)	P-val (1)=(2) (3)
Share sent to spouse by husband	0.702	0.690	0.398
	(0.269)	(0.254)	
Share sent to spouse by wife	0.520	0.513	0.597
	(0.262)	(0.260)	
W: Residual claimant	0.307	0.316	0.749
	(0.462)	(0.465)	
W: Bigger user	0.795	0.838	0.047
	(0.404)	(0.369)	
Households	664	618	

Pre-intervention water use



Outline

- Model of household decision making about water
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- **Empirical specification and results**
- Next steps and conclusions

Regression model

- Estimating equation:

$$\begin{aligned} y_{it} &= \alpha + \beta_1 PriceIncentive_{it} + \beta_2 PostSurvey_{it} \\ &\quad + \delta_1 PriceInfo_{it} + \delta_2 BillingCredibility_{it} + \gamma_i + \tau_t + \epsilon_{it} \end{aligned}$$

- $PriceIncentive_{it}$ equals 1 for treated HHs after survey/intervention
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- γ_i are HH fixed effects; τ_t are year-month FEs

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- Cluster standard errors by household

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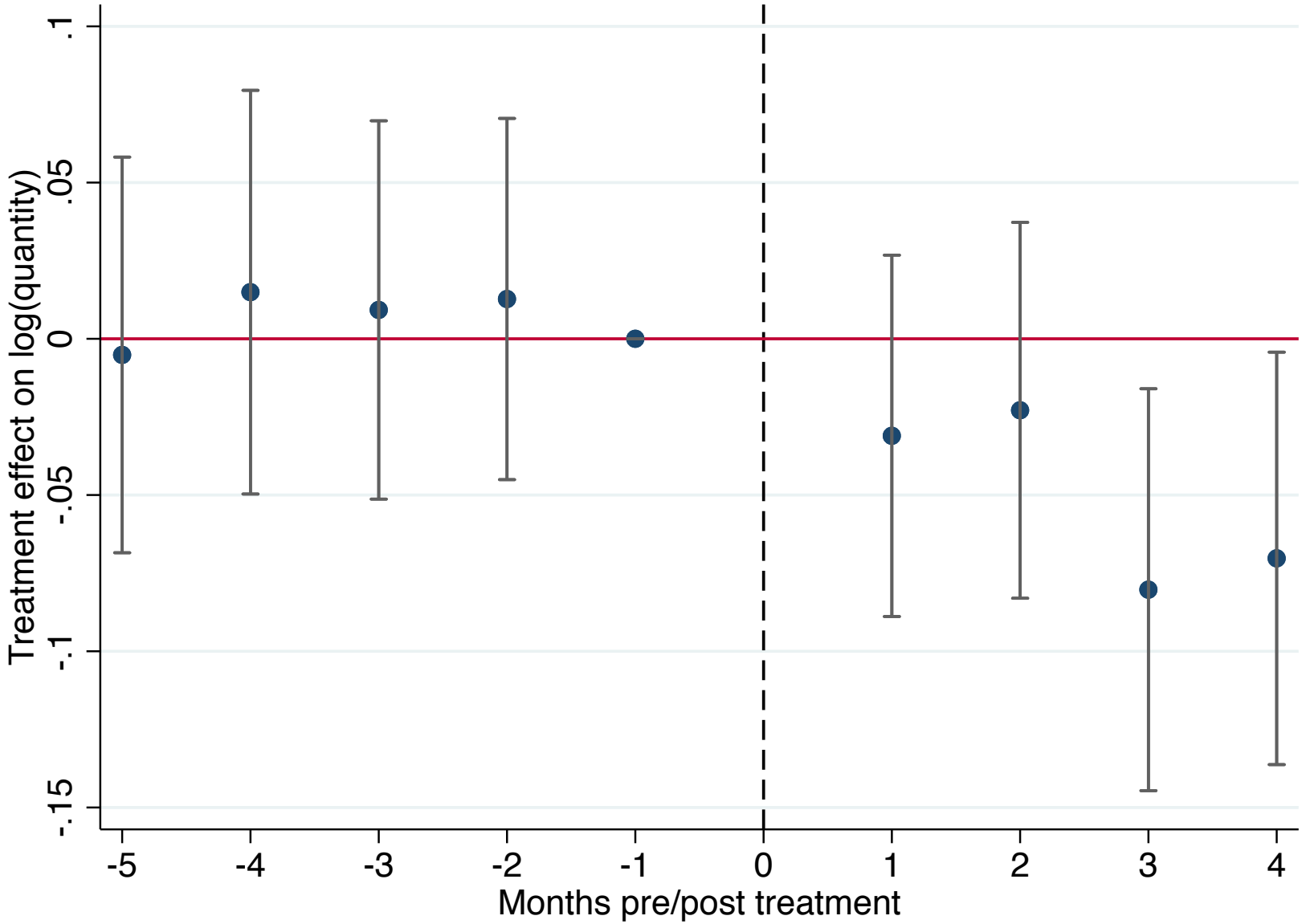
- Effect is larger for more efficient households, i.e., those with more sharing in the dictator game
- Effect is larger if person-specific incentive is directed toward:
  - Spouse who is not usually the residual claimant
  - Spouse who is the larger water user

Price incentive average effect

Outcome: log (quantity)	(1)	(2)	(3)
Assigned incentive x Post	-0.076***	-0.068***	-0.067***
	[0.026]	[0.025]	[0.025]
Survey sample x Post	0.054***	0.033*	0.022
	[0.019]	[0.018]	[0.018]
Assigned incentive treatment	-0.009		
	[0.033]		
Survey sample	-0.087***		
	[0.025]		
HH FE		x	x
Month-Year FE			x
Observations (HH)	6,594	6,594	6,594
Observations (HH-months)	129,899	129,899	129,899

Implied price elasticity: -0.28

Price incentive effect



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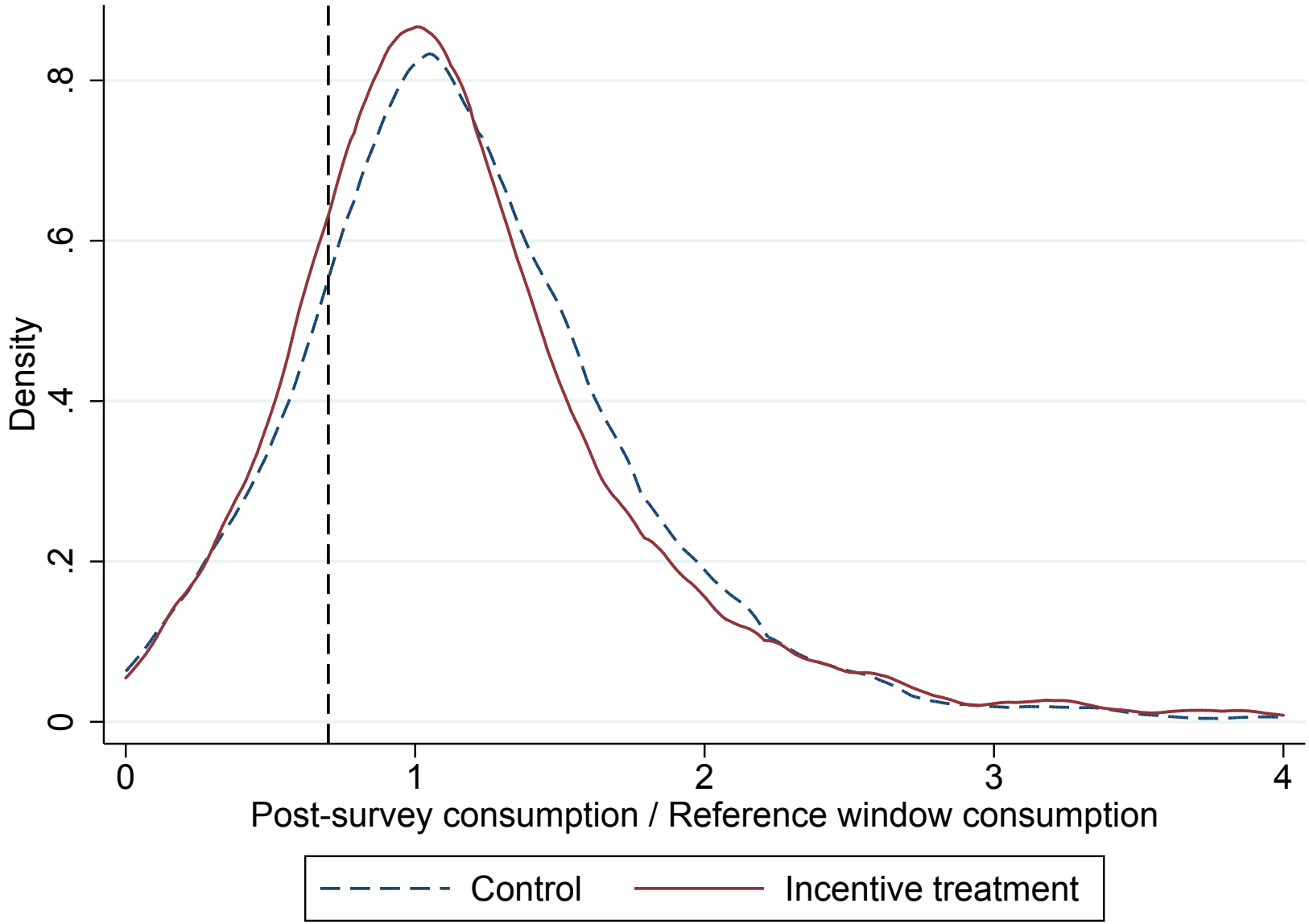
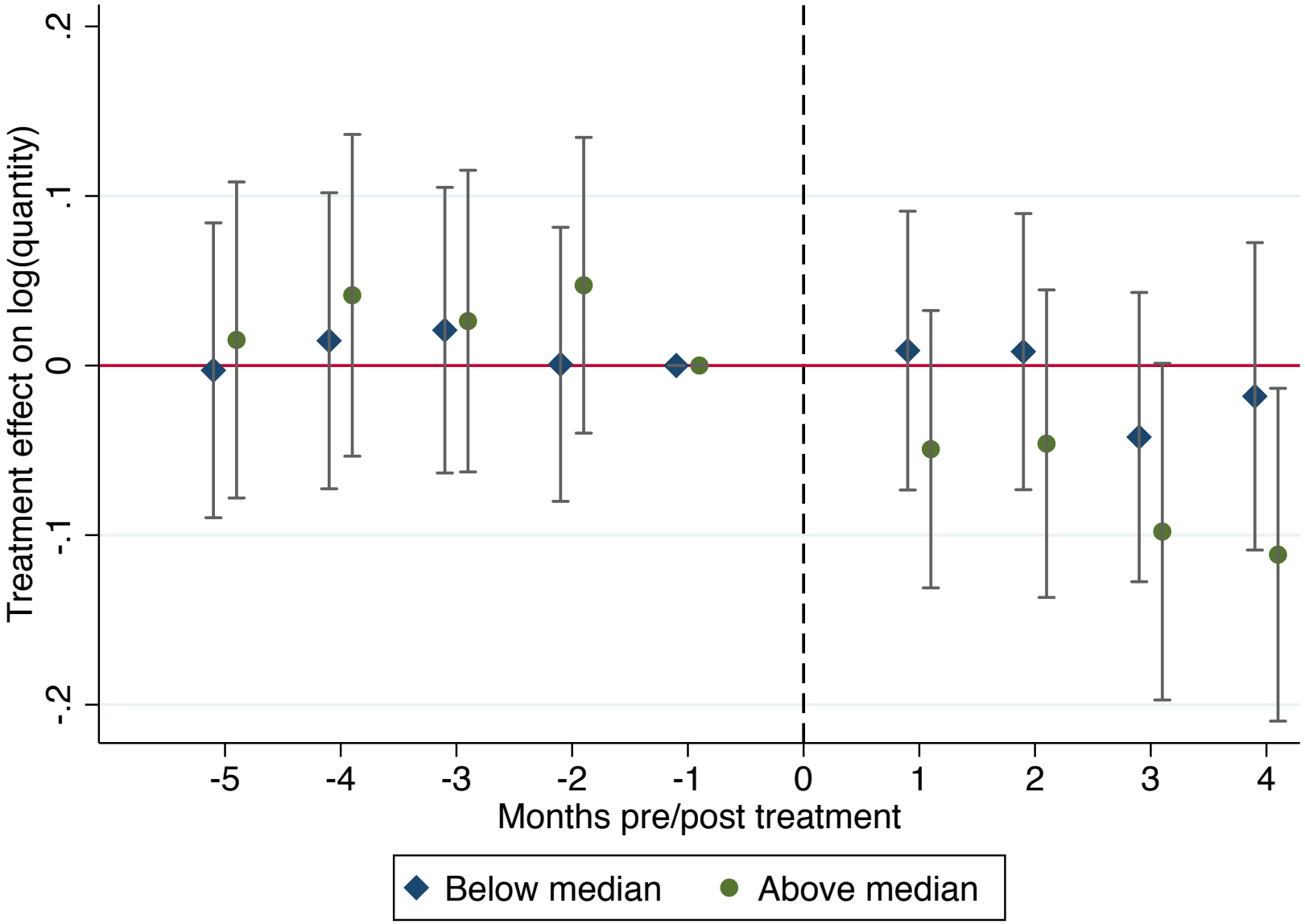


Heterogeneity by intrahousehold efficiency

Outcome: log (quantity)	(1)	(2)	(3)
Incentive treatment	-0.034	-0.058*	-0.093**
	[0.032]	[0.033]	[0.044]
Incentive x Sent above median on average	-0.071		
	[0.050]		
Incentive x Husband sent above median		-0.022	-0.011
		[0.051]	[0.066]
Incentive x Wife sent above median		-0.003	-0.079
		[0.058]	[0.075]
Total effect	-0.105***		
	[0.038]		
Total effect, husband		-0.079*	-0.104*
		[0.043]	[0.055]
Total effect, wife		-0.061	-0.172**
		[0.055]	[0.072]
Sample	Full	Full	Gender roles
Observations (HH)	6,587	6,587	6,038
Observations (HH-months)	129,775	129,775	118,452

Heterogeneity by intrahousehold efficiency



Price incentives for man, woman, and couple

Outcome: log (quantity)	(1)
Couple incentive	-0.050
	[0.041]
Husband incentive	-0.043
	[0.037]
Wife incentive	-0.095**
	[0.037]
Observations (HH)	6,594
Observations (HH-months)	129,899

Heterogeneity by residual claimant and big water user

Outcome: log (quantity)	(1)	(2)	(3)	(4)
Individual incentive	-0.030	-0.054	-0.026	-0.024
	[0.033]	[0.033]	[0.035]	[0.036]
Incentive to non-resid claimant	-0.091**		-0.087*	-0.084*
	[0.043]		[0.046]	[0.046]
Incentive to bigger user		-0.045	-0.013	
		[0.043]	[0.046]	
Wife incentive				-0.018
				[0.046]
Total effect claimant	-0.121***		-0.113**	-0.108**
	[0.035]		[0.046]	[0.048]
Total effect user		-0.099***	-0.039	
		[0.036]	[0.048]	
Observations (HH)	6,412	6,412	6,412	6,412
Observations (HH-months)	126,136	126,136	126,136	126,136

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  - Husband is responsible for fixing leaky faucets
  - Existing norm hasn't been updated as the environment has changed

Heterogeneity by observability

Outcome: log (quantity)	(1)	(2)	(3)
Incentive treatment	-0.055**	-0.038	-0.054
	[0.027]	[0.030]	[0.034]
Incentive x Know bill quantity	-0.081		
	[0.068]		
Incentive x Know spouse's water use		-0.080	
		[0.051]	
Incentive x Observability PCA			-0.028
			[0.049]
Total effect	-0.137**	-0.118***	-0.081**
	[0.063]	[0.041]	[0.035]
Observations (HH)	6,594	6,594	6,594
Observations (HH-months)	129,899	129,899	129,899

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  - Findings beg question of why couples don't give the woman more residual claim on water expenses
- Discussion of normative implications
  - Pigouvian tax helps HHs fix intraHH inefficiency
  - But, due to their high water use, they have marginal utility of income so tax hurts more

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- Transactions for water and electricity are with the HH, not individual
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  - In-kind household rewards that are especially valued by women
  - Make HH-level water usage more observable, e.g., easy-to-access high-frequency usage data
- Solving intraHH frictions might be easier/better than very high prices
- Or, Pigouvian taxes need to be set especially high in settings where intraHH frictions are large

Backup slides

Dictator game correlates

	Husband share sent (1)	Wife share sent (2)	Sent above median (3)
H: Share NGO	0.192***	0.079***	0.262***
	(0.030)	(0.030)	(0.057)
W: Share NGO	0.034	0.198***	0.269***
	(0.033)	(0.033)	(0.063)
W: Residual claimant	0.003	0.001	0.013
	(0.016)	(0.016)	(0.030)
W: Bigger water user	0.003	-0.006	-0.000
	(0.019)	(0.019)	(0.036)
Household size	-0.004	-0.009***	-0.015**
	(0.003)	(0.003)	(0.006)

Dictator game correlates

	Husband share sent (1)	Wife share sent (2)	Sent above median (3)
HH assets	0.008***	0.018***	0.030***
	(0.003)	(0.003)	(0.005)
HH english fluency	0.022	0.082***	0.112***
	(0.017)	(0.017)	(0.033)
Either underestimated price	0.009	0.017	0.033
	(0.017)	(0.017)	(0.032)
Both blame high bill on SWSC	0.012	0.016	0.000
	(0.015)	(0.015)	(0.028)

Robustness check: Endogeneity of intrahousehold efficiency

Outcome: log (quantity)	(1)	(2)	(3)
Incentive x Sent above median	-0.071		-0.060
	(0.050)		(0.052)
Incentive x Sent above median to NGO	-0.069	-0.037	-0.034
	(0.049)	(0.050)	(0.050)
Incentive x Above median SDB score	0.034	0.024	0.030
	(0.049)	(0.050)	(0.050)
Incentive x Household size	-0.005	-0.006	-0.006
	(0.011)	(0.011)	(0.011)
Incentive x Maid	-0.046	-0.003	-0.001
	(0.068)	(0.069)	(0.069)
Incentive x HH assets	-0.017*	-0.015	-0.013
	(0.009)	(0.010)	(0.011)
Observations (HH)	6,587	6,587	6,587
Observations (HH-months)	129,775	129,775	129,775

Price info and SWSC credibility interventions

Outcome: log (quantity)	(1)	(2)
Info treatment	-0.012	
	[0.055]	
Info treatment x Underestimated price	-0.020	
	[0.073]	
Provider credibility treatment		0.005
		[0.033]
Provider credibility x Distrust billing		0.046
		[0.049]
Total effect	-0.032	0.050
	[0.048]	[0.036]
HH FE	x	x
Month-year FE	x	x
Observations (HH)	6,337	6,594
Observations (HH-months)	124,826	129,899

Robustness check: Other margins of adjustment

	Any pay	Missing quant
	(1)	(2)
Incentive	0.011	-0.005
	[0.014]	[0.008]
Surveyed	0.002	0.010
	[0.014]	[0.007]
Observations (HH)	6,594	6,594
Observations (HH-months)	140,431	152,971