The Role of Goals in Motivating Behavior:

Evidence from a field experiment on resource conservation

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Goal setting to foster resource conservation?

Goal setting can motivate individuals to exert higher effort

- many studies in psychology and (some) in economics
- digitization creates new opportunities

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Our field experiment: **water conservation** in an everyday activity

- goals and feedback through a smart meter display
- 525 households in Singapore
- 4 to 6 months study duration
- exogenous variation of goal difficulty

Water conservation in Singapore

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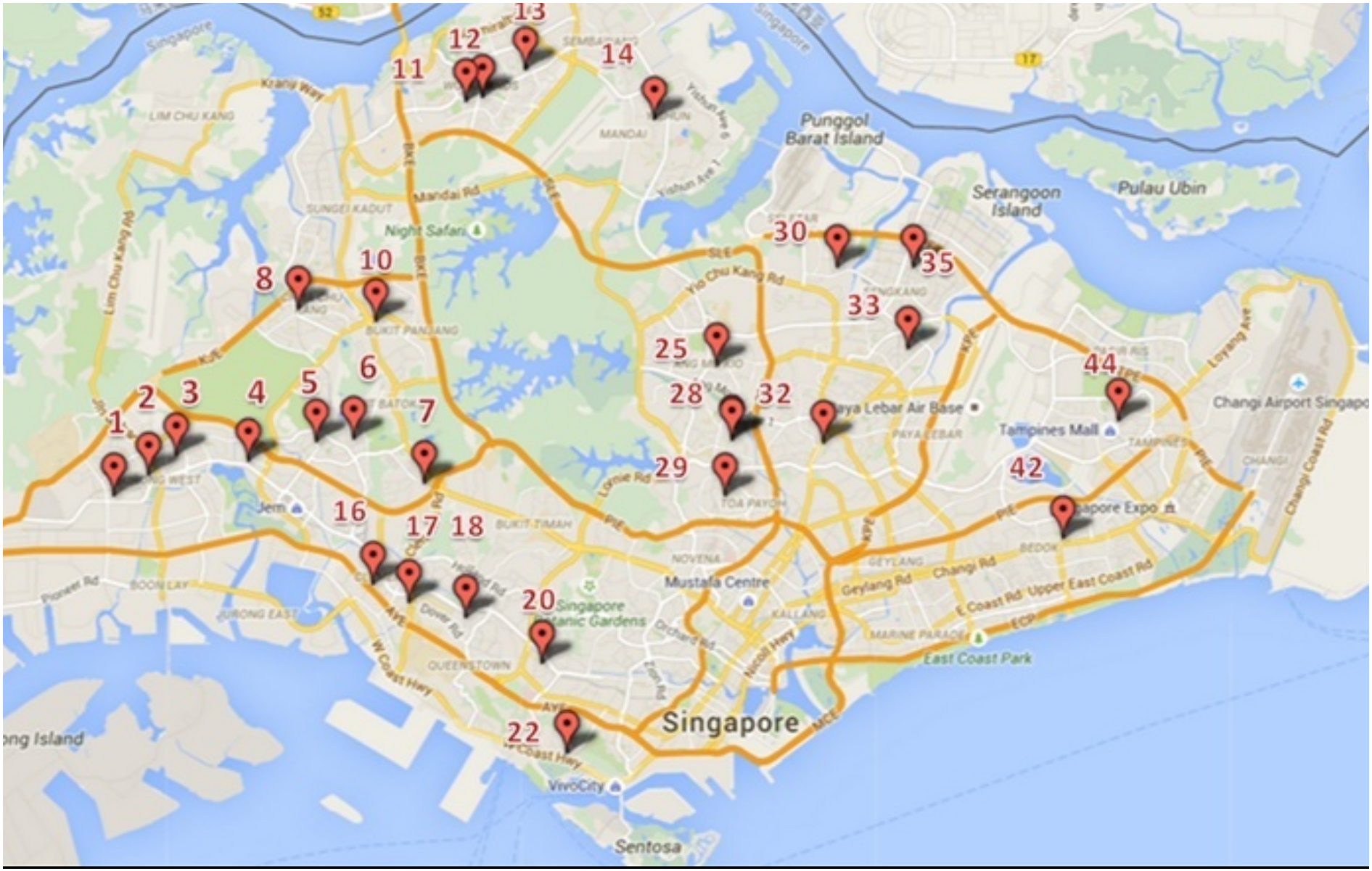
Showering is a **water intensive** activity.

Showering is prone to **behavioral biases**

- benefits are immediate and salient
- costs are abstract and vague

The field experiment



The field experiment

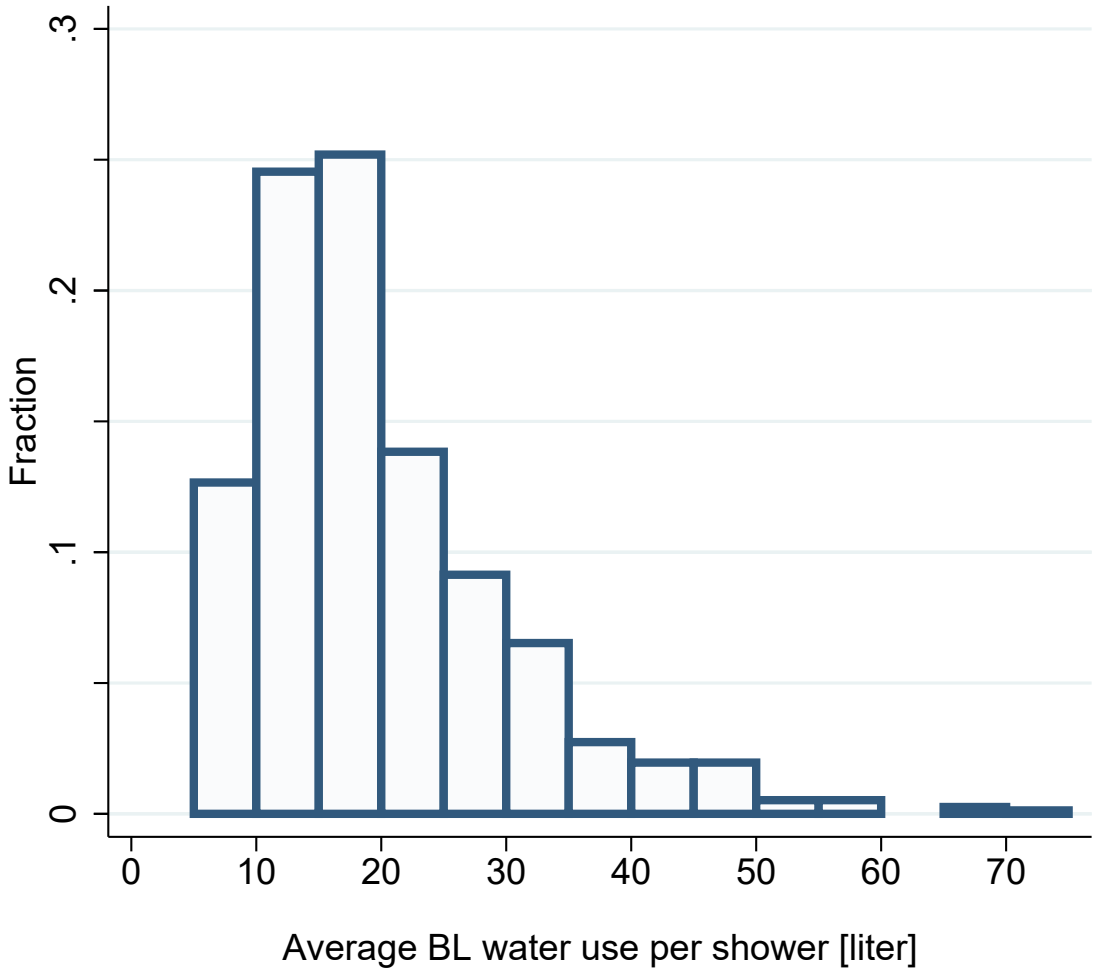
Seven experimental conditions

Households receive **smart shower meters** that measure water use

- Control group: display only shows water temperature.
- Real-time feedback: First 20 showers: water temperature. Then real-time feedback on water use (no goals).
- Real-time feedback + goals: First 20 showers: water temperature. Then real-time feedback *plus* goals (10, 15, 20, 25, or 35 liter).

Goal conditions range from hard to easy

Figure: Histogram of BL water use

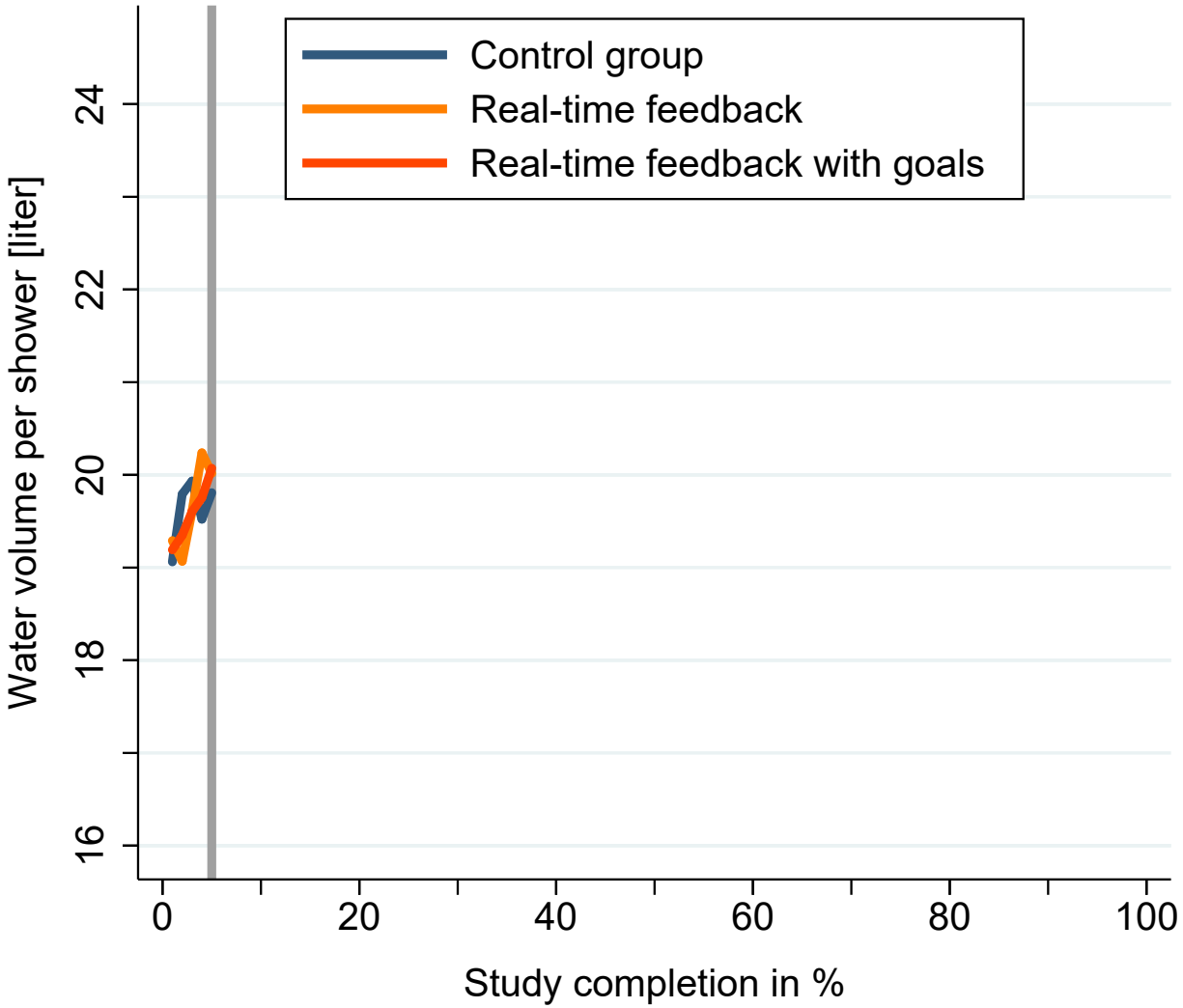


Five goal conditions:

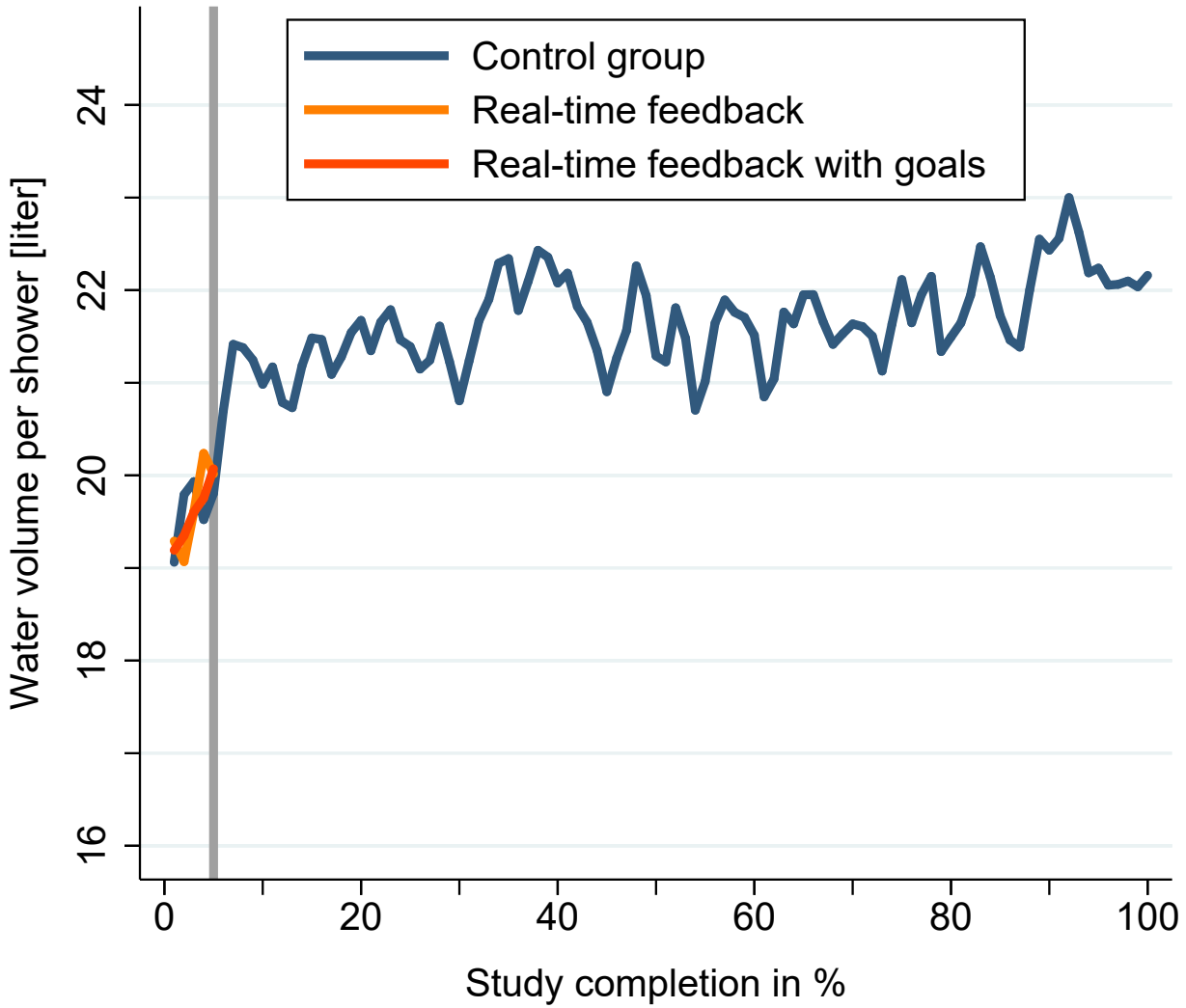
- 10 liter
- 15 liter
- 20 liter
- 25 liter
- 35 liter

▸ shower level

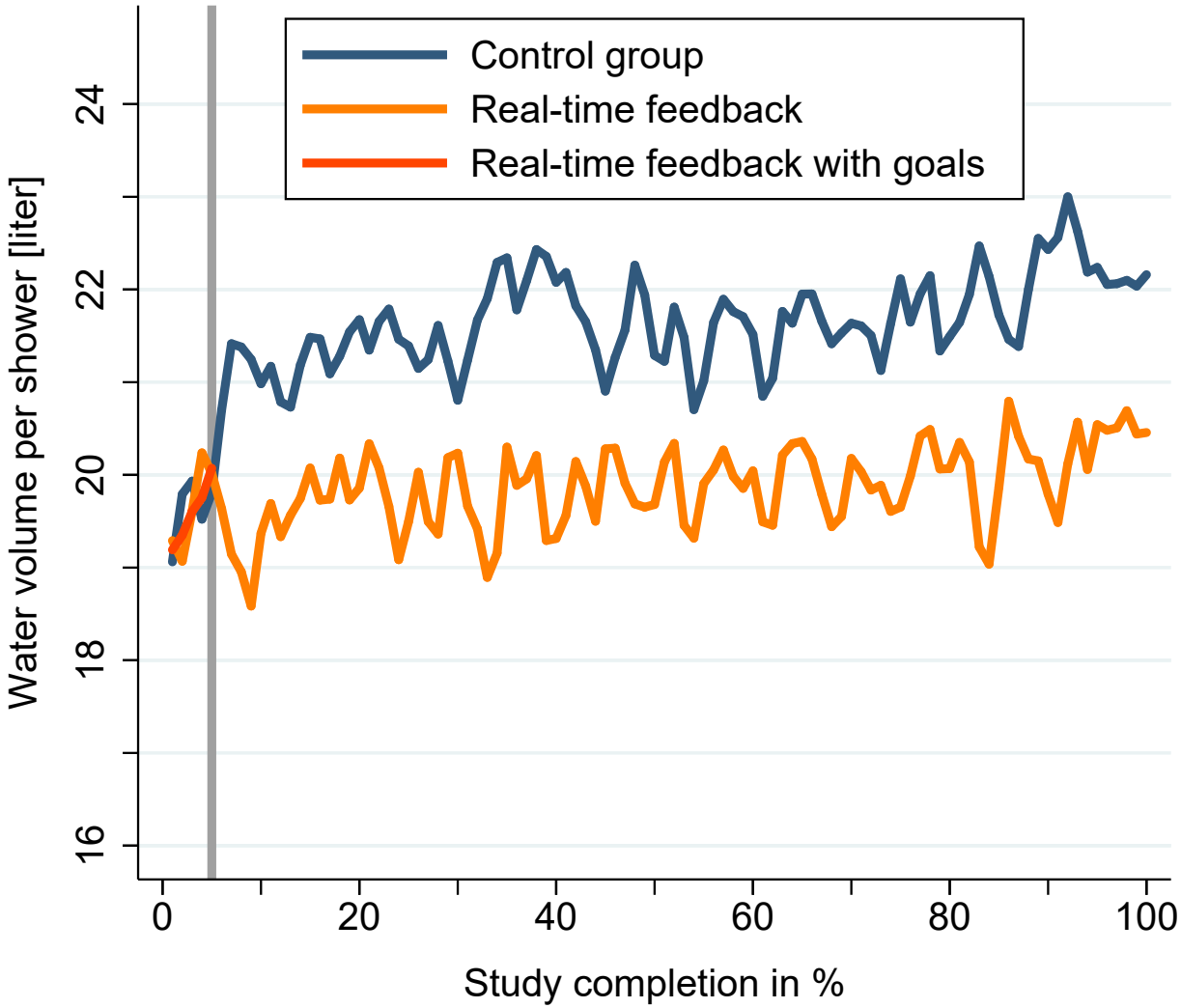
Water conservation effects over time



Water conservation effects over time



Water conservation effects over time



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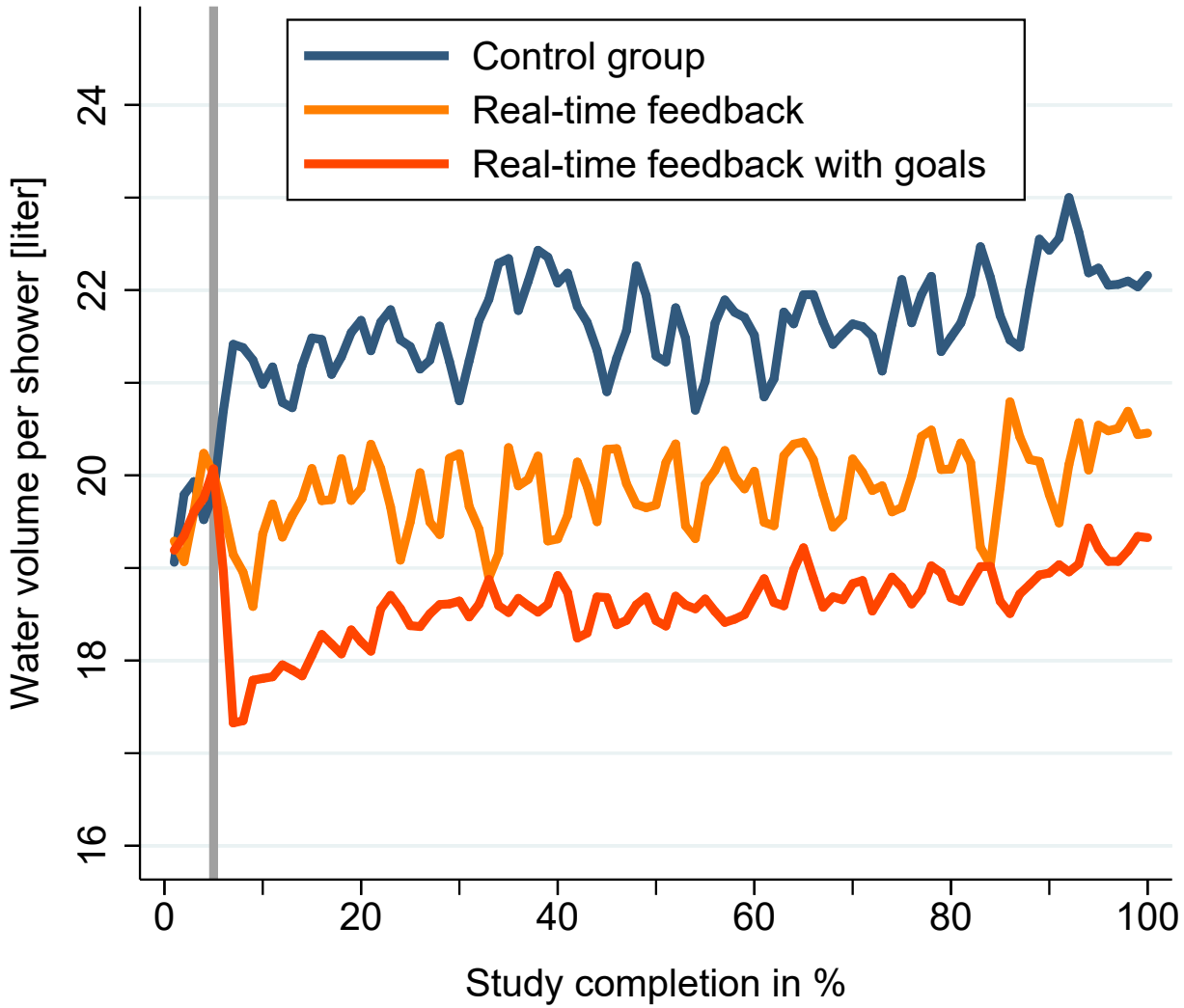
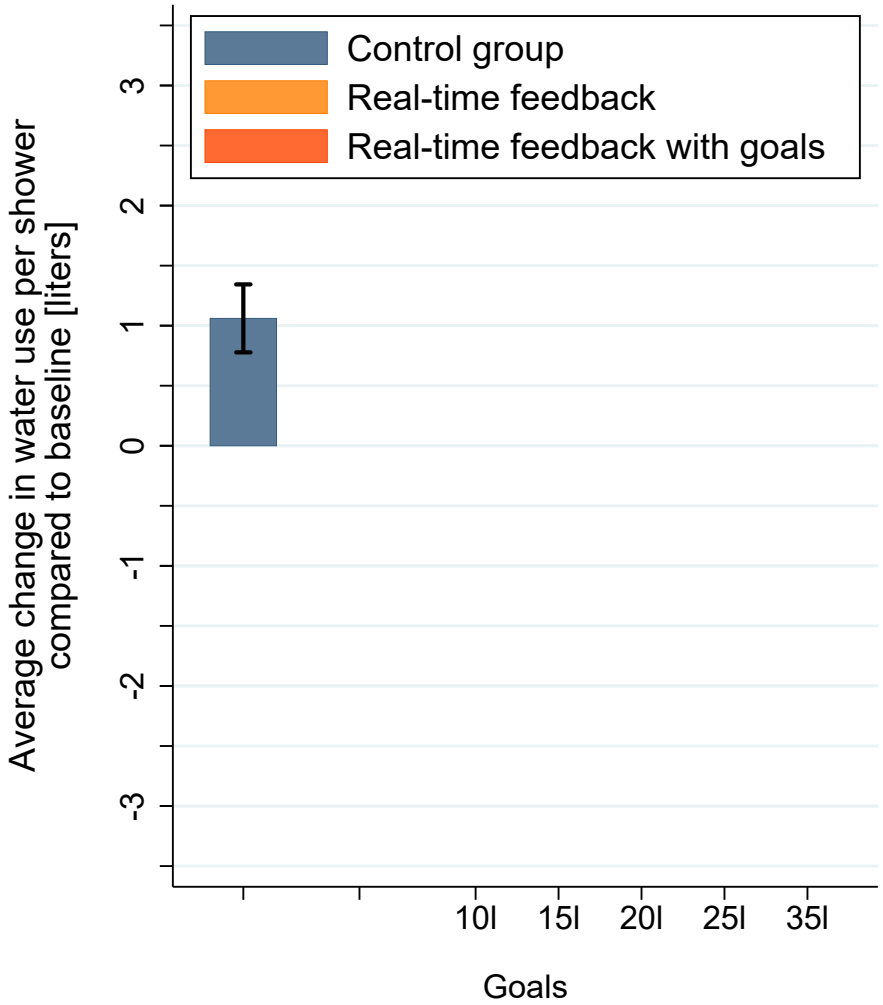


The impact on water consumption

Difference-in-differences analysis of the treatments



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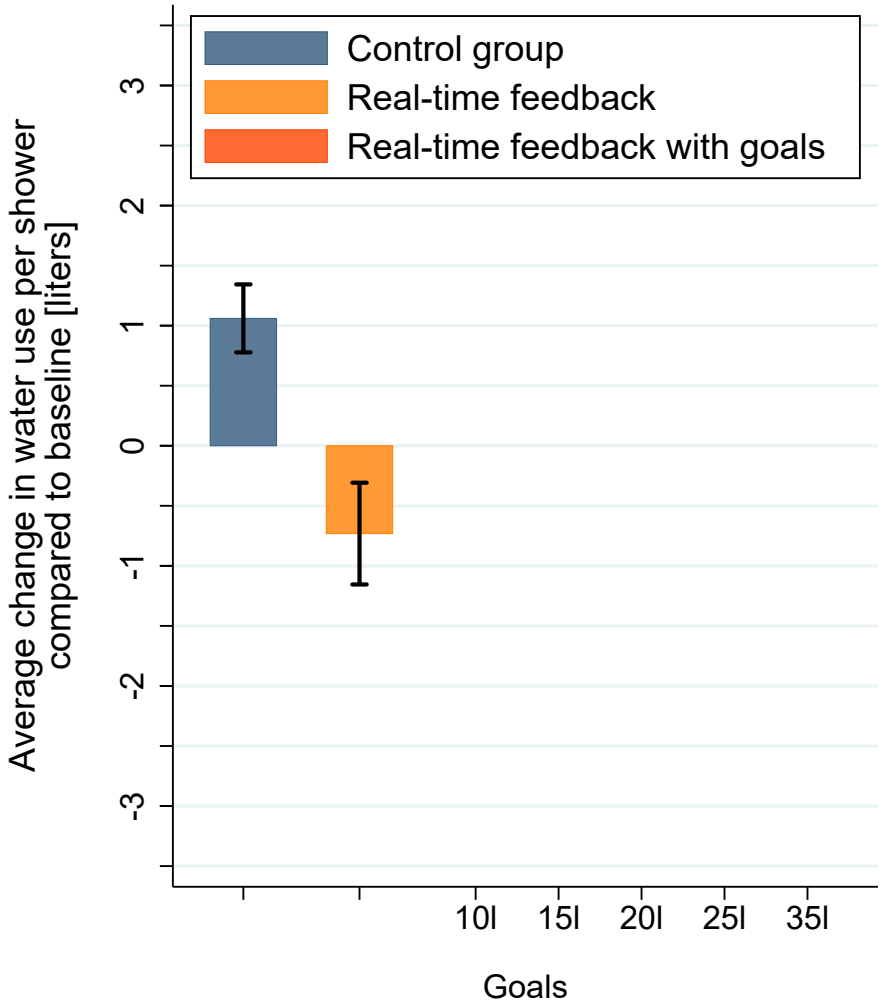

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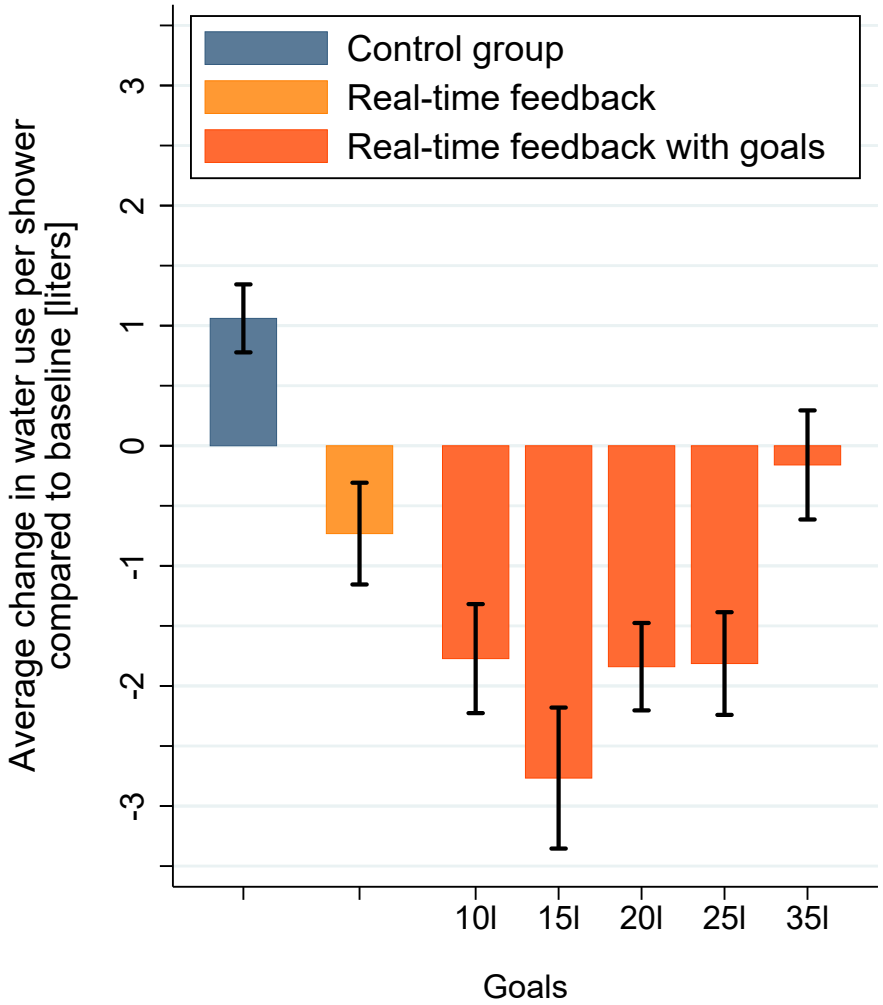
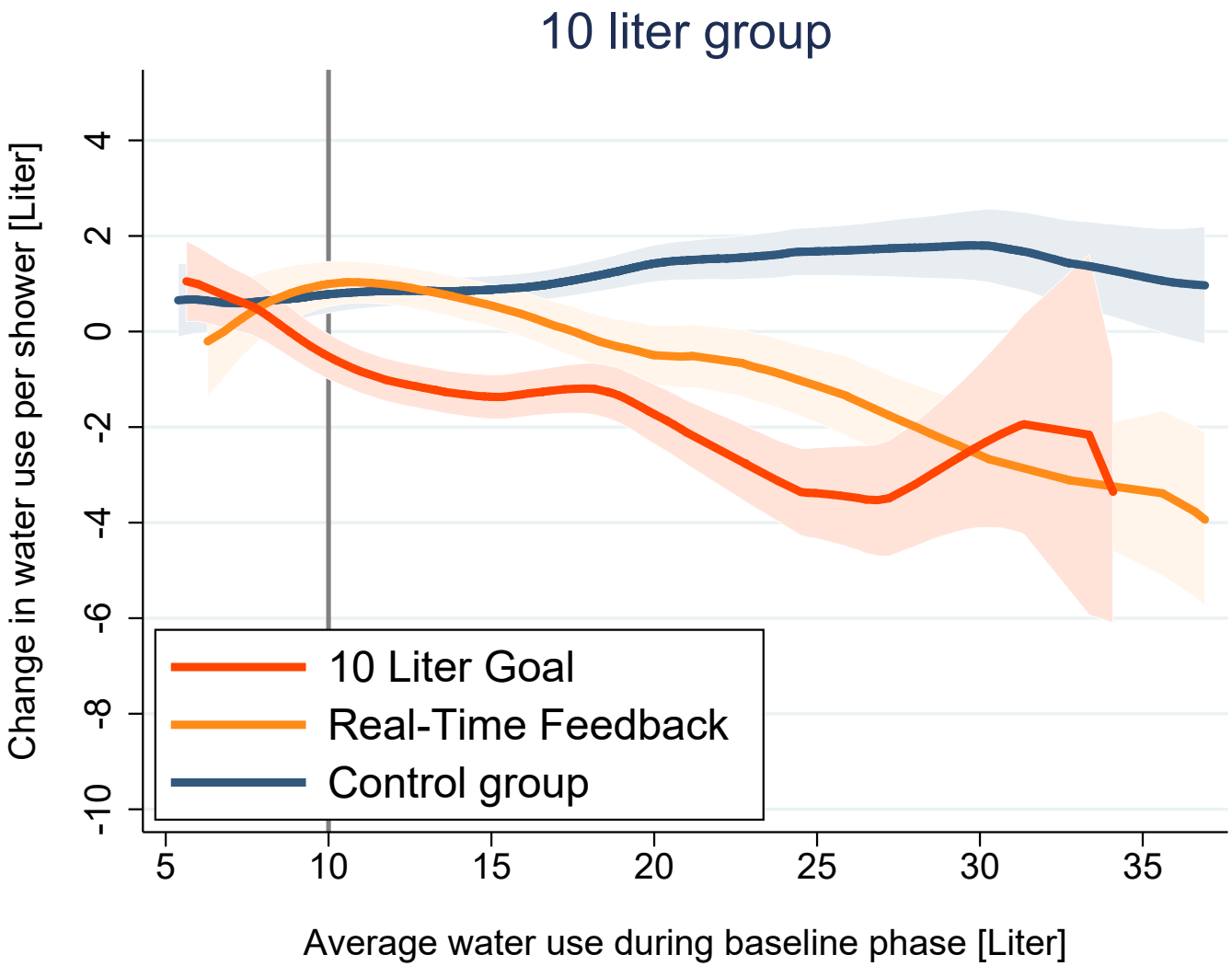


Average treatment effects

	Volume [liter]	Duration [sec]	Flow rate [liter/min]	Temperature [Celsius]
10l goal × intervention	-2.876***	-34.249***	-0.056	0.057
	(0.563)	(7.081)	(0.071)	(0.248)
15l goal × intervention	-3.815***	-36.540***	-0.215**	0.341
	(0.634)	(7.389)	(0.097)	(0.253)
20l goal × intervention	-2.901***	-28.237***	-0.119	0.198
	(0.461)	(6.065)	(0.080)	(0.255)
25l goal × intervention	-2.871***	-26.963***	-0.096	-0.011
	(0.530)	(6.783)	(0.069)	(0.316)
35l goal × intervention	-1.290**	-12.369*	-0.010	0.002
	(0.542)	(6.399)	(0.072)	(0.319)
RTF × intervention	-1.763***	-20.144***	0.010	0.050
	(0.483)	(5.630)	(0.069)	(0.287)
Intervention	1.091***	5.158	0.133**	-0.027
	(0.287)	(3.514)	(0.055)	(0.231)
Bathroom FEs	*Yes*	*Yes*	*Yes*	*Yes*
Observations	314608	286732	286732	286732
R^2	0.331	0.297	0.859	0.561

Standard errors clustered at household level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Heterogenous treatment effects



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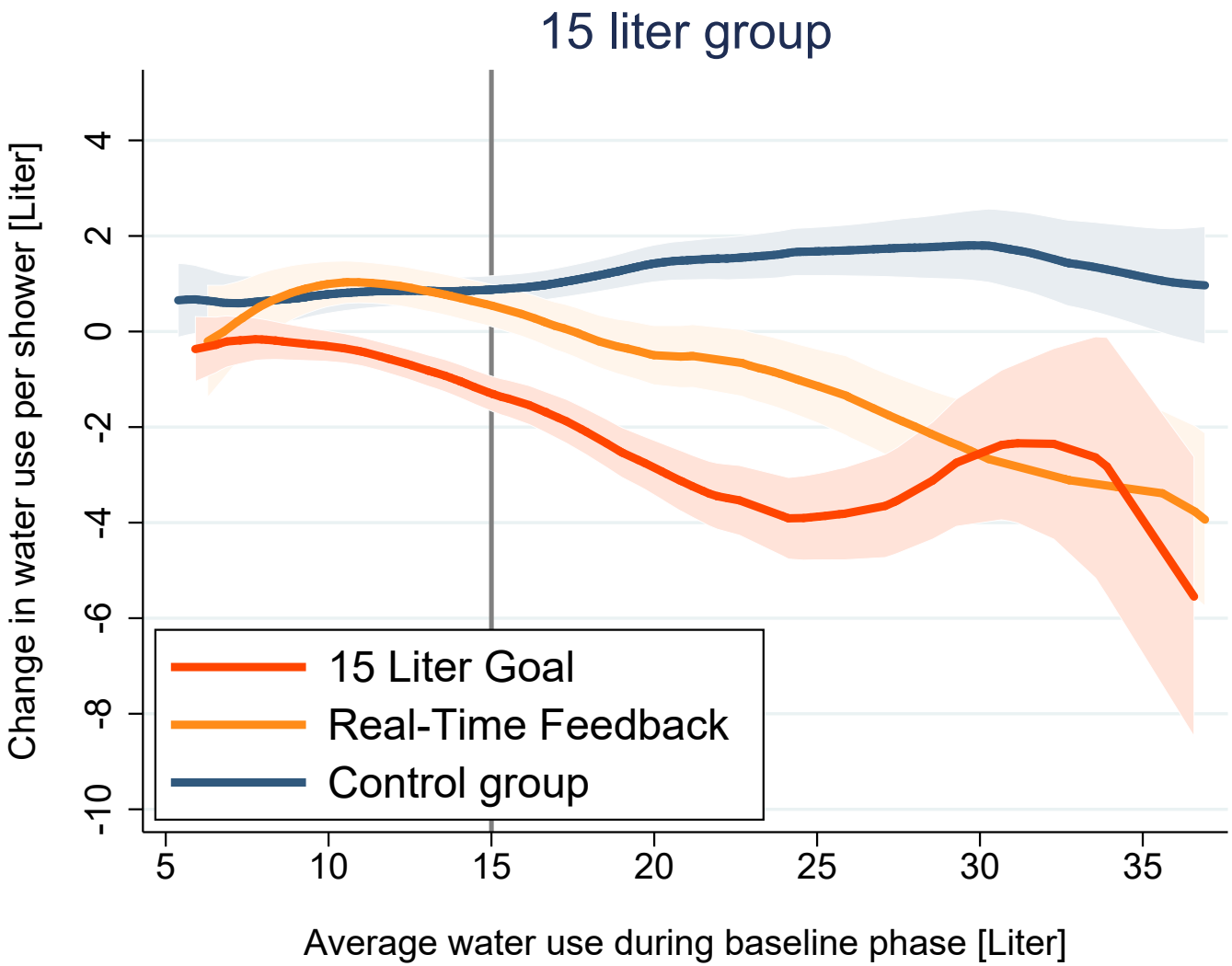

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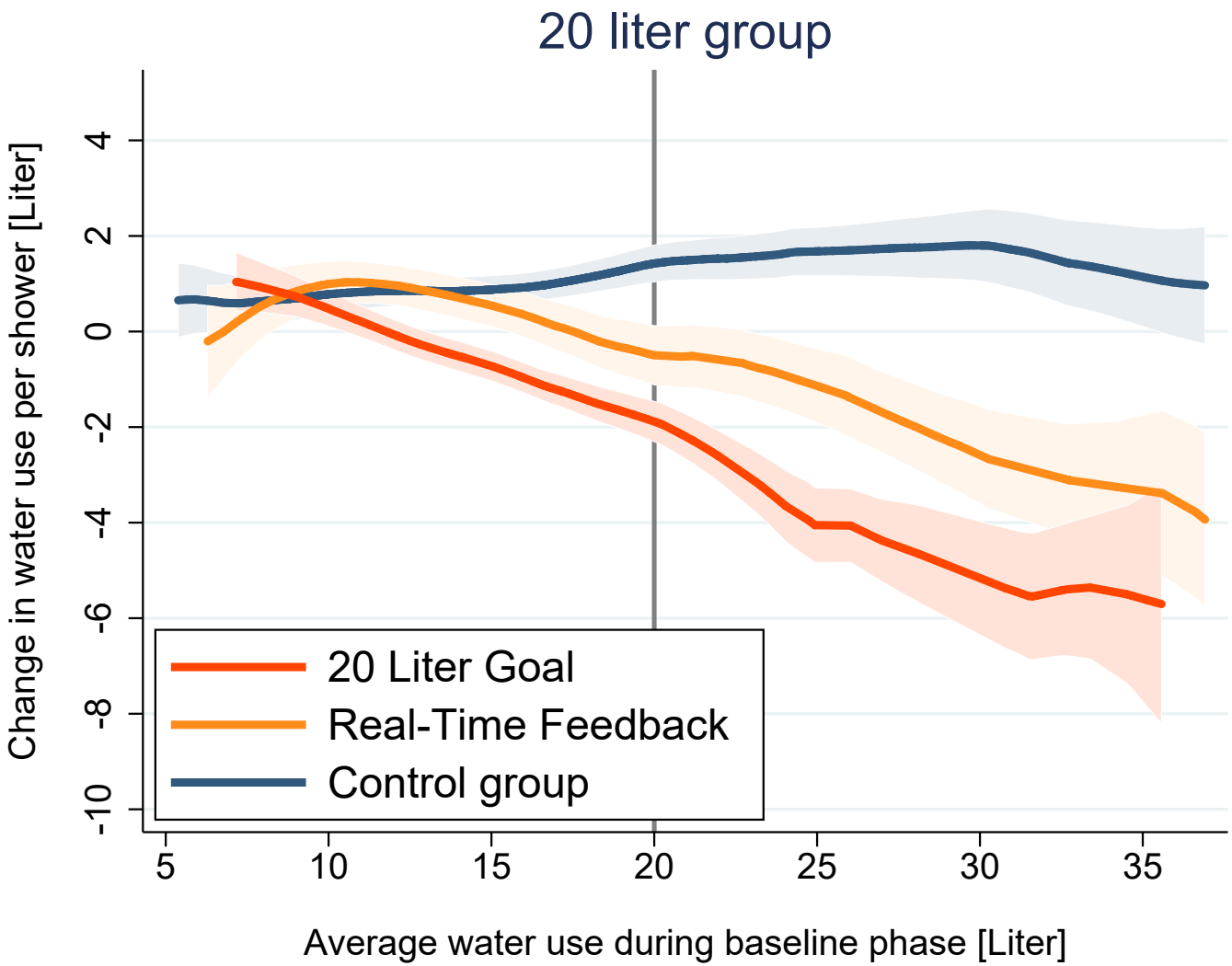

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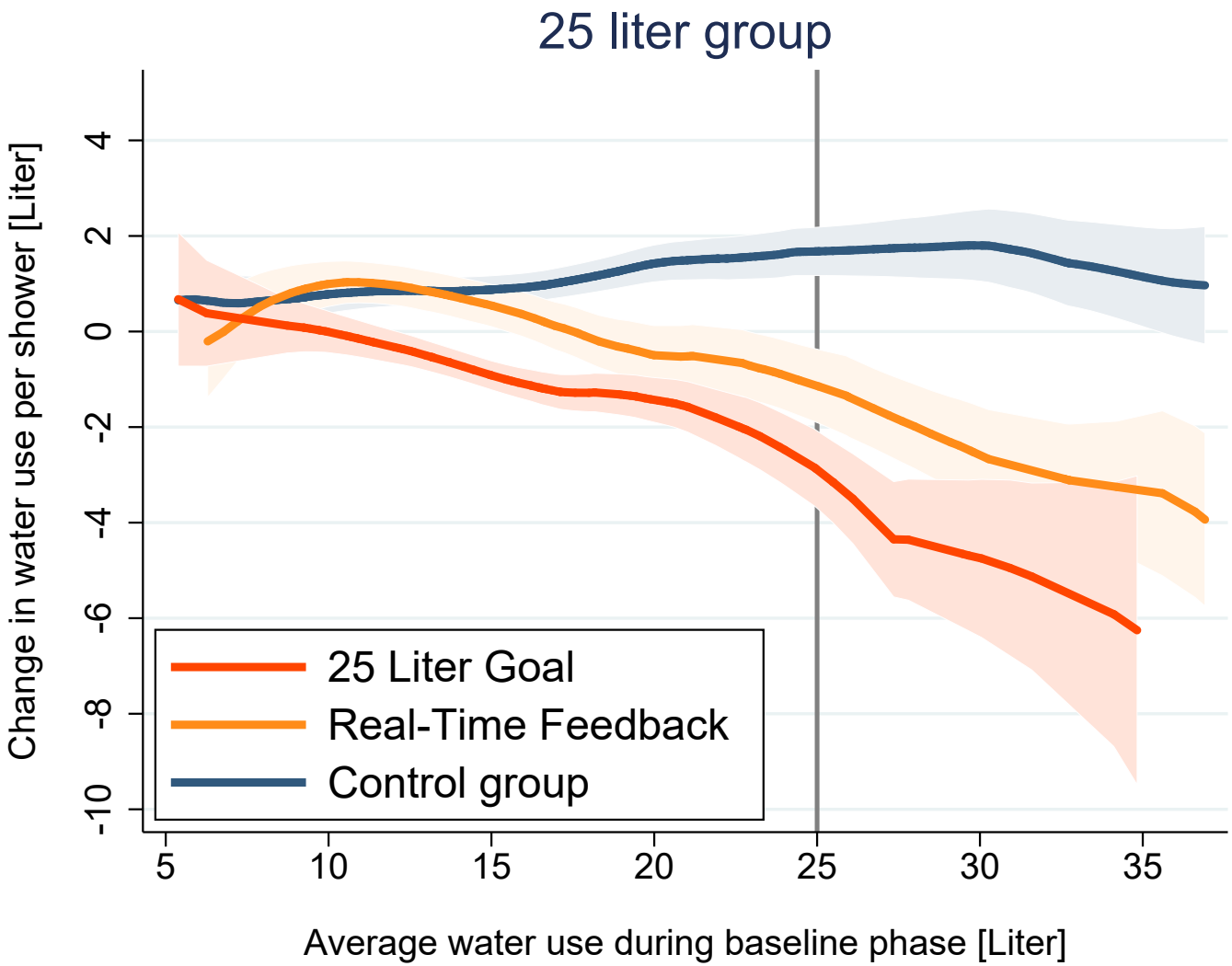

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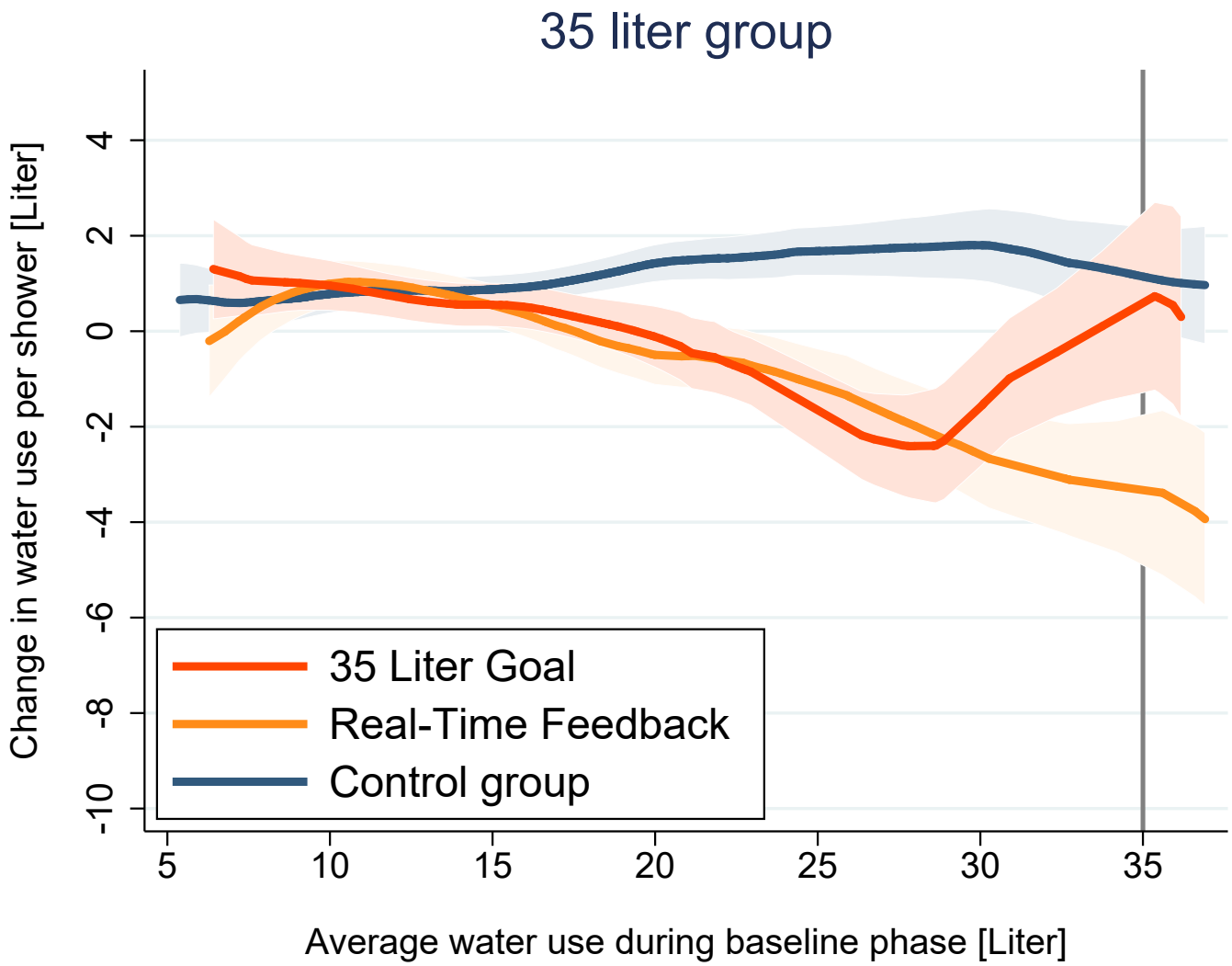
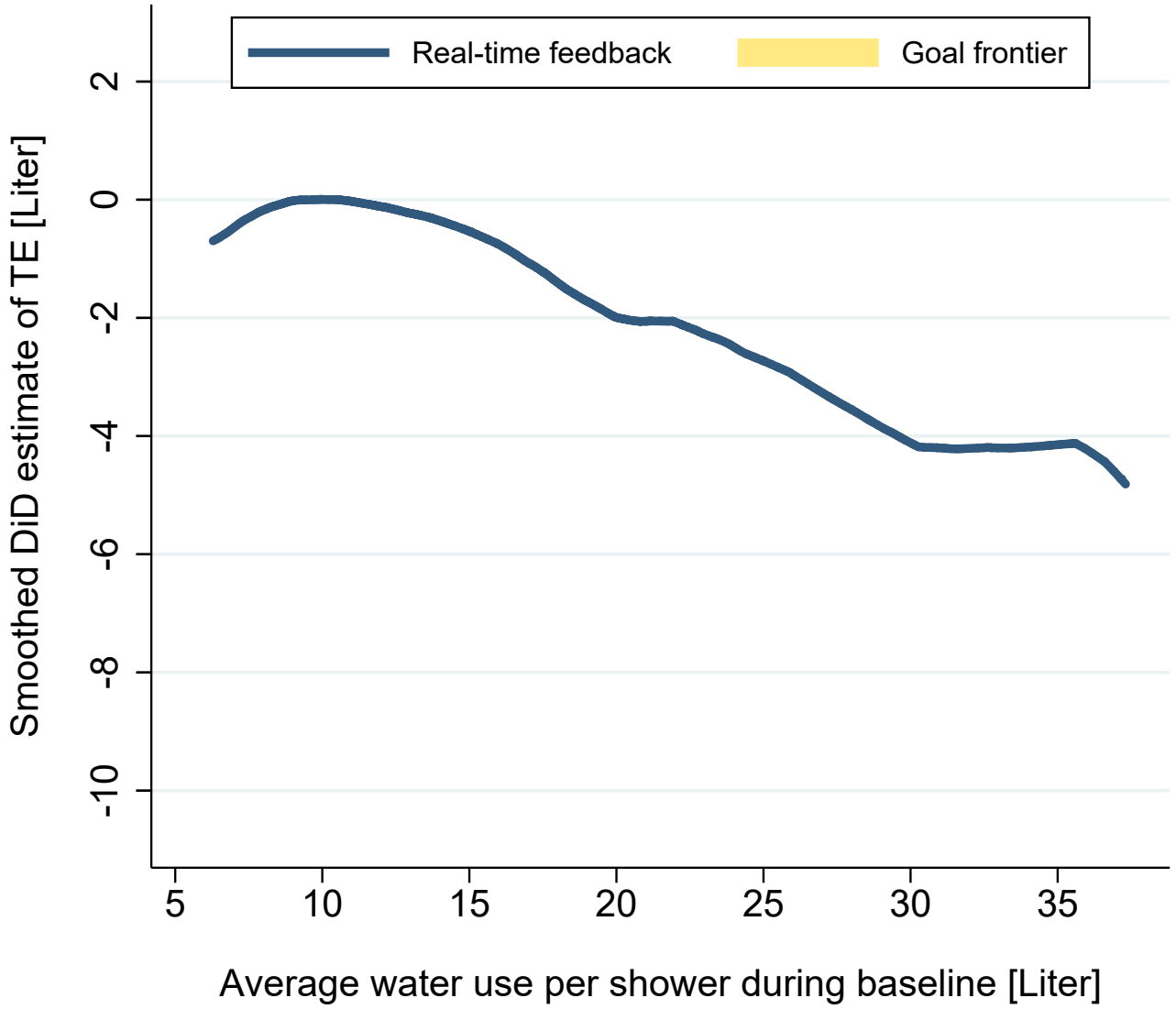


Optimal targeting



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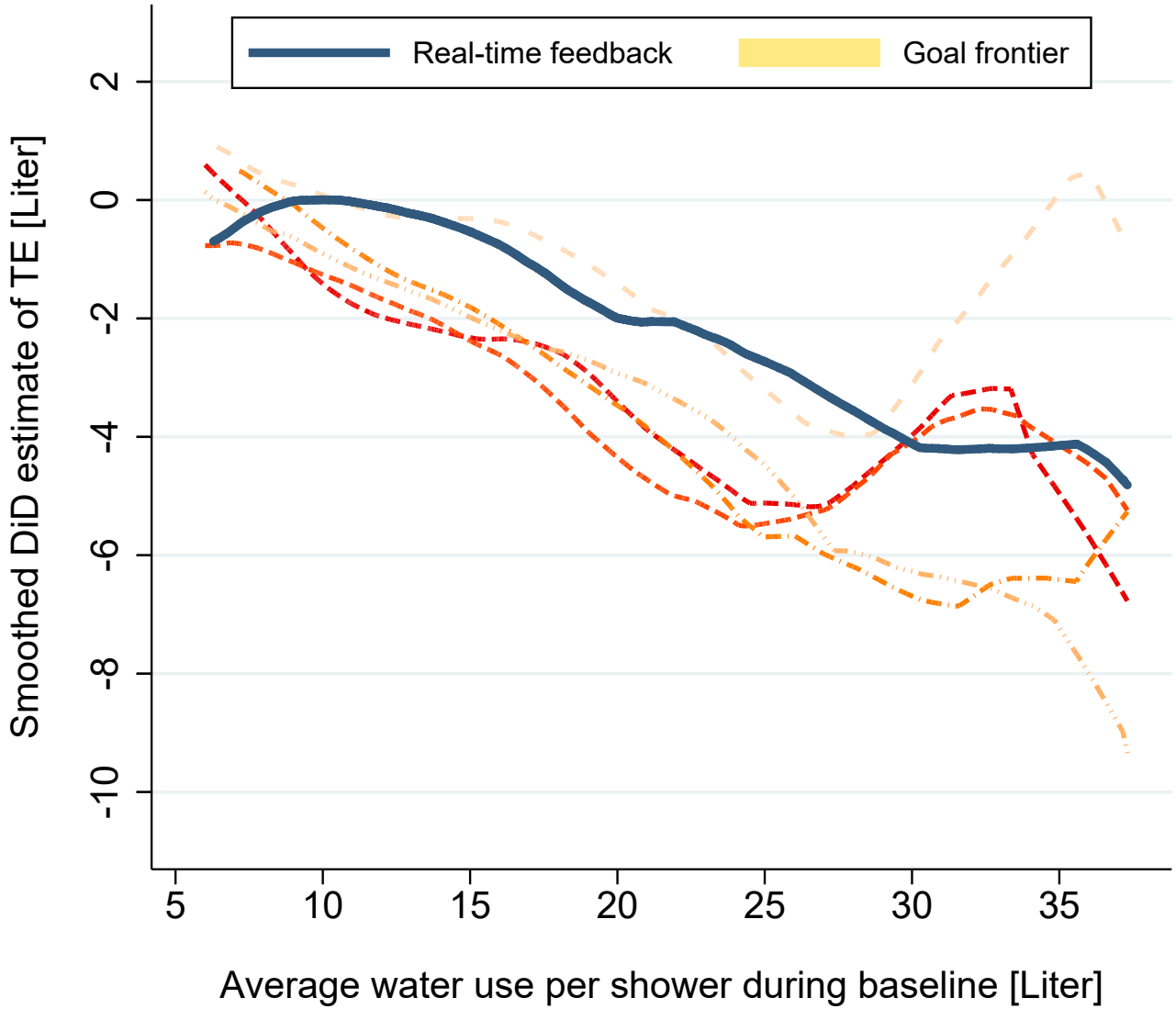

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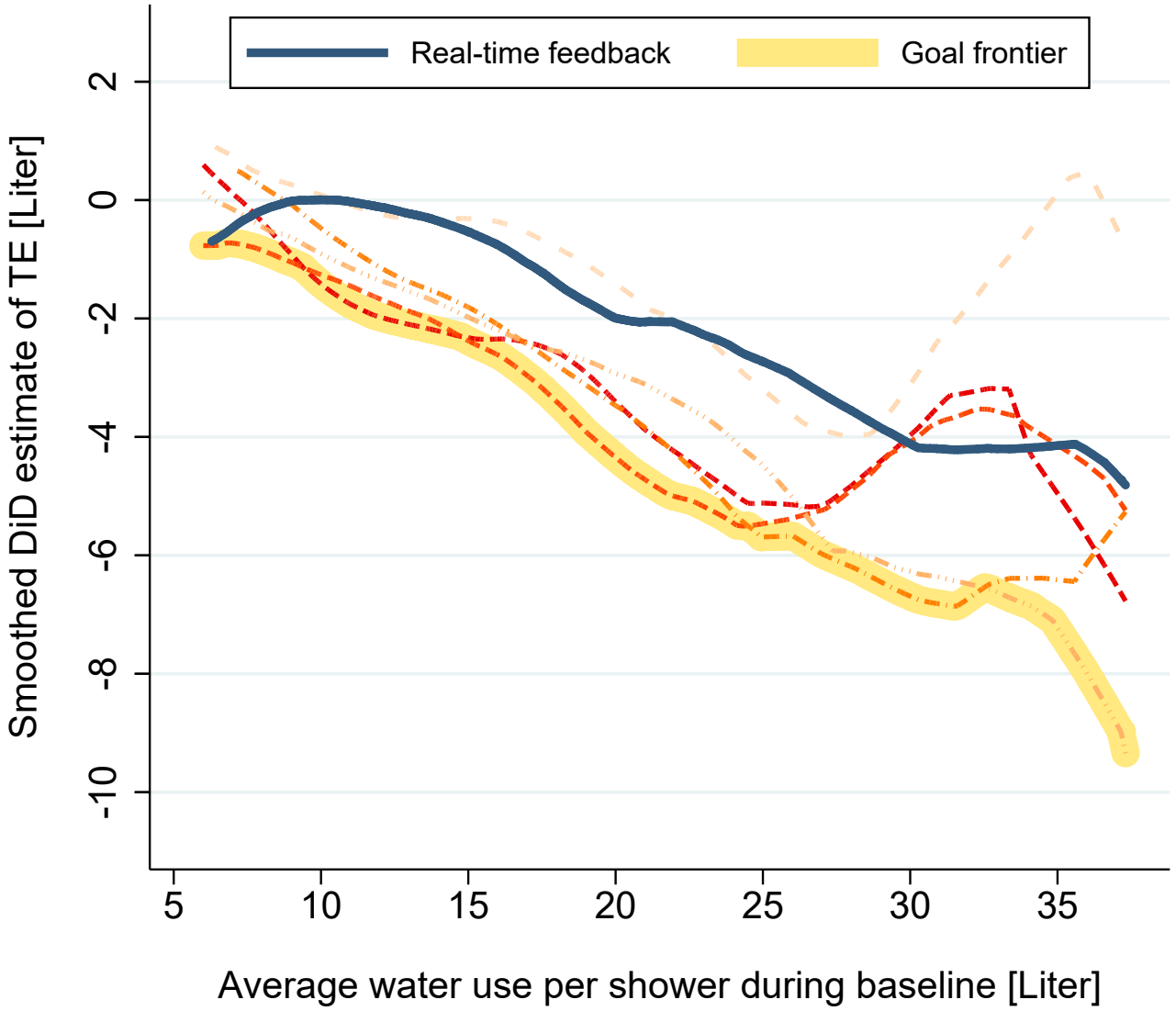

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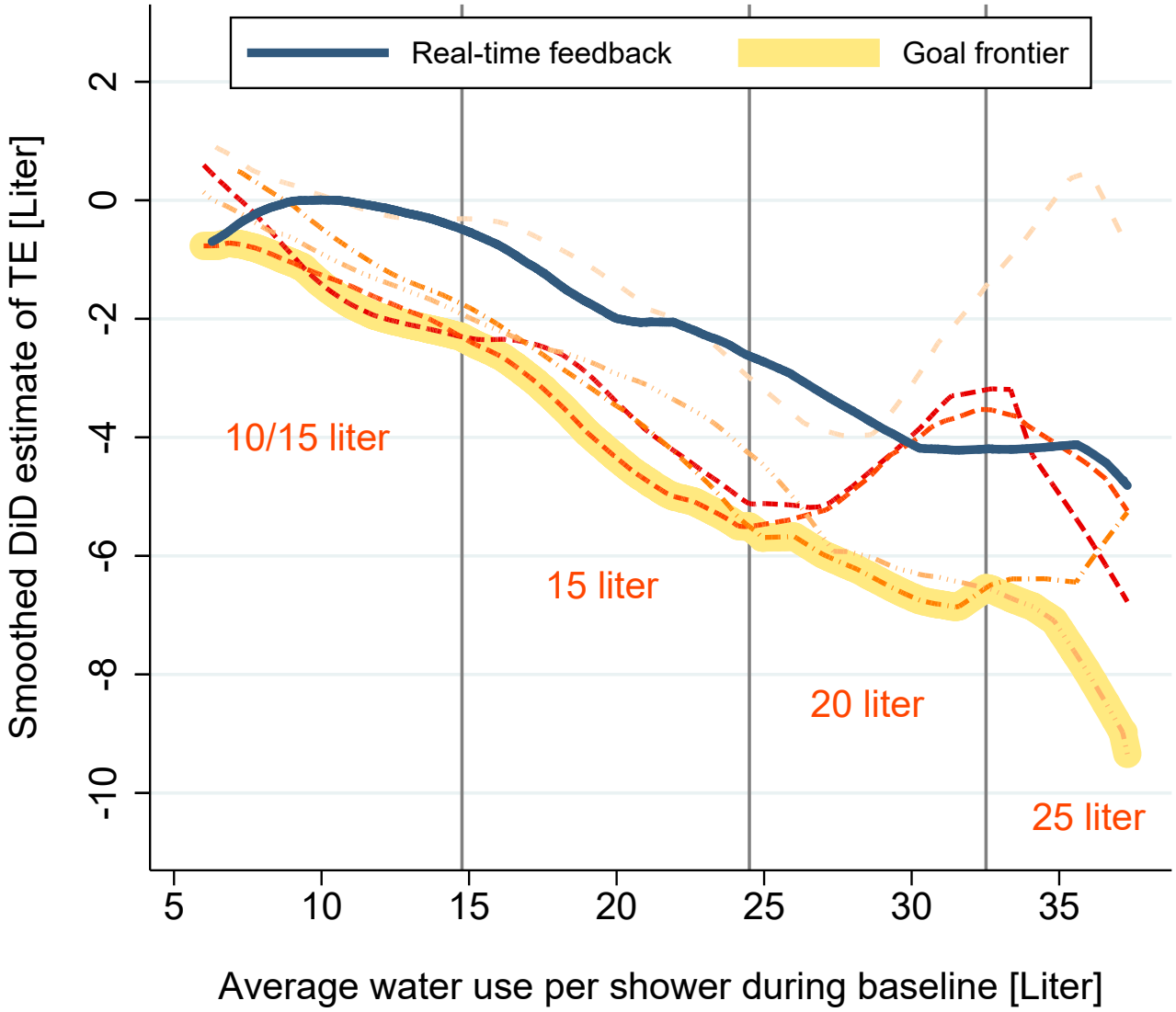
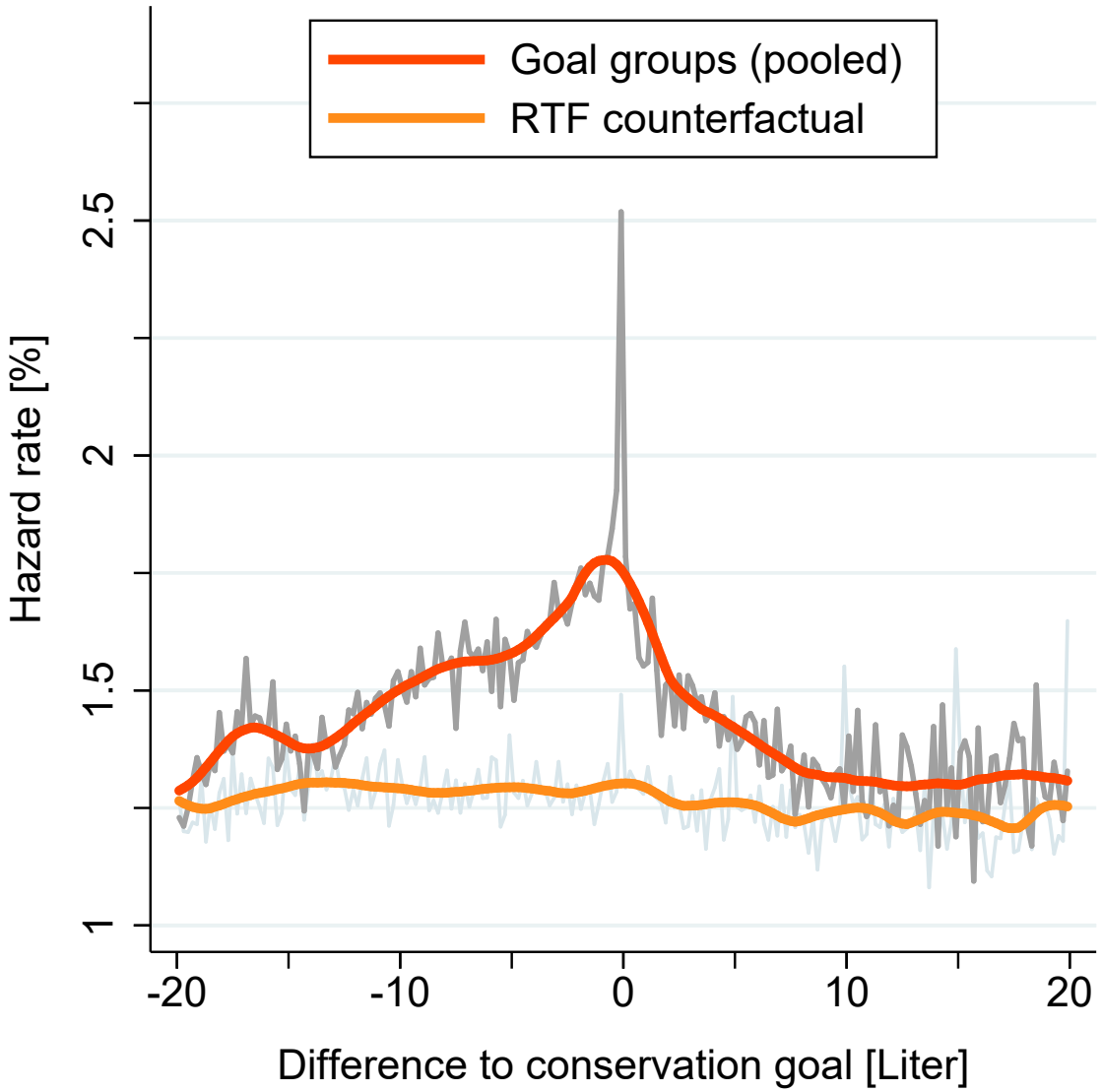


Stopping probabilities around the goal



Conclusion

- **Goal setting (with real-time feedback)** is effective in encouraging water conservation behavior
  - RTF saves 1.8 liters of water per shower (8-9%)
  - goals can more than double the effect (up to 20%)
  - effects remain stable over 4-6 months

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  - 15 liter goal seems most effective

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  - effects remain stable over 4-6 months
- **Inverse-U relation** between goal difficulty and effort
  - 15 liter goal seems most effective
- Strongest behavioral responses **at the margin of goal attainment**
  - asymmetry: larger sensitivity in gain domain
  - best explained by "warm glow" model

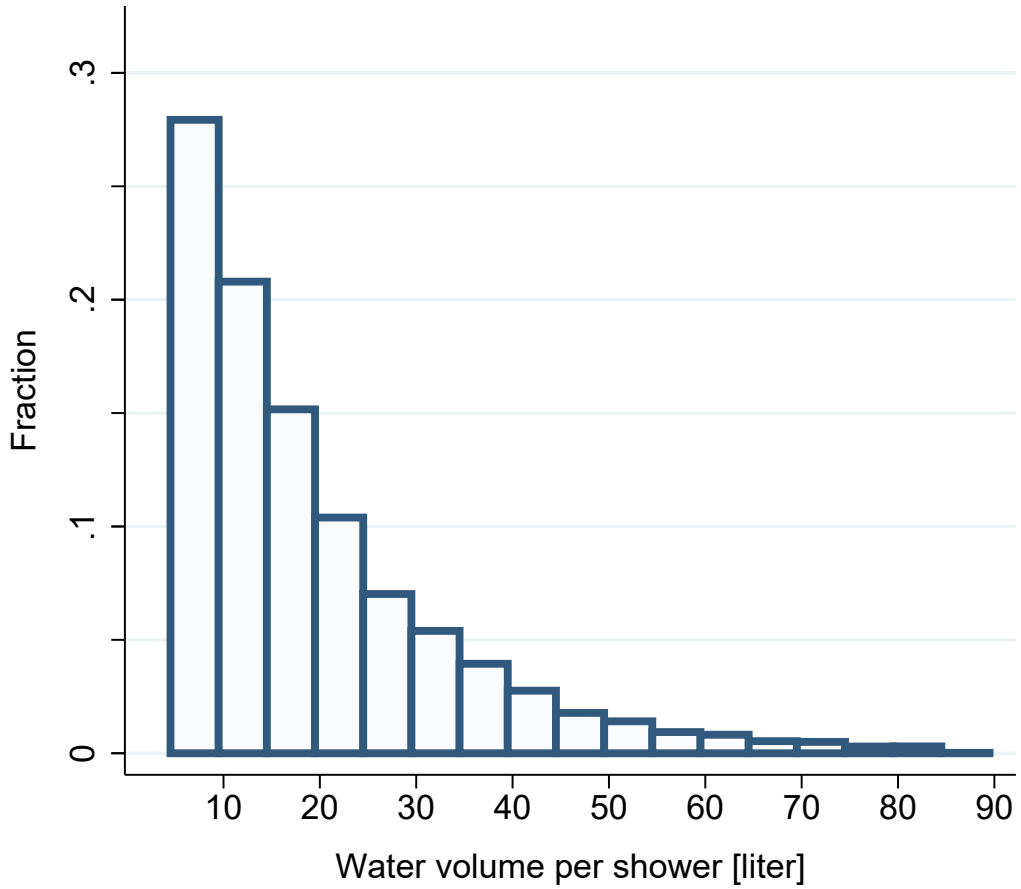
That was it.

Thanks for your attention!

Appendix

Goal conditions range from hard to easy

Figure: Histogram of shower volumes in baseline



Five goal conditions:

- 10 liter
- 15 liter
- 20 liter
- 25 liter
- 35 liter

back

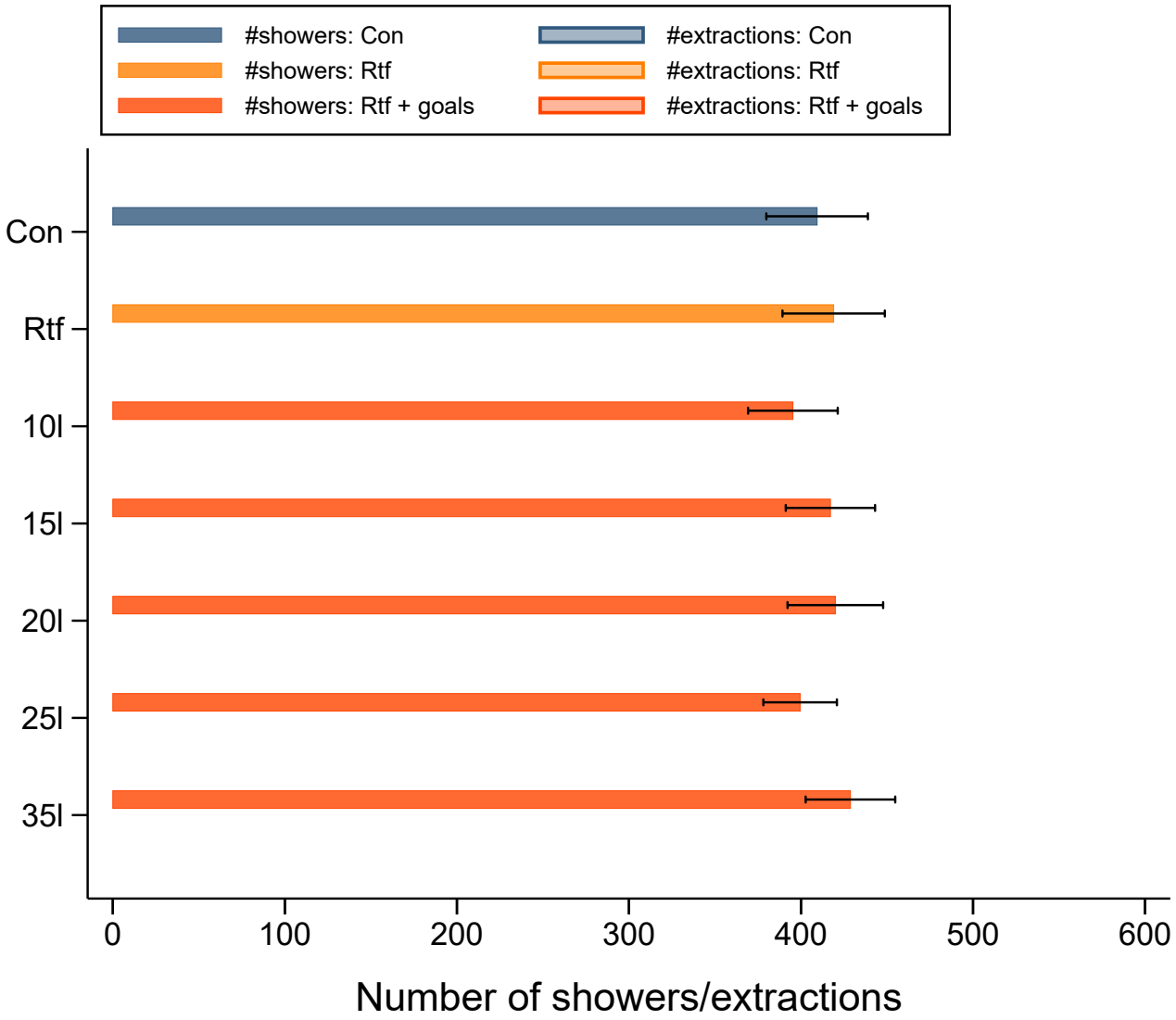
Empirical model for average treatment effects

Fixed-effects regression equation:

$$y_{is} = \alpha_i + \beta_1 T_{is}^{10l} + \ldots + \beta_5 T_{is}^{35l} + \beta_6 T_{is}^{Rtf} + \delta_t + \varepsilon_{is}$$

T_{it}^{group}	:	treatment group $\times$ intervention indicators
α_i	:	bathroom fixed effects
δ_t	:	time fixed effects
ε_{is}	:	error term (cluster on household level)

No effects on the extensive margin



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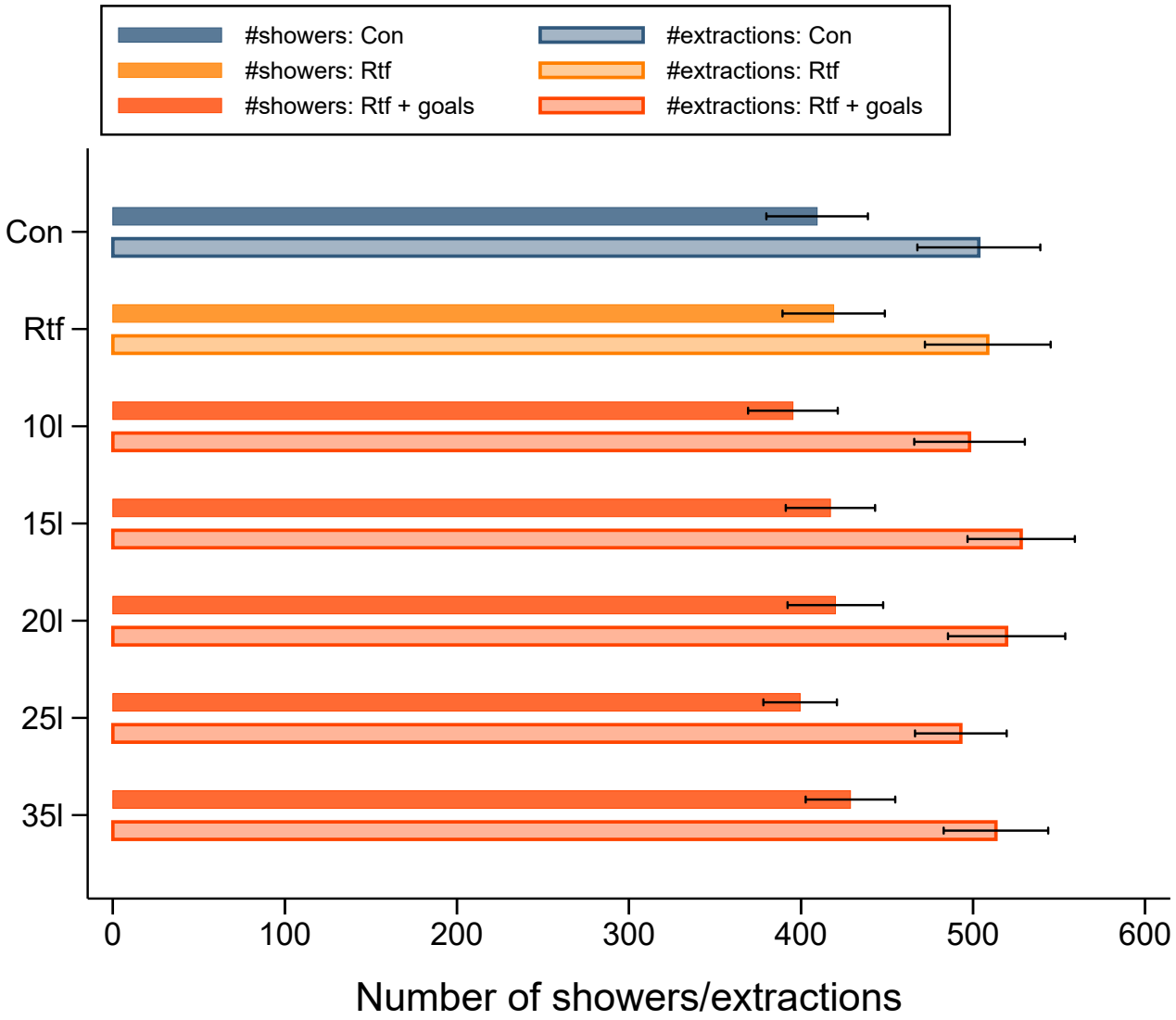
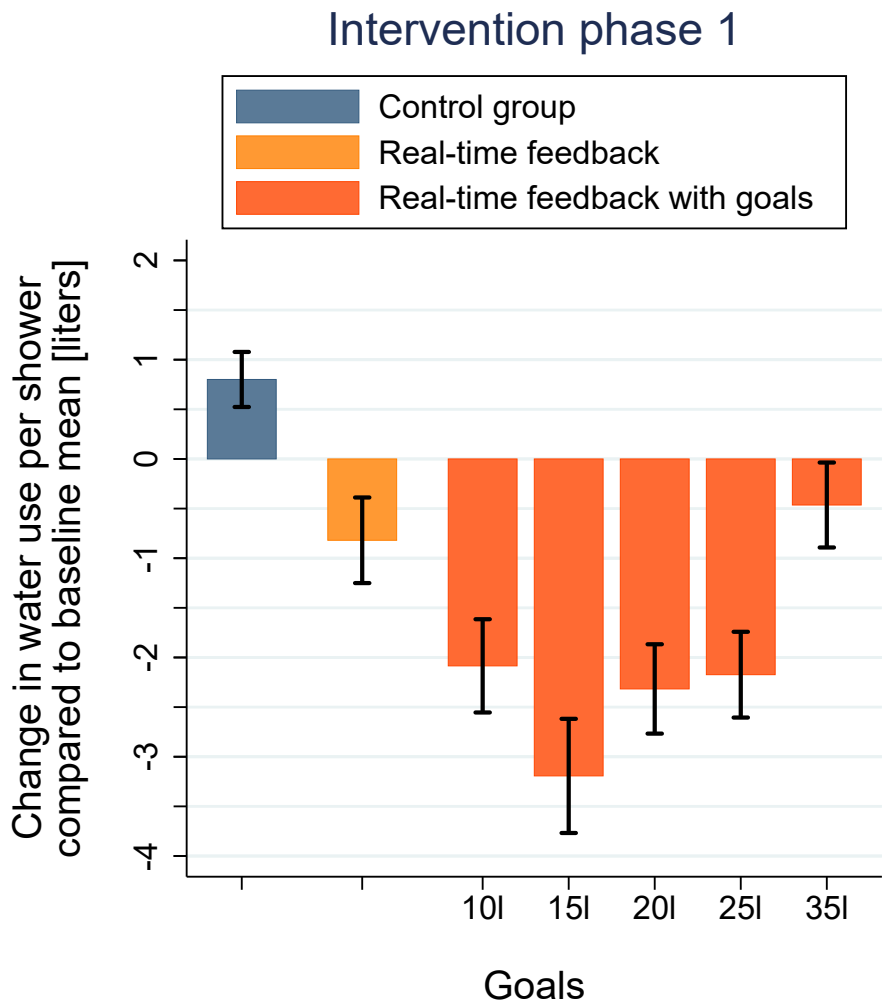


Stability of treatment effects over time

Difference-in-differences, intervention split into early, mid-, and late period



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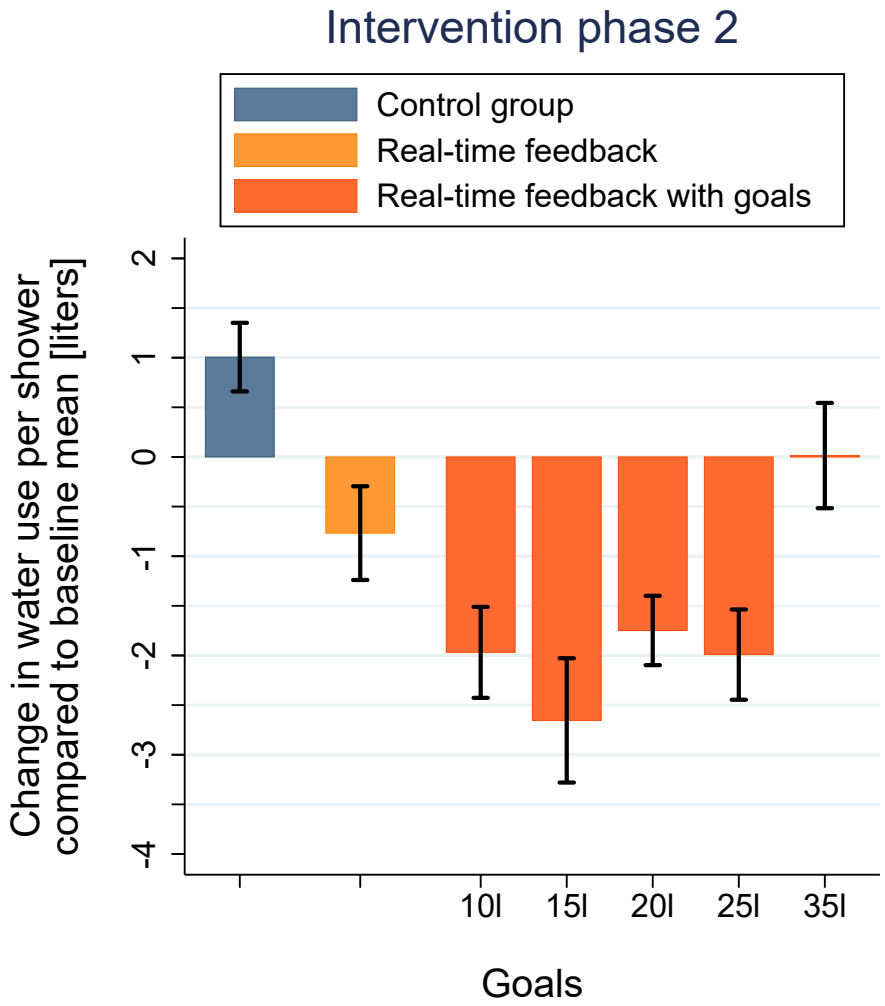

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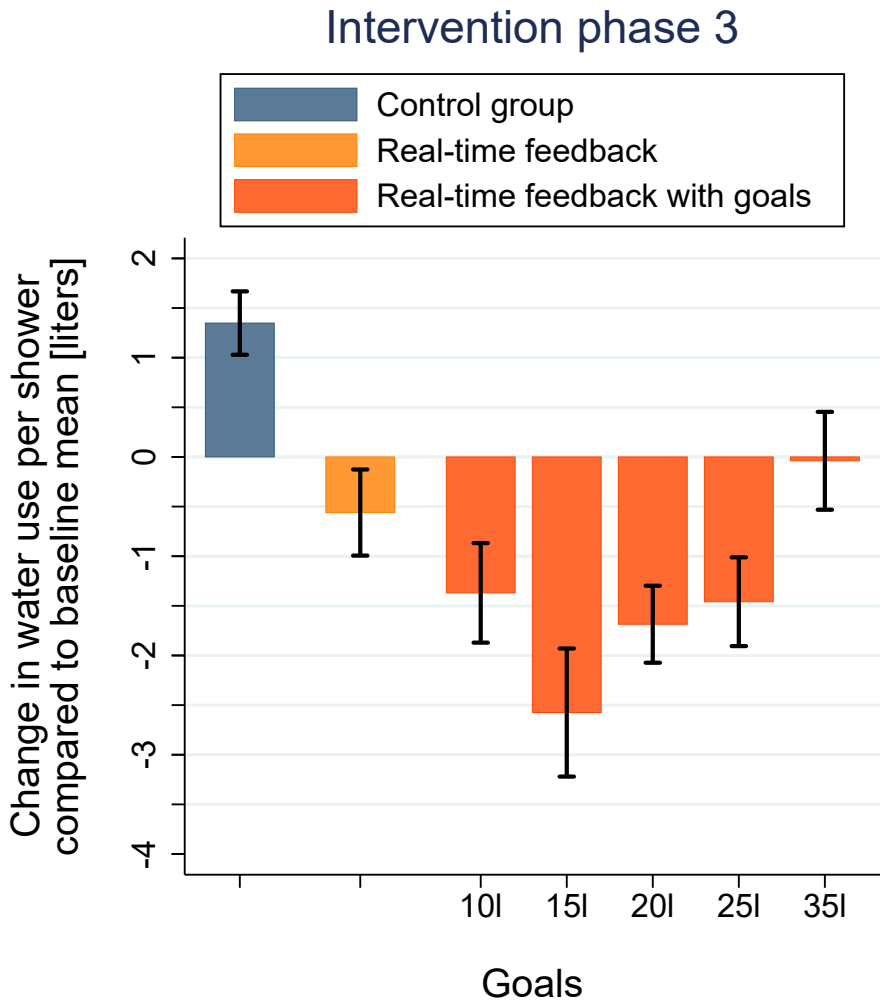


Stability of treatment effects: study progress splines

		× progress splines			
	initial effect	1st spline	2nd spline	3rd spline	4th spline
10l goal × intervention	-3.232***	0.009	0.004	0.003	0.006
	(0.593)	(0.017)	(0.013)	(0.017)	(0.018)
15l goal × intervention	-3.974***	0.012	0.008	-0.013	0.020
	(0.662)	(0.016)	(0.013)	(0.015)	(0.018)
20l goal × intervention	-2.956***	-0.003	0.016	-0.021	0.031
	(0.560)	(0.015)	(0.013)	(0.016)	(0.024)
25l goal × intervention	-2.815***	-0.010	0.010	0.005	0.018
	(0.565)	(0.015)	(0.012)	(0.016)	(0.020)
35l goal × intervention	-1.938***	0.025	0.003	-0.012	-0.006
	(0.556)	(0.018)	(0.014)	(0.017)	(0.020)
RTF × intervention	-1.558***	-0.010	0.012	-0.014	0.005
	(0.552)	(0.017)	(0.014)	(0.016)	(0.023)
F-test: all splines = 0		$p = 0.7268$			
Observations		313996			
R^2		0.332			

Empirical model for heterogeneous treatment effects

Fixed-effects model with linear interactions:

$$y_{is} = \alpha_i + \gamma_0 z_{is} + (\beta_1 + \gamma_1 z_{is})\, T_{is}^{10l} + \ldots + (\beta_6 + \gamma_6 z_{is})\, T_{is}^{Rtf} + \delta_t + \varepsilon_{is}$$

T_{it}^{group}	:	treatment group $\times$ intervention indicators
z_{is}	:	interaction variable $\times$ interv. indicator
α_i	:	bathroom fixed effects
δ_t	:	time fixed effects
ε_{is}	:	error term (cluster on household level)

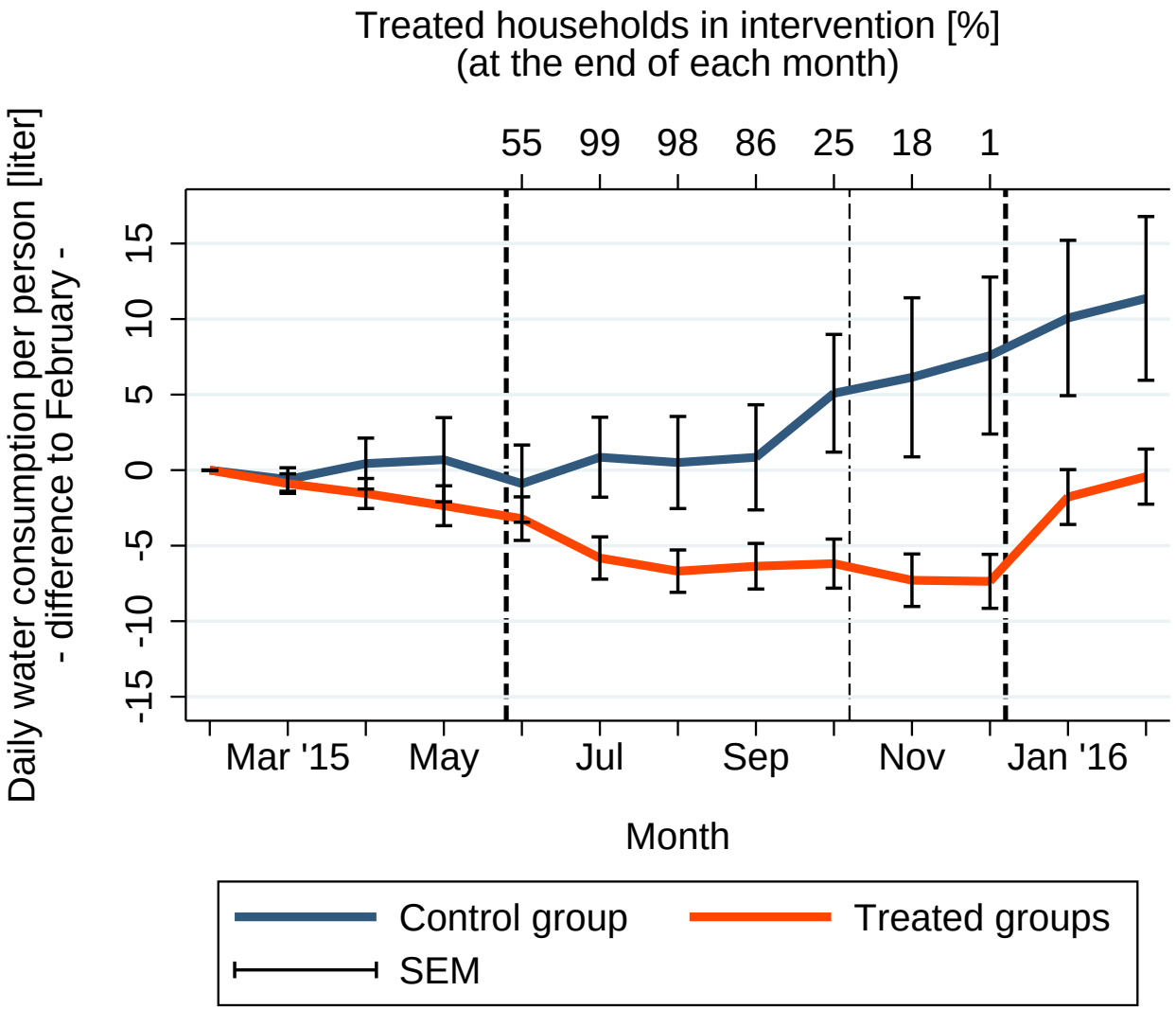
Interactions with baseline water use

	(1) linear interaction		(2) above median	
	main effect	$\times$ *baseline*	main effect	$\times \mathbb{I}_{median^+}$
10l goal $\times$ intervention $\times$ ...	-2.884***	*-0.179****	-1.854***	*-3.852****
	(0.552)	*(0.060)*	(0.503)	*(0.961)*
15l goal $\times$ intervention $\times$ ...	-3.827***	*-0.405****	-1.562***	*-6.192****
	(0.515)	*(0.077)*	(0.406)	*(1.131)*
20l goal $\times$ intervention $\times$ ...	-2.937***	*-0.296****	-1.297***	*-4.276****
	(0.413)	*(0.066)*	(0.408)	*(0.781)*
25l goal $\times$ intervention $\times$ ...	-2.946***	*-0.286****	-1.293***	*-4.783****
	(0.475)	*(0.068)*	(0.428)	*(0.977)*
35l goal $\times$ intervention $\times$ ...	-1.172**	*-0.171***	-0.352	*-2.115***
	(0.489)	*(0.071)*	(0.450)	*(0.912)*
RTF $\times$ intervention $\times$ ...	-1.699***	*-0.265****	-0.093	*-3.350****
	(0.441)	*(0.053)*	(0.508)	*(0.843)*
Intervention $\times$ ...	1.108***	*0.048*	0.967***	*1.242***
	(0.278)	*(0.035)*	(0.278)	*(0.540)*
Observations	314608		314608	
between R^2	0.287		0.109	

Margins of adjustment

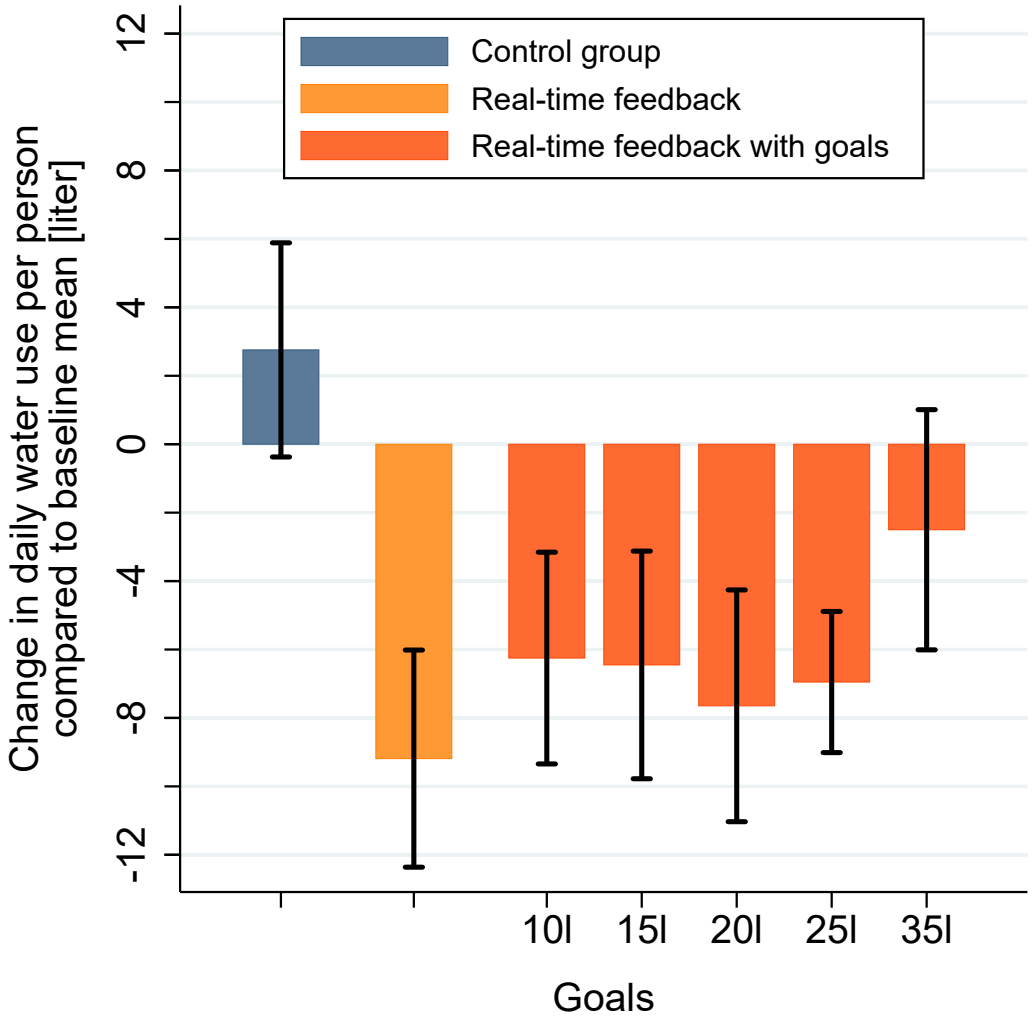
	Duration [Sec]	Flow rate [l/min]	Temperature [Celsius]
10l goal × intervention	-34.25***	-0.06	0.06
	(7.08)	(0.07)	(0.25)
15l goal × intervention	-36.54***	-0.21**	0.34
	(7.39)	(0.10)	(0.25)
20l goal × intervention	-28.24***	-0.12	0.20
	(6.07)	(0.08)	(0.25)
25l goal × intervention	-26.96***	-0.10	-0.01
	(6.78)	(0.07)	(0.32)
35l goal × intervention	-12.37*	-0.01	0.00
	(6.40)	(0.07)	(0.32)
Real-time feedback × intervention	-20.14***	0.01	0.05
	(5.63)	(0.07)	(0.29)
Intervention	5.16	0.13**	-0.03
	(3.51)	(0.06)	(0.23)
F-test for joint sign.: p-value	0.000	0.096	0.373
Observations	286732	286732	286732
between R^2	0.003	0.000	0.000

Effects on household consumption level

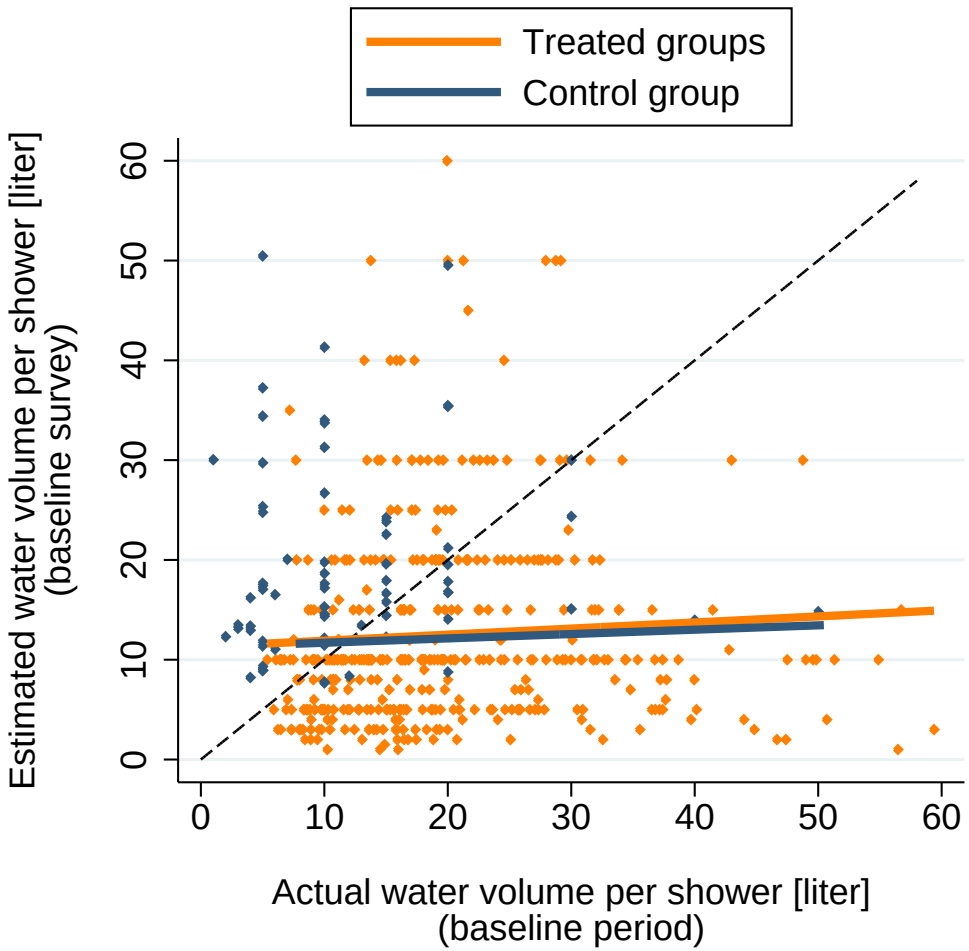


Effects on household consumption level

Treatment effects on daily household water use per capita



1. Estimated vs. actual volume before the intervention



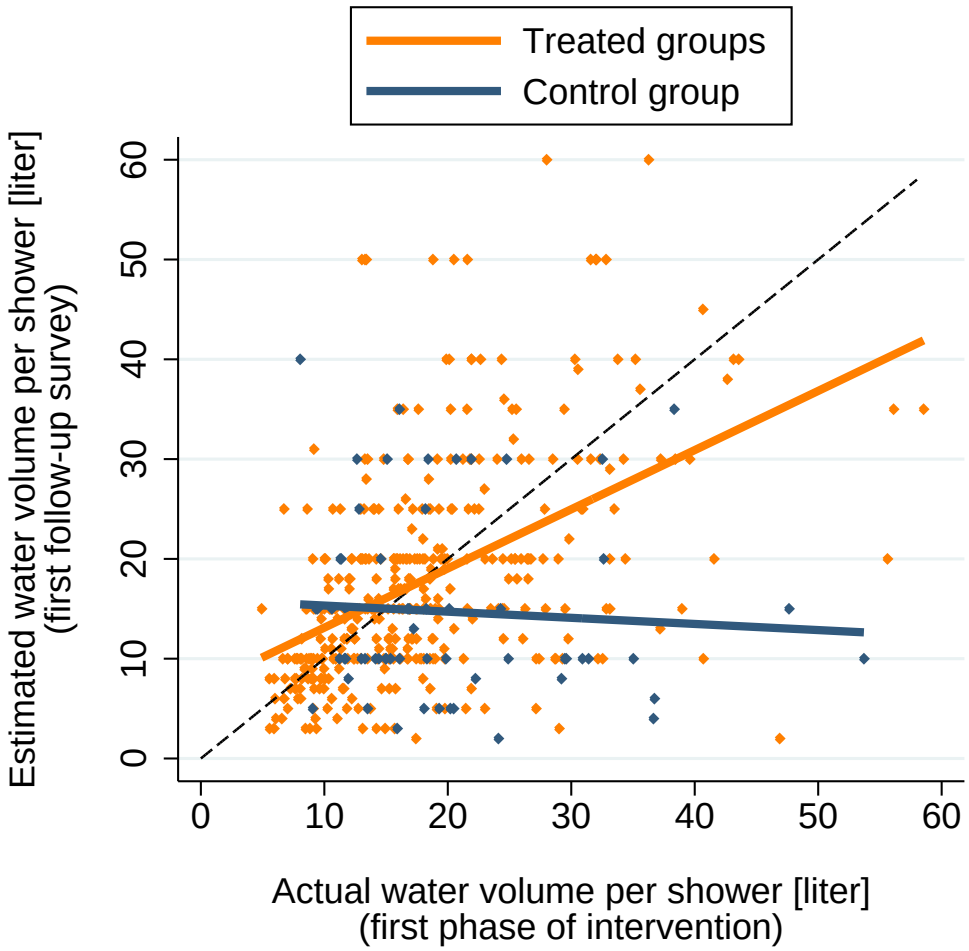
No relationship between actual and estimated water use

- Estimated average is quite close to true value (wisdom-of-the-crowd effect)
- But individuals know virtually nothing about their own water use

▶ Quite typical, seen in many other studies.

No differences between control group and experimental conditions (all collapsed into one group).

2. Estimated vs. actual volume during the intervention

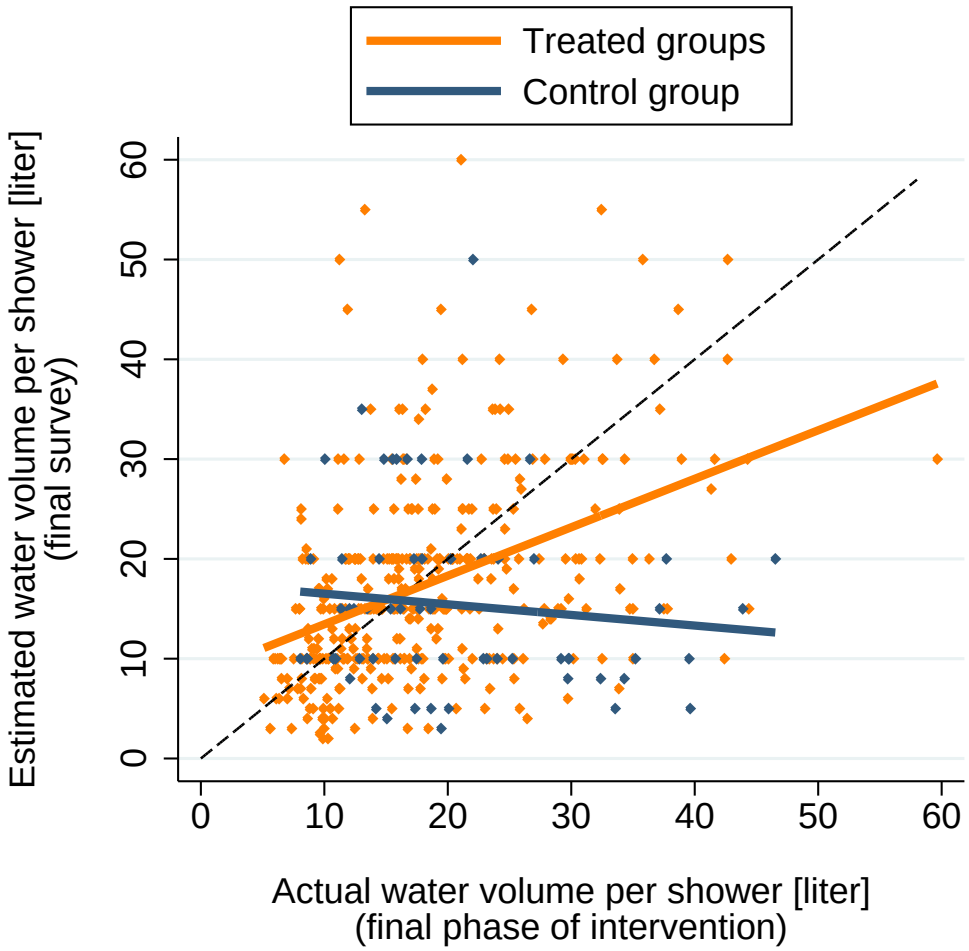


Strong improvement in awareness of resource use in the treatment conditions.

- Relationship between actual and estimated water use becomes much steeper. than it was before.

Control group shows no improvement in awareness of water use (not surprising).

3. Estimated vs. actual volume after the intervention



Awareness persists throughout the study.

- Treated groups continue to show the same, much tighter, relationship between actual and estimated water use.

Control group shows no improvement.