Information Campaigns for Residential Energy Conservation

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The paper in brief: What we do

Test the effectiveness of a letter-based information campaign on electricity consumption

- Moreover, we test whether the framing of information matters
- Two Randomized controlled trials with a sample size of 120.000 households, 44.000 households receive letters
- Based on causal forest machine learning techniques, we test the potential of targeting and whether the treatment effect heterogeneity can be explained

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**In vier Schritten die Umwelt schonen:
Machen Sie Ihr Zuhause zum Energiesparheim**

Sehr geehrter XXX,

in jedem Haushalt schlummern Möglichkeiten, Strom einzusparen und CO_2 zu vermeiden. Machen Sie Ihr Zuhause jetzt zum Energiesparheim und tun Sie der Umwelt etwas Gutes.

Mit unseren Energiespartipps geben wir Ihnen Anregungen, wie Sie Energie sparen können. Innerhalb eines Jahres erhalten Sie dazu von uns vier Briefe, in denen wir mit Ihnen durch die zentralen Bereiche gehen: **Bad & Keller, Küche, Wohnen sowie Technik & Freizeit.**

Schauen Sie die Tipps durch und entscheiden Sie, was am besten zu Ihnen passt. Mit der beiliegenden Karte können Sie die wichtigsten Tipps einfach sammeln und sehen, wie sich Ihr Zuhause im Verlauf des Jahres zum Energiesparheim entwickelt. Los geht's heute mit **Folge 1: Sparen im Bad & Keller.**

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Strom im eigenen Zuhause: Wo wird wieviel verbraucht?
Stromverbrauch eines durchschnittlichen 4-Personen-Haushalts (ohne elektrische Warmwasserbereitung)

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The paper in brief: What we find

Site-specific effects are important

- Overall, the average effect size is small and largely unaffected by framing but differs considerably across utilities
- Strong heterogeneity of effects: at one utility, savings are virtually zero, at another 1.4% (+ persistent)
- Treatment effect heterogeneity across utilities cannot be predicted by differences in socioeconomic characteristics: targeting only possible for each site

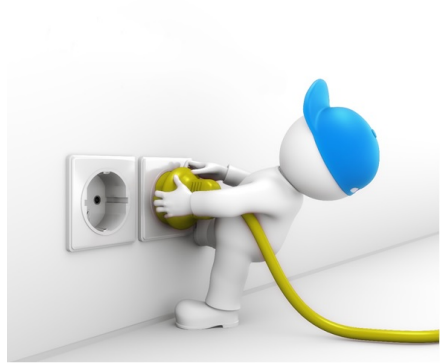
Motivation

Does Information matter?

- Information is costly and hence people are often not fully informed when making decisions (Stigler 1961)
- Information provision have been shown to affect individual decision making in various contexts, including agriculture, health, and water conservation (Bertrand et al. 2010, Duflo/Saez 2003, Hanna et al. 2014, Ferraro/Price 2013)
- Yet, information interventions differ and relatively little is known about
- “information campaigns”: interventions aiming to improve households’ knowledge about the consequences of their behavior; in our context, energy-related behaviors and investments

... and for Energy Conservation?

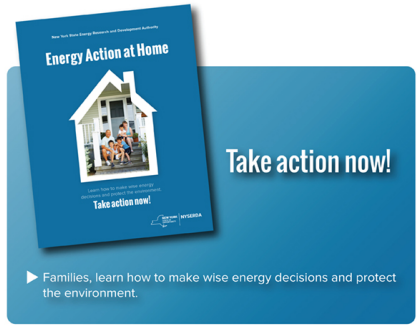
- Growing literature demonstrates that information matters:
  - Social-comparison based home energy reports (e.g. Allcott 2011, Allcott/Rogers 2014)
  - Information based on smart meters (e.g. Jessoe/Rapson 2014, Tiefenbeck et al. 2018)
- Meta-analysis by Delmas et al. (2013): 7.4% average savings, yet effects are lower in studies using rigorous evaluation approaches (see also Andor/Fels 2018)
- Studies on “information campaigns” rely on small samples and find largely different effect sizes: -12% to 8%



No large-scale evaluation of an information campaign

Our treatment compared to the literature

- If consumers are unaware of effective energy conservation measures (Attari 2010), they might overconsume energy
- Therefore, many governments implement campaigns that inform consumers about effective energy-saving behaviors and investments
- Our intervention: an information letter
  - Lower psychological cost than social-comparison based interventions
  - Low cost in comparison to smart meters
  - Easy to implement



Treatment design, implementation and data

Natural Field Experiments

- Two participating energy utilities:
  - SREG: a large supra-regional utility covering wide parts of both rural and urban Germany
  - REG: a smaller regional utility that operates in the rural north-eastern part of Germany
- Treatment consists of receiving four quarterly letters:
  - Inform about the most promising measures to conserve electricity
- Control group households receive no letters
- Three treatment groups:
  - Economic framing: Euro savings (Econ)
  - Environmental framing: CO2 savings (Env)
  - Economic + environmental framing (EconEnv)

Treatment

- In the design phase, we **cooperated with energy efficiency agencies and partners in the marketing sector**:
  - Verbraucherzentrale NRW
    - Germany's largest nonprofit organization for consumer protection
  - Energieagentur.NRW
    - A governmental agency to promote energy efficiency
  - Rheingold Institute
    - A private sector company focused on consumer behavior and psychological marketing research
  - brandseven
    - A consultancy focused on marketing services for electricity providers.

Example for the presentation of electricity-saving tips (Translated)

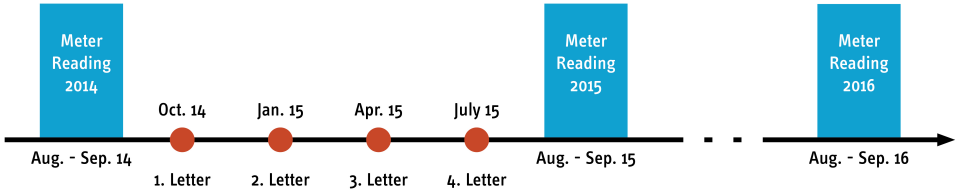
Environmental Treatment

4 **Replace old fridge:** Is your refrigerator getting old? A 15-year-old fridge-freezer combination consumes about 215 kWh/year more than a modern, energy-efficient appliance, which corresponds to 113 kg CO2/year.

Economic Treatment

4 **Replace old fridge:** Is your refrigerator getting old? A 15-year-old fridge-freezer combination consumes about 215 kWh/year more than a modern, energy-efficient appliance, which corresponds to 60 euro/year.

Timeline


Meter Reading 2014
Oct. 14
Jan. 15
Apr. 15
July 15
Meter Reading 2015
Meter Reading 2016
Aug. - Sep. 14
1. Letter
2. Letter
3. Letter
4. Letter
Aug. - Sep. 15
Aug. - Sep. 16
Episode 1: Saving in the bathroom & basement - tips and tricks for saving energy
Episode 3: Saving in the living area - tips and tricks for saving energy
Episode 2: Saving in the kitchen - tips and tricks for saving energy
Episode 4: Saving in the working area - tips and tricks for saving energy

Randomization

- Stratified on utility and baseline energy consumption

Utility	Sample size	# HH with letters	Type of letter	# HH
SREG	119.110	39.988	Econ	13.330
			Env	13.331
			EconEnv	13.327
REG	8.694	3.999	Econ	2.000
			Env	1.999

Data

- Metered yearly electricity consumption
  - 2013-2014: baseline
  - 2014-2015: treatment period
  - 2015-2016: post-treatment period

- Electricity tariffs

- Sociodemographics (at 1km grid-level) from *microm*

Descriptives and Balance

	SREG					REG			
	Control	Econ	Env	EconEnv	P-Value	Control	Econ	Env	P-Value
Baseline cons., in kWh per day	9.05	9.05	9.01	9.07	(0.88)				
Regional utility tariff, in %	0.90	0.90	0.90	0.90	(0.67)				
Green tariff, in %	0.02	0.02	0.02	0.02	(0.27)				
Heating electricity tariff, in %	0.08	0.08	0.08	0.08	(0.94)				
Number of observations	211,233	35,680	35,514	35,665	$\sum$=318,092	12,672	5,377	5,394	$\sum$=23,443
Number of participants	76,252	12,869	12,841	12,856	$\sum$=114,818	4,559	1,943	1,944	$\sum$=8,446

Descriptives and Balance

	SREG					REG			
	Control	Econ	Env	EconEnv	P-Value	Control	Econ	Env	P-Value
Baseline cons., in kWh per day	9.05	9.05	9.01	9.07	(0.88)	7.72	7.90	7.86	(0.34)
Regional utility tariff, in %	0.90	0.90	0.90	0.90	(0.67)	0.50	0.51	0.50	(0.72)
Green tariff, in %	0.02	0.02	0.02	0.02	(0.27)	0.47	0.46	0.46	(0.73)
Heating electricity tariff, in %	0.08	0.08	0.08	0.08	(0.94)	0.03	0.03	0.04	(0.43)
Number of observations	211,233	35,680	35,514	35,665	$\sum$=318,092	12,672	5,377	5,394	$\sum$=23,443
Number of participants	76,252	12,869	12,841	12,856	$\sum$=114,818	4,559	1,943	1,944	$\sum$=8,446

Descriptives and Balance

	SREG					REG			
	Control	Econ	Env	EconEnv	P-Value	Control	Econ	Env	P-Value
Baseline cons., in kWh per day	9.05	9.05	9.01	9.07	(0.88)	7.72	7.90	7.86	(0.34)
Regional utility tariff, in %	0.90	0.90	0.90	0.90	(0.67)	0.50	0.51	0.50	(0.72)
Green tariff, in %	0.02	0.02	0.02	0.02	(0.27)	0.47	0.46	0.46	(0.73)
Heating electricity tariff, in %	0.08	0.08	0.08	0.08	(0.94)	0.03	0.03	0.04	(0.43)
Regional characteristics at 1km grid-level									
Pop. density, in 1k per km2	0.308	0.316	0.300	0.301	(0.20)	0.052	0.051	0.052	(0.50)
Unemployment rate, in %	5.2	5.1	5.2	5.1	(0.72)	7.7	7.8	7.7	(0.38)
Retirees, in %	20.9	20.9	20.9	20.9	(0.86)	20.3	20.4	20.3	(0.91)
Purch. power, in 1k EUR per hh	43.4	43.3	43.3	43.4	(0.52)	35.0	35.1	35.0	(0.60)
Foreign household heads, in %	3.9	3.9	3.9	3.9	(0.93)	1.4	1.4	1.4	(0.27)
Green party voters, in %	6.9	6.9	6.9	6.9	(0.59)	3.2	3.2	3.2	(0.11)
Number of observations	211,233	35,680	35,514	35,665	∑=318,092	12,672	5,377	5,394	∑=23,443
Number of participants	76,252	12,869	12,841	12,856	∑=114,818	4,559	1,943	1,944	∑=8,446

Empirical Strategy and Results

Empirical Strategy

Differences-in-Differences model:

$$Y^n_{i,t} = \alpha_i + \beta_t + \sum_F \omega_F IL^F_i Post_t + \epsilon_i$$

- $Y^n_{i,t}$: average daily electricity consumption of household i in billing period t (normalized by control group mean)
- α_i, β_t: household i and billing period t fixed effects, $t \in \{2014, 2015, 2016\}$
- IL^F_i: treatment group dummies, $F \in \{\text{econ, env, econenv}\}$, sometimes analyzed jointly (IL_i)
- $Post_t$: dummy for post-treatment period

Average Treatment Effects (ATE) by Utility

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
IL	-1.225**			-0.072		
	(0.512)			(0.130)		
Number of obs.	23,294	23,294	23,294	316,571	316,571	316,571
Number of participants	8,359	8,359	8,359	113,903	113,903	113,903

Note: Standard errors in parantheses, clustered at the individual level. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively.

ATE by Utility, and Year

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
IL	-1.225**			-0.072		
	(0.512)			(0.130)		
IL x 2015		-1.361***			-0.061	
		(0.497)			(0.123)	
IL x 2016		-1.073*			-0.085	
		(0.625)			(0.165)	
Number of obs.	23,294	23,294	23,294	316,571	316,571	316,571
Number of participants	8,359	8,359	8,359	113,903	113,903	113,903

Note: Standard errors in parantheses, clustered at the individual level. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively.

ATE by Utility, Year, and Framing Condition

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
IL	-1.225**			-0.072		
	(0.512)			(0.130)		
IL x 2015		-1.361***			-0.061	
		(0.497)			(0.123)	
IL x 2016		-1.073*			-0.085	
		(0.625)			(0.165)	
IL x Econ			-0.815			-0.069
			(0.623)			(0.194)
IL x Env			-1.633**			-0.181
			(0.648)			(0.199)
IL x EconEnv						0.033
						(0.201)
Number of obs.	23,294	23,294	23,294	316,571	316,571	316,571
Number of participants	8,359	8,359	8,359	113,903	113,903	113,903

Note: Standard errors in parantheses, clustered at the individual level. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively.

Heterogeneity analyses based on household characteristics

Heterogeneity in Treatment Effects

- Explorative analysis
- Pools all letters into one treatment dummy, IL_i
- Interacts treatment dummy with individual-level info on tariff and baseline consumption
- Further analyses (not shown): Our random causal forest ML analysis shows that treatment effect heterogeneity across utilities cannot be predicted by differences in socioeconomic characteristics

ATE by baseline consumption and tariff

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
Subgroup	ATE	Std. Err.	n	ATE	Std. Err.	n
Baseline cons. $\leq$ median	-0.314	(0.379)	11,599			
Baseline cons. $>$ median	-2.066**	(0.946)	11,695			

Note: Standard errors are clustered at the household level, standard errors in parantheses. ATEs are estimated in the specified subgroup based on Difference-in-Differences models. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively. Participants in the above median, top quartile, and top decile groups consume more than 11.3, 14.5, and 19.2 kWh per day (REG) and 13.4, 17.8, and 24.5 kWh (SREG), respectively.

ATE by baseline consumption and tariff

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
Subgroup	ATE	Std. Err.	n	ATE	Std. Err.	n
Baseline cons. $\leq$ median	-0.314	(0.379)	11,599			
Baseline cons. $>$ median	-2.066**	(0.946)	11,695			
Baseline cons. $>$ p75	-3.629**	(1.743)	5,831			
Baseline cons. $>$ p90	-4.282	(3.646)	2,316			

Note: Standard errors are clustered at the household level, standard errors in parantheses. ATEs are estimated in the specified subgroup based on Difference-in-Differences models. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively. Participants in the above median, top quartile, and top decile groups consume more than 11.3, 14.5, and 19.2 kWh per day (REG) and 13.4, 17.8, and 24.5 kWh (SREG), respectively.

ATE by baseline consumption and tariff

		REG			SREG	
	(1)	(2)	(3)	(4)	(5)	(6)
Subgroup	ATE	Std. Err.	n	ATE	Std. Err.	n
Baseline cons. $\leq$ median	-0.314	(0.379)	11,599	-0.162*	(0.086)	157,817
Baseline cons. $>$ median	-2.066**	(0.946)	11,695	0.012	(0.243)	158,754
Baseline cons. $>$ p75	-3.629**	(1.743)	5,831	0.224	(0.447)	79,002
Baseline cons. $>$ p90	-4.282	(3.646)	2,316	0.647	(0.987)	31,330

Note: Standard errors are clustered at the household level, standard errors in parantheses. ATEs are estimated in the specified subgroup based on Difference-in-Differences models. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively. Participants in the above median, top quartile, and top decile groups consume more than 11.3, 14.5, and 19.2 kWh per day (REG) and 13.4, 17.8, and 24.5 kWh (SREG), respectively.

ATE by baseline consumption and tariff

	REG			SREG		
	(1)	(2)	(3)	(4)	(5)	(6)
Subgroup	ATE	Std. Err.	n	ATE	Std. Err.	n
Baseline cons. $\leq$ median	-0.314	(0.379)	11,599	-0.162*	(0.086)	157,817
Baseline cons. $>$ median	-2.066**	(0.946)	11,695	0.012	(0.243)	158,754
Baseline cons. $>$ p75	-3.629**	(1.743)	5,831	0.224	(0.447)	79,002
Baseline cons. $>$ p90	-4.282	(3.646)	2,316	0.647	(0.987)	31,330
Green tariff	-0.096	(0.599)	10,981	1.185	(0.961)	5,119
Default tariff	-1.425**	(0.684)	11,493	-0.163	(0.117)	294,907
Heating tariff	-14.609**	(6.947)	820	0.256	(1.309)	16,545

Note: Standard errors are clustered at the household level, standard errors in parantheses. ATEs are estimated in the specified subgroup based on Difference-in-Differences models. ***, **,* denote statistical significance at the 1%, 5% and 10% level, respectively. Participants in the above median, top quartile, and top decile groups consume more than 11.3, 14.5, and 19.2 kWh per day (REG) and 13.4, 17.8, and 24.5 kWh (SREG), respectively.

Conclusions

Conclusions

- In contrast to previous studies on retirement savings (Dolls et al. 2018) and social comparison based reports (Allcott2011), our evidence suggests that letter-based information campaigns are largely ineffective when used as a universal policy

- Site-specific factors represent a significant obstacle for bringing an informational intervention to scale

- First, they complicate learning from a pilot study about the effect sizes of the same intervention at another site

- Second, they prevent the derivation of generally applicable targeting strategies that could otherwise allow the cost-effectiveness of informational interventions to improve.

Conclusions

- Contribution to literature on home energy reports (HER): social comparison might not be the crucial element that triggers energy conservation

- Andor et al. 2020: 0.7% for HER in Germany; only about half of the conservation effect that the information letter achieve at REG

Thank you!

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