The Role of Information for Electricity Consumption: Smart Metering, Expert Advice and Social Information

Kathrin Degen [1]   Lorenz Goette [1]   Rafael Lalive [1]

[1]University of Lausanne
Facult des HEC

BFE Workshop: Current Issues in DSM - October 16, 2013

Energy policy today

Policy challenges in the energy sectors are great

- Providing a secure energy supply
- Reducing CO_2 emissions
- Phasing-out of nuclear power in the medium run

Different approaches to achieve this goal

- Concentration on renewable energy and hydrodynamic power technologies
- Strengthen research in energy
- Reduce baseline energy consumption and foster energy-efficiency

2000-watt society: Aims at reducing the baseline energy use per capita from 6300 watt today to 2000 watt in the year 2100

How can we affect individual behavior?

Information as potentially cheap and efficient way to reduce electricity consumption

- Can providing information about electricity consumption help to save electricity?

What type of information helps?

- **Smart Metering:** Individual and detailed real-time feedback on electricity use
- **Expert advice:** Information about savings potentials through advice from energy experts
- **Social comparison:** Information about own electricity consumption relative to a comparable partner household

Policy analysis: Randomized trials

The **pitfalls** of correlations

- If individuals using smart meters use less electricity, how should this be interpreted?
- ▶ Possible that individuals asking for a smart meter are more motivated to save energy.

- Correlational analysis confounds two effects: smart meter and motivation.
- ▶ Dangerous to interpret in a causal way!
- ▶ Cannot base policy on such evidence!

Random assignment to treatments solves this problem

- ▶ Need to run a randomized study

Policy analysis: Understanding psychological mechanisms

Little is known about the **psychological mechanisms triggered by the intervention**

- What are the effects of an intervention on individuals' wellbeing?
- What are the mechanisms that make the treatment effective

Individual heterogeneity is important

- A treatment may not work on all individuals, but on which does it?

Policy analysis needs to understand the mechanisms

▶ If resources are limit, to whom best target the intervention?

Outline

1. Motivation

Outline

1. Motivation

2. The Experimental Setup

Outline

Outline

Outline

1 Motivation

2 The Experimental Setup

3 Results

4 Conclusions

The *ewz* Smart Metering Field Study

Scope: Large-scale study to understand the role of information

- Joint development of design with *ewz*
- Implementation with the lead of *ewz*
- Evaluation with the lead of UNIL, supported by Swiss Federal Office of Energy.

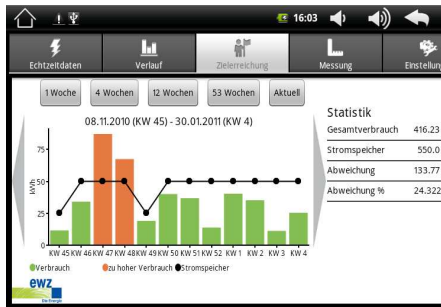**Design:** Randomized study accompanied with surveys and choice experiments to understand mechanisms.

- Randomized assignment to one of five experimental groups
- All participants are surveyed at regular intervals: focus on measuring personality traits.

Procedures: Conducted with roughly 5,000 customers of *ewz* 2011 - 2013.

Treatment groups

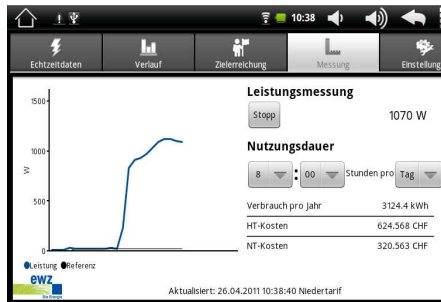Households were randomly assigned:

- **Control Group:** No intervention

- **Smart Metering:** Households receive real-time feedback on their electricity consumption using smart metering technology.

Treatment groups

Households were randomly
assigned:

- **Control Group:** No
  intervention

- **Smart Metering:**
  Households receive real-time
  feedback on their electricity
  consumption using smart
  metering technology.

Treatment groups

Households were randomly assigned:

- **Control Group:** No intervention
- **Smart Metering:** Households receive real-time feedback on their electricity consumption using smart metering technology.
- **Expert Advice:** Households get access to expert advice

Wünschen Sie eine persönliche Energieberatung?

Besuchen Sie uns im Kundenzentrum am Beatenplatz 2. Wir beraten Sie gerne und kostenlos. Ob Haushaltgeräte, Licht oder Heizung – wir haben die Antworten auf Ihre Energiefragen.

Gerne leihen wir Ihnen kostenlos Energiemessgeräte aus, mit denen Sie den Stromverbrauch Ihrer Geräte messen und so allfällige Stromfresser aufspüren können.

Auch Fragen zur Stromrechnung, Umzugsservice, Ökostrom und Förderbeiträge des Stromsparfonds beantworten wir Ihnen gerne im Kundenzentrum.

Energieeffizient sanieren oder bauen.

Rund die Hälfte der Energie wird in der Stadt Zürich durch Gebäude verbraucht. Die Stadt Zürich unterstützt Immobilienbesitzerinnen und -besitzer mit zwei Beratungsangeboten: dem Energiecoaching für Neubauten und Sanierungen, in denen das Steigerungspotenzial des Gebäudes geschätzt wird.

Ausleihservice und Tipps.

|	
Energiemessgerät	Energiespartipps
LED- und Energiesparlampen testen	Ökostrom bestellen

Treatment groups

Households were randomly assigned:

- **Control Group:** No intervention

- **Smart Metering:** Households receive real-time feedback on their electricity consumption using smart metering technology.

- **Expert Advice:** Households get access to expert advice

- **Social Information:** information about own and a partner household's electricity consumption.
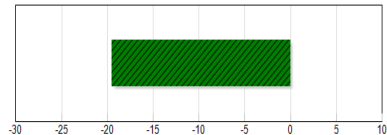
Ihr Stromverbrauch liegt -19.49 % unter dem Ihres Vergleichshaushalts.
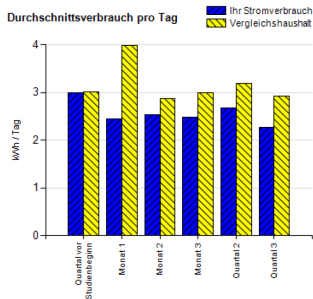
Data Sources

Electricity consumption data: 8 readings over a period of 15 months: pre-treatment, then monthly (m1-m3) and quarterly (q2-q4) rythm

Surveys: 2 comprehensive surveys before and after the treatment phase; 4 intermediary surveys during treatment phase

- Household and demographic characteristics, personality traits, attitudes about environmental and knowledge of energy-relevant topics

The empirical specification

We estimate the following regression model

$$\Delta y_{it} = \beta_0 + \gamma_0 T_i + \gamma_1 T_i \times z_i + \beta_1 z_i + \omega_t + \epsilon_{it}$$

where

$$\Delta y_{it} \quad : \quad$$ Change in electricity consumption of household i at measurement t relative to baseline measurement

$$T_i \quad : \quad$$ Treatment indicator

$$z_i \quad : \quad$$ personality trait of individual i (centered to mean).

- β_0 measures the average change in the control group.
- β_1 measures how consumption grows as a function of z_i.
- γ_0 measures the average response to the treatment.
- γ_1 measures how the response to the treatment varies with personality trait z_i.

Empirical strategy

Personality traits z_i and the response to the treatments: Focus is on
two traits

- Conscientiousness: just that.
- Emotionality: fearfulness of things that come from outside,
  dependence on others to guide one.

Outline

1 **Motivation**

2 **The Experimental Setup**

3 Results

4 **Conclusions**

Result 1: Emotionality reduces treatment effects

Quarter 1 (monthly readings)

Dependent variable: change in kWh/day consumption relative to baseline

Interacting personality trait	Honesty	Emotionality	Dependence	Fearfulness & Anxiety
Trait	0.010	-0.162**	-0.011	-0.136**
	(0.068)	(0.081)	(0.049)	(0.062)
Smart Meter	-0.239***	-0.240***	-0.244***	-0.238***
	(0.070)	(0.070)	(0.071)	(0.070)
Expert Advice	-0.106	-0.107	-0.106	-0.107
	(0.066)	(0.066)	(0.066)	(0.066)
Social Info	-0.198***	-0.199***	-0.200***	-0.200***
	(0.054)	(0.054)	(0.054)	(0.054)
SM × Trait	-0.207	0.279**	0.133	0.247*
	(0.132)	(0.136)	(0.100)	(0.129)
EA × Trait	-0.051	0.011	-0.062	0.070
	(0.108)	(0.122)	(0.074)	(0.100)
Social × Trait	0.027	0.216**	-0.001	0.195**
	(0.099)	(0.105)	(0.062)	(0.080)

Result 1: Emotionality reduces treatment effects
Quarters 2 - 4 (quarterly readings)

Dependent variable: change in kWh/day consumption relative to baseline

Interacting personality trait	Honesty	Emotionality	Dependence	Fearfulness & Anxiety
Trait	0.010	-0.162**	-0.011	-0.136**
	(0.068)	(0.081)	(0.049)	(0.062)
Smart Meter	-0.183***	-0.181***	-0.184***	-0.179***
	(0.064)	(0.064)	(0.065)	(0.064)
Expert Advice	0.047	0.046	0.049	0.044
	(0.067)	(0.067)	(0.067)	(0.067)
Social Info	0.024	0.027	0.026	0.028
	(0.054)	(0.054)	(0.054)	(0.054)
SM $\times$ Trait	-0.166	0.338***	0.171**	0.283***
	(0.119)	(0.126)	(0.086)	(0.109)
EA $\times$ Trait	-0.154	0.020	-0.016	-0.001
	(0.111)	(0.119)	(0.075)	(0.096)
Social $\times$ Trait	-0.004	0.141	0.019	0.105
	(0.104)	(0.105)	(0.065)	(0.083)

Result 2: Conscientiousness increases treatment effects
Quarter 1 (monthly readings)

Dependent variable: change in kWh/day consumption relative to baseline

Interacting personality trait	Extraversion	Agreeableness	Conscientiousness	Openness
Trait	0.000	0.083	0.168**	-0.093
	(0.097)	(0.086)	(0.084)	(0.070)
Smart Meter	-0.245***	-0.241***	-0.233***	-0.240***
	(0.071)	(0.071)	(0.070)	(0.071)
Expert Advice	-0.105	-0.106	-0.101	-0.108
	(0.066)	(0.066)	(0.066)	(0.066)
Social Info	-0.202***	-0.201***	-0.197***	-0.203***
	(0.054)	(0.054)	(0.054)	(0.054)
SM × Trait	-0.197	-0.150	-0.626***	0.061
	(0.188)	(0.155)	(0.164)	(0.125)
EA × Trait	0.092	-0.156	-0.215	0.073
	(0.137)	(0.136)	(0.138)	(0.122)
Social × Trait	0.040	-0.077	-0.141	0.126
	(0.115)	(0.112)	(0.103)	(0.084)

Result 2: Conscientiousness increases treatment effects
Quarters 2 - 4 (quarterly readings)

Dependent variable: change in kWh/day consumption relative to baseline

Interacting personality trait	Extraversion	Agreeableness	Conscientiousness	Openness
Trait	0.000	0.083	0.168**	-0.093
	(0.097)	(0.086)	(0.084)	(0.070)
Smart Meter	-0.187***	-0.181***	-0.178***	-0.181***
	(0.065)	(0.065)	(0.064)	(0.064)
Expert Advice	0.050	0.047	0.051	0.046
	(0.067)	(0.067)	(0.067)	(0.067)
Social Info	0.026	0.025	0.030	0.025
	(0.054)	(0.054)	(0.054)	(0.054)
SM × Trait	-0.261*	-0.105	-0.542***	0.033
	(0.151)	(0.131)	(0.141)	(0.113)
EA × Trait	0.129	-0.018	-0.293**	0.120
	(0.143)	(0.127)	(0.132)	(0.121)
Social × Trait	0.097	-0.016	-0.135	0.111
	(0.116)	(0.112)	(0.106)	(0.086)

Outline

1 **Motivation**

2 **The Experimental Setup**

3 **Results**

4 **Conclusions**

Summary and interpretation of the results

Information in various forms can help reduce energy consumption

- smart metering and social information: by roughly 3 to 4 percent of baseline consumption.

Important behavioral heterogeneity in response to treatment

- Anxious individuals display a much weaker response to smart seter and Social information treatment.
- Conscientious individuals show a larger response to smart meter.

Results for social information are only significant if frequency is high enough

- ▶ Potential to combine this with new technologies to make it more interactive.

What can we learn for policy analysis

Randomized trials provide the only reliable evidence for policy advice

Solid tests of psychological mechanisms provide useful insights for research and policy

Our study shows that such trials can be integrated into normal business