Demand-side management by electric utilities in Switzerland: Analyzing its impact on residential electricity demand

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Energy efficiency

- Energy efficiency a part of the strategy of many industrialized nations to reduce the emissions of greenhouse gases
- Benefits of energy efficiency:
  - Reduce air pollution from SO_2, NO_x, O_3 and PM.
  - Improve energy security
  - Prevent the need for constructing expensive new power plants
  - Prevent the need for upgrades in the transmission networks
- Discussion on energy efficiency, and energy policy in general, received added impetus due to the Fukushima Daiichi nuclear accident on 11 March, 2011

DSM in Switzerland

- *Energy Strategy 2050* seeks to reduce $\sim$ 16 TWh of electricity by 2050 compared to BAU
- Utilities are key players as they have contact with end-use consumers
- Demand-side management (DSM) may be one strategy used to reach this goal
  - DSM refers to *"the planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify patterns of electricity usage, including the* **timing and level** *of electricity demand"* (EIA, 1999)

DSM

- Why should utilities pay to sell less of their product?
- Two possible reasons are:
  1. (Public) mandate
  2. It is profitable for them to reduce demand
- May be profitable for a utility to reduce its demand when it faces a large cost elasticity
  - The costs to reduce the demand by a unit is less than to build a new power plant

DSM in Switzerland

- Information material (leaflets, magazine, web-page)
- Public relations (Fairs, etc.)
- Rental of energy meters
- Personal consulting at home
- Energy advice centres
- Funding for replacement of appliances / electric heating systems
- Tariff design (Time-of-use and others)

Research questions and approach

Research Questions

- Do utility DSM programs in Switzerland have an impact on residential electricity consumption?
- What is the magnitude of this impact, if any?
- How cost effective are these DSM programs?

Approach:

- Difference-in-differences in a regression framework

Contribution

- Contributes to public policy debate about degree to which DSM programs can reduce demand for electricity in residential sector
- To our knowledge, the **first econometric estimation** of the effectiveness of DSM programs **in a European country**
- We also construct an EE score similar to the ACEEE score card to measure a utility's commitment to promote energy efficiency

Survey data

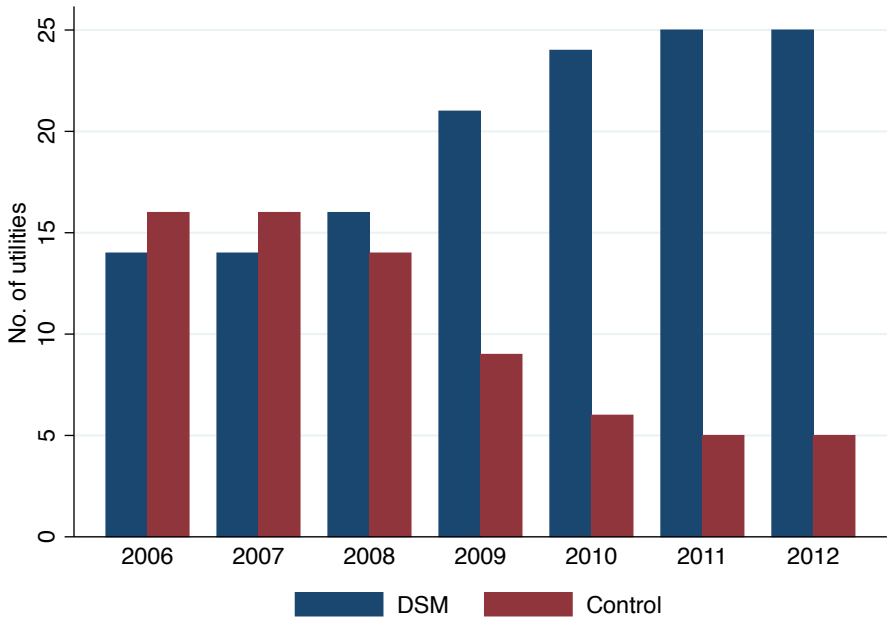
- Survey sent to 105 utilities (including the 50 largest ones), 30 useful answers collected
- **Panel data** (2006–2012) on
  - electricity sales, tariffs and number of residential customers
  - characteristics of the utility company
  - DSM measures and expenditure
- These 30 utilities served 50% of the Swiss population in 2011
- Additional data:
  - Heating and cooling degree days (MeteoSchweiz)
  - Population, political variables and taxable income (BFS)

Empirical strategy

$$\ln E_{it} = \beta_0 + \beta_1 DSM_{it} + \beta_2 p_{it}^E + \beta_3 Y_{it} + \beta_4 HS_{it} + \beta_5 HDD_{it} + \beta_6 CDD_{it} + \lambda_i + \delta_t + \epsilon_{it}$$

- E_{it}: electricity consumption (kWh per customer)
- DSM_{it}: relevant DSM policy variable
- p_{it}^E: electricity price
- Y_{it}: average taxable income per taxpayer
- HS_{it}: average household size
- HDD_{it}, and CDD_{it}: heating and cooling degree days
- λ_i: utility fixed effect
- δ_t: year fixed effect
- ϵ_{it}: usual idiosyncratic error term

Policy variables



Variable	Mean	Std. Dev.	Min.	Max.
Positive DSM expenditure	0.66	0.47	0	1
DSM expenditure per customer	2.86	6.13	0	30.83
EE Score	1.20	0.88	0	3.50

Energy efficiency score

- We create an energy efficiency index using five categories:
  - Utility's strategy
  - Tariff design
  - Consulting offers: 6 measures from weblinks to energy advice centre
  - Replacement of appliances
  - Spending on financial programs
- Score can be between 0 and 4 points.
- Equal weight of 20% to each category

Effects of DSM on consumption

(1) DSM Dummy

Introduction of DSM	$\beta_1 \cdot 100$	$\Rightarrow -4.70\%$

(2) DSM Spending

Increasing CHF/cust by CHF 1	$\beta_1 \cdot 100$	$\Rightarrow -0.50\%$
Increasing CHF/cust by 10%	$\beta_1 \cdot \overline{CHF/cust} \cdot 10$	$\Rightarrow -0.14\%$

(3) EE-Score

Increasing EE score by one point	$\beta_1 \cdot 100$	$\Rightarrow -3.00\%$
Increasing EE score by 10%	$\beta_1 \cdot \overline{Score} \cdot 10$	$\Rightarrow -0.36\%$

Robustness checks

- Parallel trend assumption: Do treated and untreated groups have the same trend?
- Placebo tests:
  1. Exclude utilities that had DSM in all years
  2. Shift change of treatment status to earlier years
  3. Check for significant effect
- Placebo tests show no significant results
- However number of observations reduced drastically

Robustness checks

- Utilities with a higher consumption may implement DSM
- IV as robustness check
- Problem: Find good instruments
- We use share of own production and legal form of the utility as instruments
- However, low variation of instruments over time
  - Dummy endogenous variable model
  - Bootstrapped IV for continuous policy variables
- IV approaches show significant and negative effects of DSM

Policy implications

Simple **counterfactual exercise** to obtain an estimate of the cost to a utility of DSM programs

- Average cost of 0.04 CHF per kWh
- Using $\pm$ one standard deviation of the point estimates cost is 0.03 to 0.09 CHF per kWh
- Average cost of producing and distributing electricity in Switzerland is CHF 0.18 per kWh

Conclusions

- Results of the econometric part indicate a statistically significant impact of DSM programs
- Size of the impact is "*small*"
- Cost per kWh saved is smaller than cost per kWh of producing and distributing electricity
- DSM programs are a valuable option for Switzerland

Thank you for your attention...

QUESTIONS?
COMMENTS?

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