Consumer behavior

Lecture 5

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The question: can we trust that consumers respond to economic incentives?

How sensitive consumers are to the expected cost of using energy-consuming durables?

- Automobiles: changes in fuel prices should lead to changes in the relative value of fuel-efficient cars
- consumers should be indifferent between spending a dollar in present value on energy and a dollar in present value on purchase price
- Energy durables: future energy prices should affect the equilibrium upfront purchase price

Illustration: heating technologies in Finland. Can households evaluate the long-term cost of using?

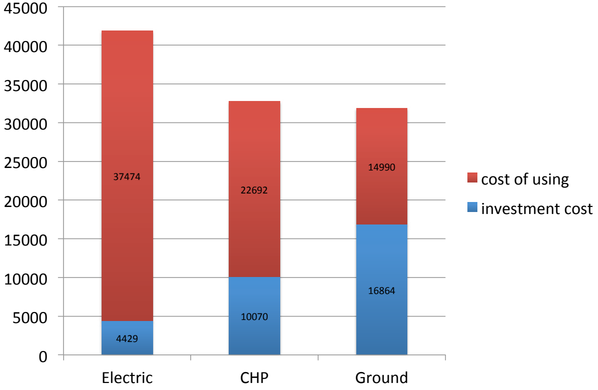


Figure: Present-value heating cost in heating for three technologies. Average house, 2010 RTS cost reports, 25 years, 5 % discount

Does the market reward for energy efficiency?

- Important for policies: policies affecting future prices should have some effect on purchase decisions today; otherwise, better to use more paternalistic approaches
- There is a belief and some evidence that consumers are myopic. Used to justify significant regulations
  - billions of dollars in subsidies for energy efficient durables such as air conditioners and lightbulbs (NHTSA 2010)
  - European Union: the Energy Performance of Buildings Directive (EPBD)
  - subsidy schemes for ”green cars”

Illustration

$$q^d = \alpha_0 - \alpha_1 p - \gamma C + u \quad (1)$$
$$q^s = \beta_0 + \beta_1 p + v \quad (2)$$
$$q^d = q^s \quad (3)$$

q^d is the quantity demanded, q^s is the quantity supplied, and p is the price. The error terms (u, v) are shifters of the demand and supply schedules on the quantity-price plane. C measures the consumer cost of using the good over the relevant life time, with discount factor $\delta < 1$. For example:

$$C = \sum_{t \geq 0} \delta^t (usage)_t \times (usageunitcost)_t \quad (4)$$

Illustration, cont.

Questions:

- What is the equilibrium price in this market? Quantity?
- If consumers do not pay full attention to the cost of using, where does it exactly show up in the model?
- How does the consumer myopia distort the market outcome?
- Can we identify the consumers' willingness to pay for lower usage costs with this model?

Energy Paradox & Energy Efficiency Gap

- Hausman (1979): consumers have ”defective telescopic faculty”.
- Dubin & Hausman (1984): 15-25 per cent interest needed to justify the choices
- explanations
  - Uncertainty information
  - Asymmetric information
  - Market imperfections
  - Inattention

Further readings in the dropbox.

A simple model to fix ideas

- $U(x)$, utility from energy service (temperature, transportation, etc.) for individual i
- p, price of energy (fuel, electricity)
- e, measure of energy efficiency (Kwh/m2 in heating, miles per gallon, etc).

The consumer's problem is to choose how much to consume:

$$V_i(e) = \max_x [U(x) - p \cdot e \cdot x]$$

Naturally, the value is greater, the better is energy efficiency:

$$V_i(e_0) < V_i(e_1)$$

where $e_0 > e_1$.

The investment in energy efficiency:

- c, one-time cost of upgrading the technology from e_0 to e_1
- $1 + r$, gross return requirement

Invest if and only if:

$$[V_i(e_1) - V_i(e_0)]/(1 + r) > c$$

Note:

- a better technology can lead to more consumption, i.e., x may increase
- we can do similar analysis for price changes

Distortions: unawareness, imperfect information

- $\gamma > 1$, a measure of imperfection

The consumer may not be able to evaluate gains, and thus

$$[V_i(\gamma e_1) - V_i(e_0)]/(1 + r) < c$$

even though for $\gamma = 1$, the investment would pay off.

- the consumer may not understand the technology..
- ..or may not be able to evaluate costs of using it..
- ..or may not pay attention
- If so, what are the policy options? See next page.

Information campaign can work:

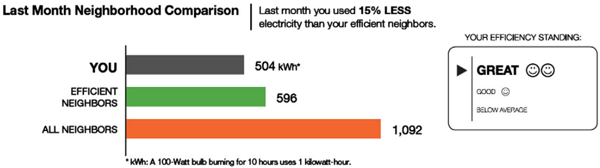


Fig. 1. Home energy reports: social comparison module.

Figure: Source: Social norms and energy conservation, Hunt Allcott, Journal of Public Economics 95 (2011) 1082-1095

Information campaign can work:

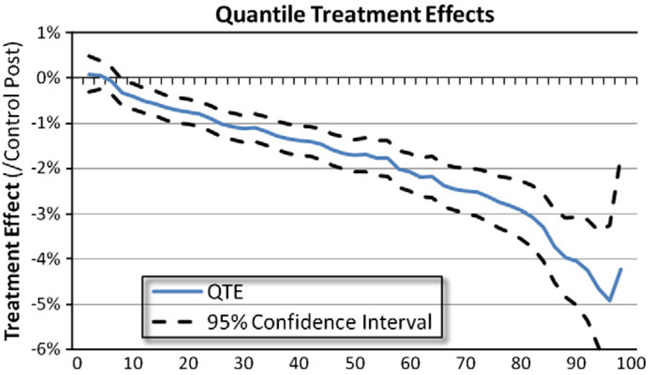


Figure: Allcott: This paper evaluates a series of programs run by a company called OPOWER to send Home Energy Report letters to residential utility customers comparing their electricity use to that of their neighbors. Using data from randomized natural field experiments at 600,000 treatment and control households across the United States, I estimate that the average program reduces energy consumption by 2.0%. The program provides additional evidence that non-price interventions can substantially and cost effectively change consumer behavior: the effect is equivalent to that of a short-run electricity price increase of 11 to 20%, and the cost effectiveness compares favorably to that of traditional energy conservation programs. Perhaps because the treatment included descriptive social norms, effects are heterogeneous: households in the highest decile of pre-treatment consumption decrease usage by 6.3%, while consumption by the lowest decile decreases by only 0.3%.

Uncertainty

Consider that it is not known with certainty how much the new technology saves, for example, because the cost of using is uncertain. Savings can be low or high, $V_i^L(e_1) < V_i^H(e_1)$. High with prob. π and low with prob. $1 - \pi$. Assume that it makes sense to invest using expected values but not if the value is known to be low:

$$[\pi V_i^H(e_1) + (1-\pi) V_i^L(e_1) - V_i(e_0)]/(1+r) > c$$
$$[V_i^L(e_1) - V_i(e_0)]/(1+r) < c$$

Investment today: must be based on expected values. Wait-and-see strategy: invest in the future after learning the true value. Can you see when precisely it makes sense for the consumer to wait and why? Note that this option value of waiting shows in behavior as if the consumer is inattentive but this is not at all the case!

Distortions: credit constraints

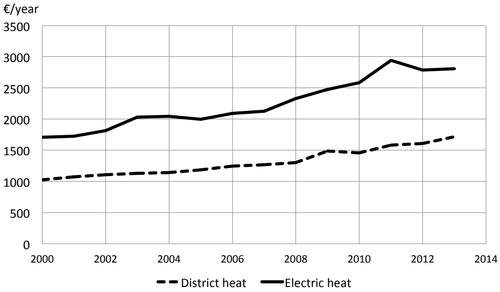
- $r^i > r$, individual's interest rate may differ from the market rate

The following defines the implicit discount rate used:

$$[V_i(e_1) - V_i(e_0)]/(1 + r^i) = c$$

- there is recent evidence that the myopia may not be a major issue. See the article below.

Illustration I: Heating costs and house prices



National averages in energy costs for electricity and district heating. Annual cost in 2013 euros for the reported years; house size 170 m^2 with energy need 130 kWh/m^2 (22100 kWh per year). Source: The Finnish Energy Industries.

Figure: Source *here*

Illustration I: Heating costs and house prices

Energy cost savings from district heat					
Discount rate	1%	2%	3%	4%	5%
Saving (€)	23662	21094	18925	17084	15513

The energy cost difference between electric and district heating for an average house: 170 m^2 (size), 130 kWh/m^2 (energy need). The number is the present-value of the 25-year saving in 2013 when the annual saving is given by the historical average energy cost difference obtained from electricity and district heat contract prices 2006-2013 in the Helsinki metropolitan area. Electricity prices are from default contracts available to any household in the region (data source: The Finnish Energy Industries and Energy Authority).

Figure: Source *here*

Illustration I: Heating costs and house prices

Energy cost capitalization for an average house		
	In Euros	Implied discount rate
Point estimate	21 080	2 %
Standard error	[12 580, 29 600]	[0%, 6.6%]

The estimated main effect of the technology on the house price in euros for the mean transaction in the data. The implied real discount rate obtained by assuming that the house price premium reflects 25-year savings in energy costs.

Figure: Source *here*

Illustration II: Heating technologies in new houses

Anna Sahari (2016, doctoral thesis) estimates households' willingness to pay higher investment costs in order to obtain reductions in lifetime energy costs

- reveals how households value future operating costs, and can be used to infer household-specific implied discount rates.
- based on extensive micro-level data on Finnish households? choice of heating technology at the moment of building a new house.
- The data from administrative records, and allows estimating willingness to pay as a function of several observable household characteristics. Heating costs are based on regional electricity prices.
- On average, households are estimated to be willing to pay €14 more in investment cost to save one euro annually in heating costs.
- This implies discount rates averaging 5 to 6 percent, when calculated at the lifetimes commonly used

Illustration II

Table 1: Summary statistics on builders and houses.

	Oil	Electric	Hydroelectric	Ground heat	Wood	Other
Age	39	37	35	36	36	35
High education, share	0.29	0.32	0.41	0.48	0.29	0.39
Net Income	46 969	46 540	47 786	52 428	42 454	48 428
Family size	3.29	3.29	3.36	3.40	3.26	3.27
Young children, share	0.31	0.37	0.44	0.46	0.39	0.41
Area (m^2)	195	161	172	199	180	181
Wood houses, share	0.86	0.94	0.92	0.85	0.93	0.86
Element houses, share	0.39	0.50	0.60	0.47	0.32	0.49
Town plan area, share	0.52	0.65	0.67	0.55	0.21	0.62
Overall share	0.01	0.39	0.17	0.32	0.07	0.05

Notes: The table presents summary statistics of house and household characteristics by installed heating technology. Numbers calculated for the time period 2007-2011, used in estimation. The education variable refers to the share of home owners with at least bachelor level education. Income is defined as all earnings and benefits net of taxes, in 2010 values. 'Young children' refers to the share of families with children under 3 years of age. 'Town plan' is an indicator for whether a town plan is in force at the building site as opposed to a less detailed master plan.

Figure: Source: Anna Sahari, 2016

Illustration II

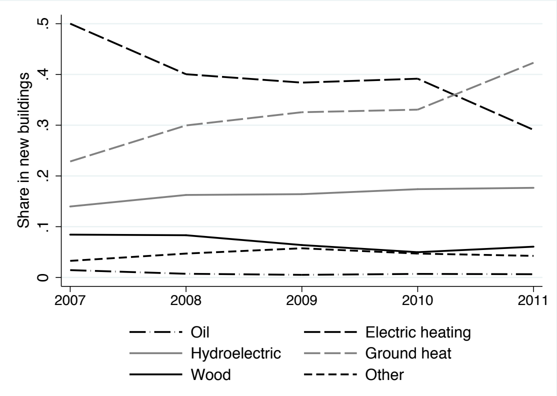


Figure: Source: Anna Sahari, 2016

Illustration II

Table 2: Costs and house characteristics by heating system

	Electric	Hydroelectric	Ground heat
Average size (m^2)	164	173	199
Average heat need (kWh)	19 512	20 055	22 661
Investment cost	4355	8248	17 561
Electricity cost	830	847	346
Distribution cost	800	773	330
Lifetime cost at T=20 and r=5%			
	26 295	30 053	26 660

Notes: The table shows average costs for installed heating systems in the data. The investment costs are based on cost estimates obtained from the annual Building Information Foundation catalogue on material and labour costs of building. The operating costs are based on electricity and distribution prices, house size and expected annual heat consumption for each house.

Figure: Source: Anna Sahari, 2016

Illustration II

Investment cost	1	1	1
Heating cost (WTP)	-10.982***	-13.519***	-14.230***
	(1.117)	(1.796)	(1.783)
Interaction terms			
Income (€10 000)			-0.425***
Education			-1.285***
Age			0.202**
Family size			0.668***
Children			-1.163***
Child benefits			-0.370*
Unemployment benefits			0.378*
House owner			1.957***
Building sold			3.458***
SD of random coefficients			
Heating cost (WTP)		3.055***	
Log likelihood	-19 721	-19 716	-19 457
% correctly predicted	0.56	0.56	0.57
Number of households: 20 556			

Notes: The table presents results from a logit estimation of heating system choice. The options are electric heating, hydroelectric heating and ground heat. The coefficient on investment costs is constrained to one, other coefficients are directly interpreted as willingness to pay-values. All specifications include alternative-specific constants interacted with year indicators and indicators for location in a town plan area. Significance levels: * 10%, ** 5%, *** 1%.

Figure: Source: Anna Sahari, 2016

Illustration II

Table 4: Implied discount rates (%) from estimated WTP

	T=15	T=20	T=25
Mean	2.5	5.1	6.4
Minimum	-4.3	-0.8	1.1
Maximum	20.5	21.4	21.7
Mean by household characteristic			
High education	1.6	4.3	5.6
Low education	3.6	6.1	7.2
Current residence own house	3.9	6.3	7.4
Building sold	8.0	9.9	10.8

Notes: The table presents discount rates implied by willingness to pay-estimates based on specification 3 in table 4. In this specification, the variance in WTP is based on observable household characteristics. A WTP and the corresponding discount rate is calculated for each household in the estimation sample, amounting to 20 556 observations. Of household characteristics, high education refers to education at least at the bachelor level. House owners are households who reside in their own detached house at the time of building. 'Building sold' refers to the implied discount rate for those households who sell the newly built home during the observation period.

Figure: Source: Anna Sahari, 2016