Prices vs. Nudges: A Large Field Experiment on Energy Efficiency Fixed Cost Investments

Jacob LaRiviere, University of Tennessee
Michael Price, Georgia State & NBER
Scott Holladay, University of Tennessee
David Novgorodsky, University of Chicago

August 11, 2014

Camp Resources 2014

Studying Nudges Informed By a Model

Why study nudges?

- Nudges affect behavior, at least in electricity choices
  (Allcott 2011, Costa and Kahn 2011, Ferraro and Price 2013, and Ito et. al. 2013)
- 1 nudge = \$20 value? \$50 value?

Why do we need a model?

- If nudges increase in-home energy audits, but leave electricity use and investment in energy-efficient durables unchanged, what have we learned?
- Does the interpretation of the above change if it holds *only* for nudges that appeal to public good? What if the above result holds *independent* of the type of nudge (so it's merely the act of nudging)?
- Theoretical model takes us beyond a description of average treatment effects.

Experimental Decision Tree

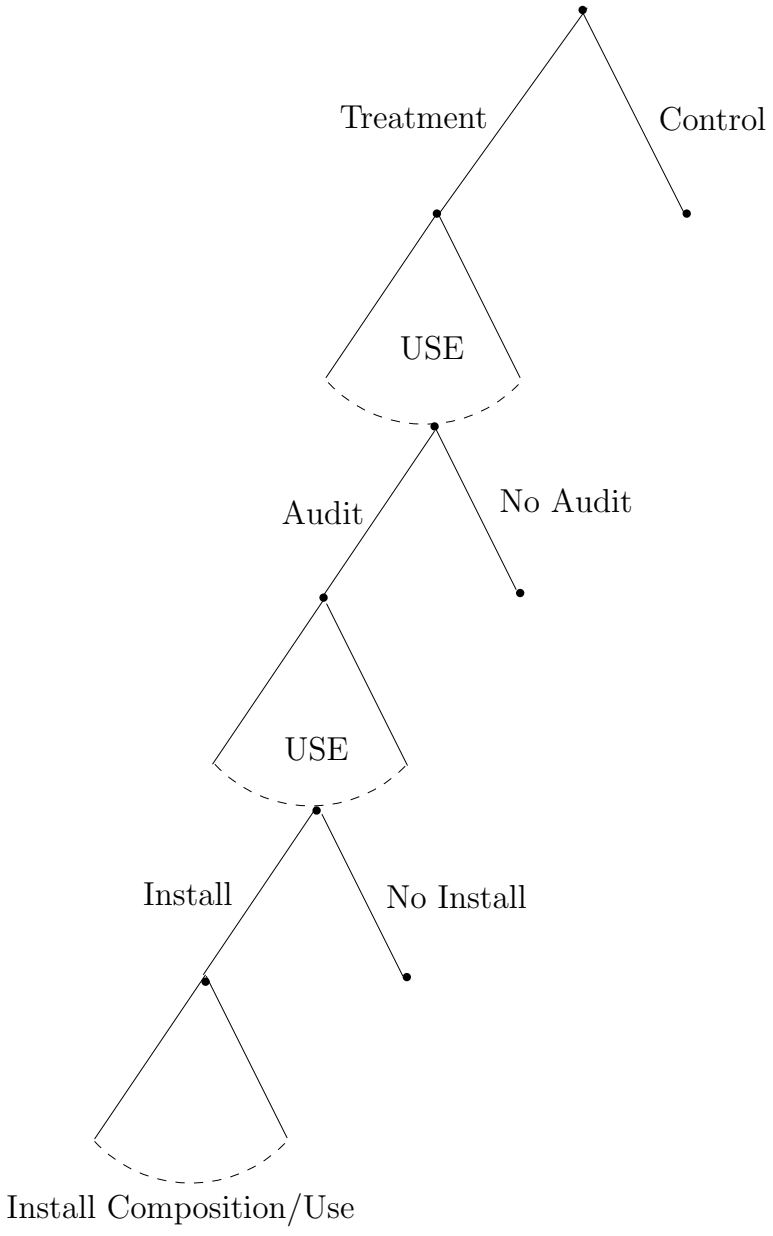


Table: Treatments Used in Field Experiment

Message Subsidy	No Comparison	KWh Comparison	$ Comparison	CO2 Comparison
$0	1	2	3	4
$20	5	6	7	8
$50	9	10	11	12

NOTE: Numbers indicate individual treatments only.
There was a large control group as well.

Example Letter

Company Logo

Date

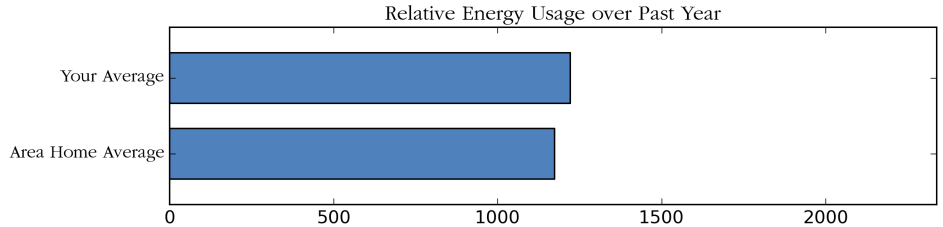
Dear Valued Customer,

There's no place like home, and there's no time like now to make your home more energy efficient. You can conserve energy, save on utility bills, and get cash rebates by participating in [redacted] program. If you qualify, you can also use on-bill financing to pay for [redacted]

If you sign up for an [redacted] will visit your home at a time convenient for you. The advisor will recommend cost-effective ways to increase your home's energy efficiency and will install free CFLs and low-flow water saving measures if you choose.

The [redacted] evaluation fee is $150 (currently with an instant rebate of $100). And you will receive the remaining $50 fee back if you spend $150 or more on qualifying improvements. You will also receive matching rebates of up to $500 for installing eligible improvements. As an additional thank you for participating, if you have an [redacted] within 30 days from the date of this letter you will receive a $20 Visa gift card.

We thought that you might be interested in the following information about your energy usage last year:



Kilowatt hours is a unit of energy equal to one kilowatt of power used for one hour.
A 100 Watt bulb burning for 10 hours/week uses 1 kWh (100/1000 * 10)

Your Average Energy Usage	1221.75 kWh
Local Area Homes' Average Energy Usage	1173.03 kWh

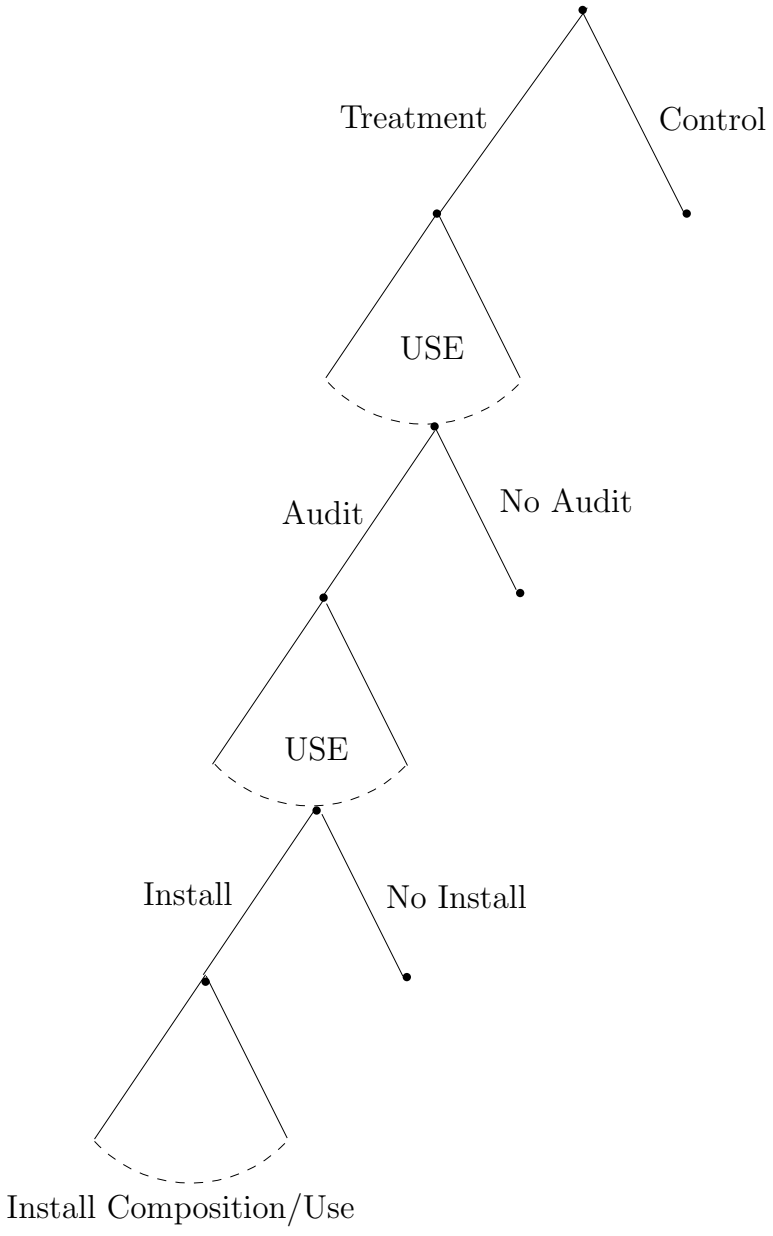
You consumed 4% more energy than other area homes

For more information about the [redacted] program, including on-bill financing, call [redacted] You can also find more information about the program and details about qualifying improvements by following the [redacted] link on the [redacted] home page.

Sincerely,

[redacted]

Experimental Decision Tree



Theoretical Model

$$U_i(a, A, I; \delta, s, n(t), \Theta) =$$
$$E\left[c(a, A, I; \delta, s, \Theta) - p_e a\right] - M(a, A, I; s, n(t), \Theta) - (p_A 1\{A\} + p_I 1\{I\})$$

- 3 actions: a = electricity use, $A = 1\{Audit\}$, $I = 1\{Install\}$
- 4 treatment shifters:
  δ = monthly expenditure salience (in the spirit of Bordalo, Gennaioli, and Shliefer 2013)
  s = relative use signal
  $n(t)$ = normative shading (depends on treatment, e.g., KWh shading, etc.)
- 3 prices: p_e = price of electricity, p_A = price of audit, p_I = price of durable good install

Theoretical Model

Consumption benefits for signing up for an audit:

$$E\left[\underbrace{c(a_1,1,I;\delta,s,\Theta)-p_e a_1-p_A}_{\text{Net consump. utility with audit}}-\underbrace{(c(a_0,0,I;\delta,s,\Theta)-p_e a_0)}_{\text{Net consump. utility w/out audit}}\right]$$

Moral benefits for signing up for an audit:

$$E\left[\underbrace{M(a_0,1,I;s,n(t),\Theta)}_{\text{Moral cost with audit}}-\underbrace{M(a_1,0,I;s,n(t),\Theta)}_{\text{Moral cost w/out audit}}\right]$$

Estimating Equation

$$ln\left(use_{it}\right) = \alpha_i + \nu_{tz} + 1\{post\ treatment_{it}\}\gamma$$
$$+\Sigma_{s=1}^{3} 1\{post\ treatment\ shading_{it}^{s}\}\beta_s + \epsilon_{it}$$

β_s: the marginal effect of "shaded" comparisons on use
NOTE: Experiment powered to pick up small change in use at 10% level.

Results on use

Table: Impact of Treatment on Electricity Use

	1	2	3
Any Letter	0.024***	0.022***	0.020***
	(0.003)	(0.003)	(0.004)
KWH Comparison	0.001	0.001	0.004
	(0.004)	(0.006)	(0.007)
Expenditure Comparison	-0.006	-0.010*	0.001
	(0.004)	(0.006)	(0.006)
CO2 Comparison	-0.010	-0.013*	-0.006
	(0.006)	(0.008)	(0.010)
Constant	7.071***	7.534***	7.060***
	(0.043)	(0.002)	(0.003)
Fixed Effects	House	House	House
	Month-Year	Month-Year	Month-Year
R^2	0.567	0.554	0.426
N	1256353	636746	619607
Sample	Full	Above Median	Below Median

Note: Dependent variable is logged monthly electricity use. Any treatment is an indicator for receiving any of the social comparison letters or an information only letter. Zip codes with fewer than 10,000 houses are grouped into a single unit in zip code fixed effects regressions. Column 2 is estimated on a sample restricted houses with average pre-experiment use below the median of our sampling frame and column 3 is estimated on houses with use above the median. All standard errors clustered at the house level. *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Estimating Equation

$$1\{uptake_{it}\} = \alpha + \nu_{tz} + 1\{post\ treatment_{it}\}\gamma$$
$$+\Sigma_{s=1}^{3} 1\{post\ treatment\ shading_{it}^{s}\}\beta_s$$
$$+subsidy_{it}\delta_1 + subsidy_{it}^2\delta_2 + \epsilon_{it}$$

β_s: the marginal effect of "shaded" comparisons on use
δ_1: Effect of subsidy on audit uptake

Table: Impact of Treatment on Audit Uptake

	1	2	3
Any Treatment	0.0002	0.0003	0.0001
	(0.0002)	(0.0003)	(0.0002)
KWH Comparison	0.0008**	0.0011**	0.0005
	(0.0003)	(0.0005)	(0.0004)
Expenditure Comparison	0.0005	0.0005	0.0004
	(0.0003)	(0.0005)	(0.0004)
CO2 Comparison	-0.0004	-0.0003	-0.0005**
	(0.0003)	(0.0005)	(0.0002)
Subsidy Amount	0.0042**	0.0057*	0.0026
	(0.0021)	(0.0034)	(0.0023)
Subsidy Amount^2	-0.0001*	-0.0001	-0.0000
	(0.0000)	(0.0001)	(0.0000)
Constant	0.0002***	0.0002***	0.0002***
	(0.0000)	(0.0000)	(0.0000)
R^2	0.001	0.001	0.001
N	1,251,369	634,118	617,251
Sample	Full	Above Median	Below Median

Note: Dependent variable is a dummy indicating an energy audit occurred in a given month at a house. Subsidy amount is defined in hundreds of dollars for readability. Column 2 is estimated on a sample restricted to3houses with average pre-experiment use below the median of our sampling frame and column 4 is estimated on houses with use above the median. All columns estimated via OLS with month-by-year-zip fixed effects and standard errors clustered at the house level. *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table: Impact of Treatment on Install Conditional on Audit

	1	2	3
Any Treatment	0.0669	0.1599	-0.1852
	(0.0959)	(0.1103)	(0.1570)
KWH Comparison	-0.2160*	-0.1705	-0.2363
	(0.1170)	(0.1404)	(0.2197)
Expenditure Comparison	-0.2242**	-0.2718*	-0.0770
	(0.1133)	(0.1394)	(0.1565)
CO2 Comparison	-0.3231***	-0.1960	-0.5803***
	(0.1210)	(0.1838)	(0.2160)
Subsidy Amount	-0.0864	-1.2804	2.5547*
	(0.8045)	(0.9742)	(1.5095)
Subsidy Amount^2	-0.0046	0.0150	-0.0545**
	(0.0147)	(0.0183)	(0.0255)
Constant	0.4426***	0.4221***	0.4774***
	(0.0292)	(0.0369)	(0.0470)
R^2	0.103	0.121	0.240
N	4466	2769	1697
Sample	Full	Above Median	Below Median

Note: Dependent variable is a dummy indicating an energy efficiency enhancing installation occurred in a given month at a house. Subsidy amount is defined in hundreds of dollars for readability. Column 3 is estimated on a sample restricted houses with average pre-experiment use below the median of our sampling frame and column 4 is estimated on houses with use above the median. All columns estimated via OLS with month-by-year-zip fixed effects and standard errors clustered at the house level. *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Take Home Results

- Private cost *and* social costs nudges affect intensive margin (use). Quantity nudges affect extensive margin (audits).
  - Same info, different shadings, different margins.
- Value of "right" signal is \$20 (\$10) for audit (install) uptake.
- Selection important: subsidies versus nudges have different effects for installs and install composition