Automatic Bill Payment and Price Salience: Evidence from Residential Electricity Consumption

Steven E. Sexton

NC State

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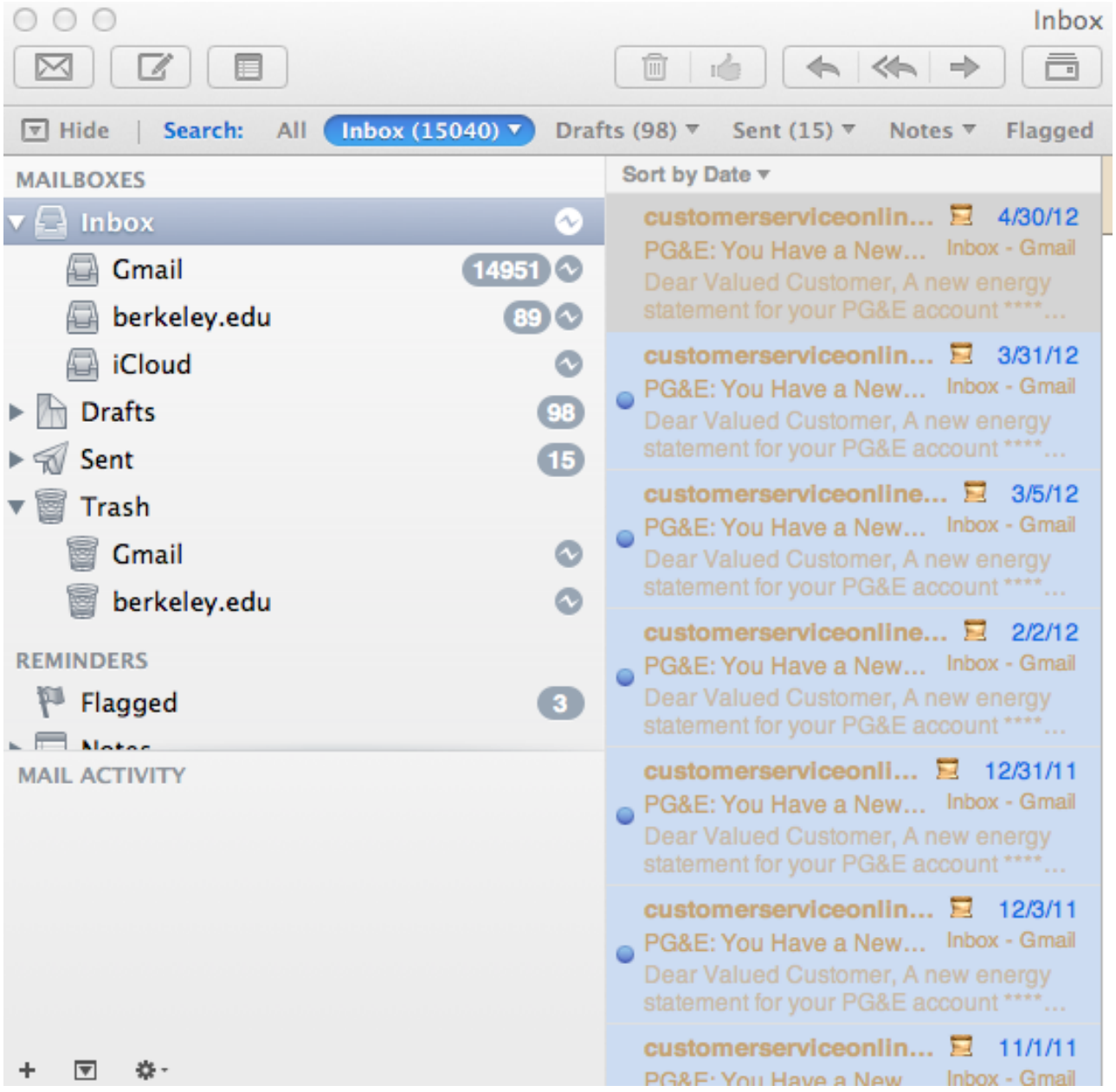
Motivation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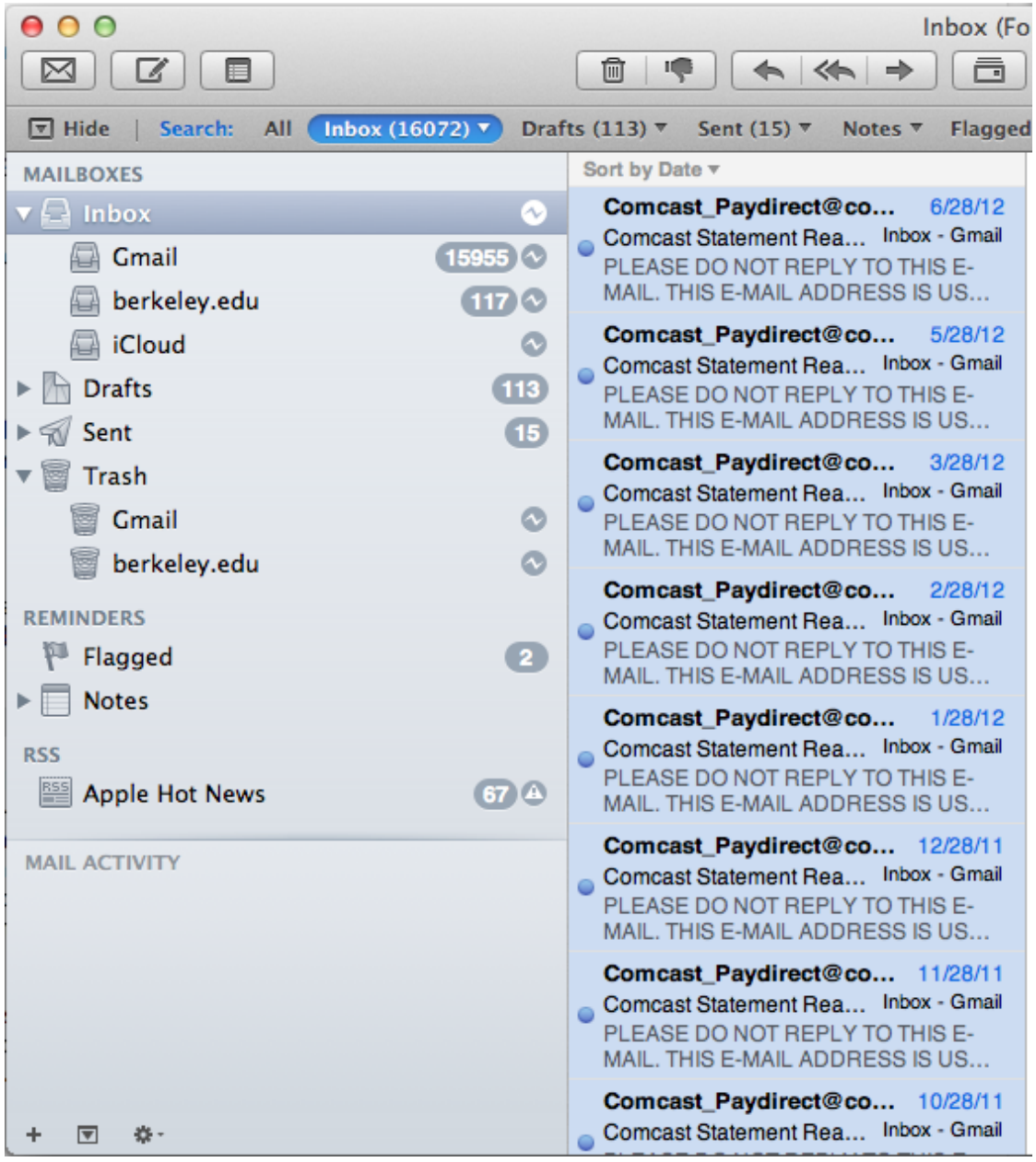
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Motivation

- ABP employed by electric, gas, water utilities; cable and telecommunications; cellular; insurance; home maintenance; etc.
- 2/3 of U.S. customers with recurring bills use ABP
- 3/4 of UK consumers paid at least one account automatically
- Among credit/debit cardholders, ABP used for:
  - 53% phone
  - 44% cable
  - 37% utility

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Theory

- Std. theory: decisions of rational agents are invariant to salience of product attributes
- Cognitive constraints, limited attention $\Rightarrow$ systematic biases (Simon 1955, Tversky and Khaneman 1974)
  - Agents respond *less* to ad valorem taxes than to excise taxes (Chetty et al. 2009);
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Theory

Prices

Define the exogenous price of a good X:

$$P(x) = \begin{cases} (x-k)p_2 + kp_1 + a & \text{if } x > k \\ xp_1 + a & \text{if } 0 < x \leq k \\ 0 & \text{if } x = 0 \end{cases},$$

for $p_2 = p_1 + n$

Theory

Utility

Consumer utility:

$$U(L, M) = L + \theta V(M)$$

- L is a numeraire; $M = \alpha x$ for technology parameter, α.
- θ is a taste parameter
- $V(\cdot)$ is well-behaved

Theory

Perceived Prices and Technology

Following DellaVigna (2009) . . . For inattention parameter $\beta \in [0, 1)$:

$$\tilde{a} = (1 - \beta)a$$

$$\tilde{p_j} = (1 - \beta)p_j \text{ for } j \in \{1, 2\}$$

$$\tilde{\alpha} = \bar{\alpha} + (1 - \beta)\ddot{\alpha}$$

Define $\delta = 1 - \beta$

Theory

Consumer's Objective:

$$\max_{x} \quad U(L, M) = L + \theta V(M)$$

$$s.t. \quad I = \begin{cases} L + ((\bar{\alpha} + \delta\ddot{\alpha})x - k)\,\delta n + (\bar{\alpha} + \delta\ddot{\alpha})x\delta p_1 + \delta a & \text{if } x > k \\ L + (\bar{\alpha} + \delta\ddot{\alpha})x\delta p_1 + \delta a & \text{if } 0 < x \leq k \\ L & \text{if } x = 0 \end{cases}$$

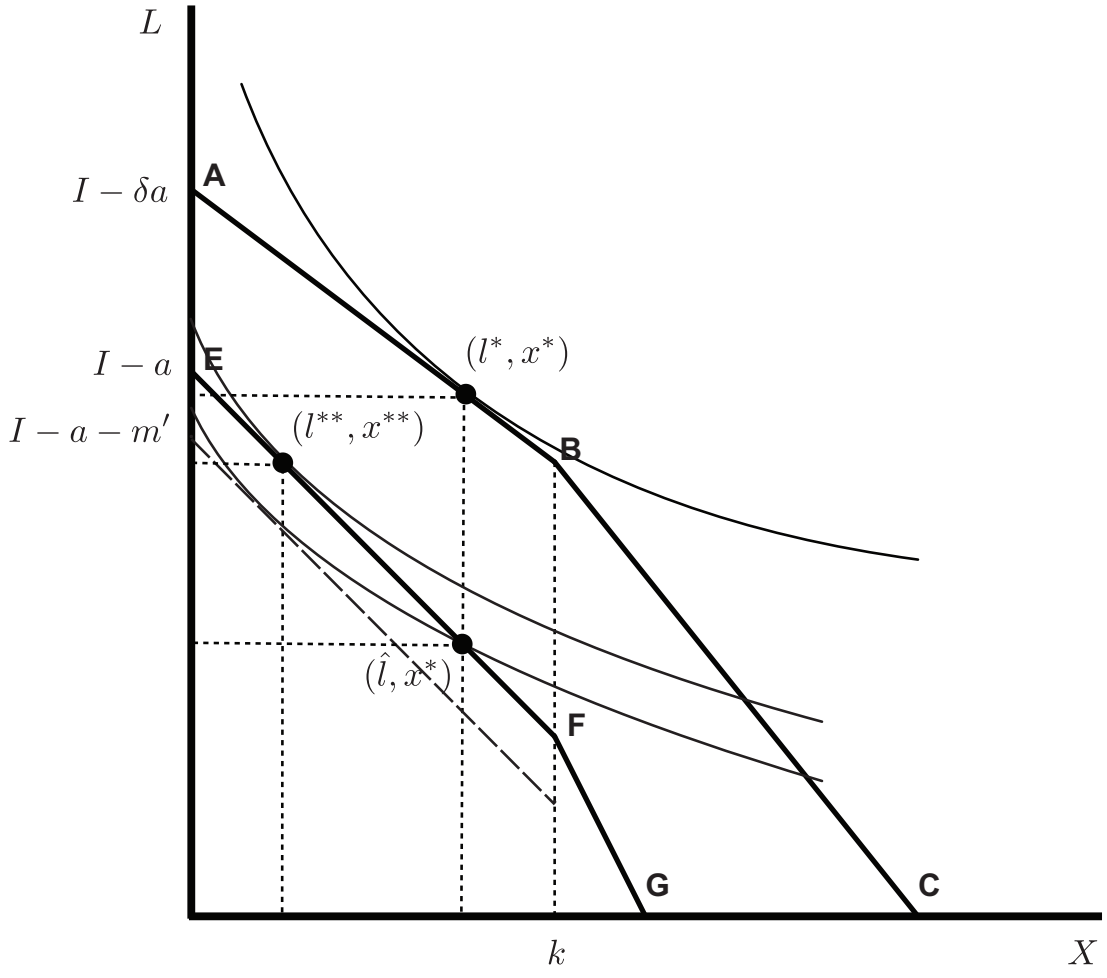
Theory

Inattention to marginal price

Suppose
$x^* \in (0, k)$ defined by:

$$V'(M) = \frac{(\bar{\alpha} + \delta\ddot{\alpha})\delta p_1}{\theta}$$

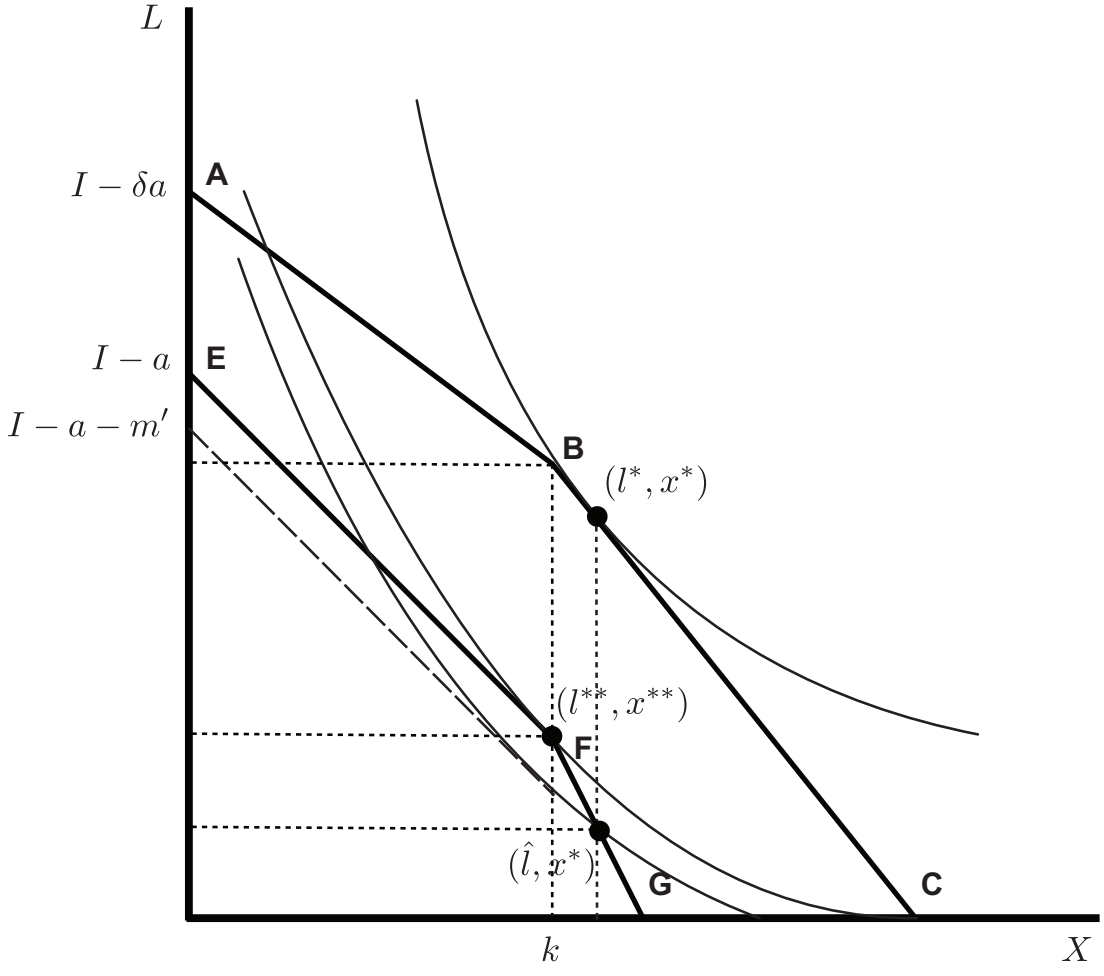
Figure: Inattention to marginal price



Theory

Inattention to increasing block rates

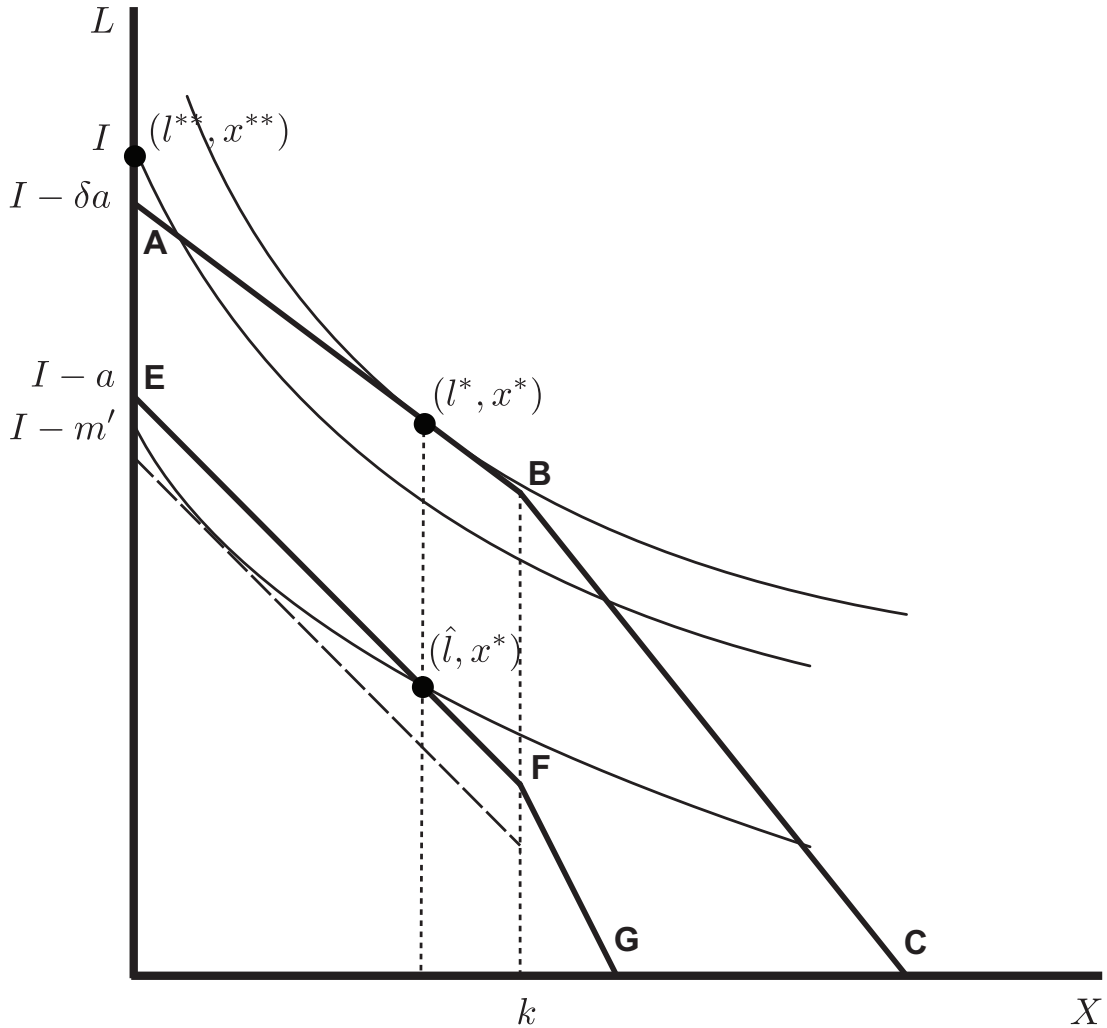
Figure: Inattention to increasing block pricing



Theory

Inattention to entrance fee

Figure: Inattention to entrance fee



Theory

Proposition

Proposition: "Overconsumption"

Inattention reduces perceived prices and can induce consumption levels in excess of those chosen by fully attentive agents – regardless of the level of consumption and the characteristics of the pricing regime.

$\Rightarrow$ Diminished price salience causes higher average consumption for electric and gas utilities, telecommunications, gym memberships, etc.

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Theory

Inattention to changes in tastes, technology, prices

By the implicit function theorem:

$$\left.\frac{\partial \frac{dm}{dp}}{\partial \beta}\right|_{\ddot{\alpha}=0} = -\frac{\bar{\alpha} - 2(1-\beta)\ddot{\alpha}}{V''(M)} > 0$$

and

$$\frac{\partial \frac{dm}{d\alpha}}{\partial \beta} = \frac{2(1-\beta)p}{V''(M)} < 0$$

Theory

Propositions

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Proposition: "Taste Changes"

An inc. in preference for an insalient good induces too large an increase in demand and a decline in preference for an insalient good induces too small a decrease in demand.

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Demand falls too little in response to price increases. The degree of "under-responsiveness" increases in inattention.

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Proposition: "Price Changes"

Demand falls too little in response to price increases. The degree of "under-responsiveness" increases in inattention.

Proposition: "Technology Changes"

Demand for an insalient good increases "too little" due to an increase in technical efficiency. The degree of "under-responsiveness" increases in inattention.

Empirics

Data

- Monthly observations on household (and commercial) electricity consumption from Santee Cooper
  - 163,000 residential customers along SC coast from Charleston to Myrtle Beach
  - 1994-2010
  - matched to zip5
- Obtained pursuant to PRA request; personal info is not released
- 1 in 4 accounts enrolled in ABP in 2010

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Empirics

Methods

Estimate:

$$y_{it} = \lambda_t + c_i + x_{it}\beta_1 + x_{it}^2\beta_2 + w_{it}^A\gamma_i^A + w_{it}^B\gamma_i^B + u_{it},$$

- y_{it} is log monthly electricity consumption (in kilowatt hours) of household i in period t
- λ_t is year-month time effect; c_i is time-invariant heterogeneity
- x_{it} and x_{it}^2 are account duration and square of account duration, respectively
- w_{it}^A, w_{it}^B are treatment indicators for autopay, budget bill, respectively
- u_{it} is an idiosyncratic error

Empirics

Heterogeneous treatment effects

For γ_i^j for $j = \{A, B\}$ and $\ddot{w}_{it} = w_{it} - \bar{w}_i$, a valid estimator of PATE is:

$$\hat{\gamma^j} = N^{-1} \sum_{i=1}^{N} \hat{\gamma}_i^j$$

if

$$E(\gamma_i^j | \ddot{w}_{it}) = E(\gamma_i^j) = \gamma^j \; \forall t$$

- If indiv. treatment effects are uncorrelated with deviations from average propensity to recieve treatment
  - Unintended nature of treatment effect likely alleviates selection bias
  - if $w_{it} = 1$ whenever $w_{ir} = 1$ for $r < t$, strict exogeneity is a reasonable assumption (Wooldridge and Imbens 2007)

Empirics

PATE vs. PATT

- Sequential exogeneity almost surely satsified (see Wooldridge and Imbens 2007)
- Strict exogeneity will still hold amid correlated deviations from mean characteristics if underlying characteristics determining treatment are unrelated to outcome of interest (Imbens 2004)
- Regardless, absent strict/sequential exogeneity, still identify PATT, which is of policy interest anyway

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Residential Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resid.		R1-4		R5-6, RG, RS		RE	
	All	Recent	All	Recent	All	Recent	All	Recent
ABP	0.0204**	0.0447***	0.0234***	0.0584***	0.0278***	0.0509***	-0.00211	0.0405***
	(0.0104)	(0.00668)	(0.00664)	(0.0115)	(0.00690)	(0.00999)	(0.00594)	(0.00962)
BB	0.0838***	0.0913***	0.0523***	0.0548**	0.105***	0.0888***	0.0818***	0.0788***
	(0.00869)	(0.0102)	(0.0125)	(0.0239)	(0.0137)	(0.0157)	(0.0131)	(0.0239)
Observations	739,539	670,467	1,897,882	704,311	1,101,064	326,614	1,438,610	409,755
No. of accounts	14,146	18,240	40,154	22,882	18,637	9,173	33,182	15,703

Standard errors in parentheses

*** p < 0.01, ** p < 0.05, * p < 0.1

Commercial Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Comm.		GN		GS		GL		GC	
	All	Recent	All	Recent	All	Recent	All	Recent	All	Recent
ABP	0.011	0.063**	0.015	0.103***	0.029**	0.027	0.018	0.020	0.067	0.221**
	(0.021)	(0.028)	(0.021)	(0.032)	(0.014)	(0.019)	(0.094)	(0.056)	(0.072)	(0.109)
Observations	630,553	153,490	544,261	135,856	590,772	143,476	6,943	1,483	60,101	9,069
No. of accounts	9,703	3,964	8,327	3,470	10,645	3,938	107	24	782	251

Standard errors in parentheses

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Implications

- Growing use of ABP across industries and salience effects $\Rightarrow$ consumers may be "overconsuming" telecommunications, household and financial services, and natural resources
- Resource conservation can be enhanced by boosting the salience of private costs of consumption
  - Cost effectiveness compares favorably to other conservation projects attracting research and policy attention
  - Kotchen and Grant 2011: DST 1% increase in resid. energy consumption
  - Alcott 2011: Opower 2% reduction in resid. energy; \$0.33 per kWh
- Energy Paradox a consequence of insalient future savings from efficiency investments *and* insalient present consumption costs
- Effect may grow over time due to generational effect

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Thank You!

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