How Many Economists Does it Take to Change a Light Bulb?

David Herberich & Michael Price

John A. List
University of Chicago, NBER, and RFF

A. Theoretical Model

B. Initial Results

C. Conclusions

Encouraging HH Technology Adoption

- Question and Motivation
  - What are the best ways to encourage adoption and diffusion of green technologies at the HH level?

  Our case study revolves around CFLs

- 70% of residential households have 1 CFL *but* only 11% of potential sockets have CFLs

- Ceteris paribus, replacing 1 incandescent light bulb in every American household with a CFL would:
  - Prevent the equivalent annual greenhouse gas emissions from 420,000 cars
  - Save $806 million in annual energy cost

Sample of the Previous Literature

Social-Psychology

Goldstein, Cialdini and Griskevicius (2008)

Schultz et al. (2007)

Economics

Griliches (1957)

Jaffe and Stavins (1995)

Gallagher and Muehlegger (2008)

Hall (2004)

Economics: Social Norms

Allcott (2009)

Ferraro and Price (2010)

Recent work largely focuses on “curtailment” behaviors such as turning down thermostats rather than behaviors such as technology adoption

Our Approach

- Question and Motivation
  - How best to encourage diffusion of CFLs

  *apples to apples comparison of prices and social norms

- Large Scale Natural Field Experiment
  - Door-to-door in suburbs of Chicago (some precedent for distributing green technologies in this way—Pakistan, India, Boulder)

- Model
  - Two stage consumer decision

What are the welfare effects of our drive?

Model

Model follows Della Vigna, List and Malmendier (2010)

Altruism of impure public good

Purchase decision

$$\max_{q} U(q) = \underbrace{u(W\text{-}pq)}_{\text{“Wealth” Utility}} + \overbrace{a}^{\text{Altruism of impure public good}}\underbrace{v(q,Q_{-i})}_{\text{“impure public good”}} - \underbrace{s(q)}_{\text{Social Pressure}}$$

How can we separate social pressure from “altruism”?

- If we can allow people to sort in and out of purchase decision we can determine the component of the model responsible for the purchase decision

NFE Overview

Randomize households into treatments

Not Warned

Warned (2 types of warnings)

Warning

THE UNIVERSITY OF
CHICAGO

Energy Cost Initiative

Students will visit this address tomorrow (/) between and to offer for purchase and discuss energy saving light bulb options.

Opt Out

THE UNIVERSITY OF
CHICAGO

Energy Cost Initiative

Students will visit this address tomorrow (/) between and to offer for purchase and discuss energy saving light bulb options.

☐ Check this box if you **do not want to be disturbed**.

Model

Model follows Della Vigna, List and Malmendier (2010)

2nd Stage: Purchase decision

$$\max_{q} U(q) = u(W\text{-}pq) + \boxed{a}v(q,\boxed{Q_{-i}}) - s(q)$$

1st Stage: Avoidance decision

Baseline Prob

$$\max_{h\in[0,1]} h\cdot[u(W-pq^{*}) + \boxed{a}v(q^{*},\boxed{Q_{-i}}) - s(q^{*})] + (1-h)[u(W) + \boxed{a}v(0,\boxed{Q_{-i}})] - c(h;\boxed{h_0})$$

Prob(answer)

$a \sim N(\mu,\sigma^2)$ – altruism

optimal decision|answer

Prob(not answer)

decision|not answer

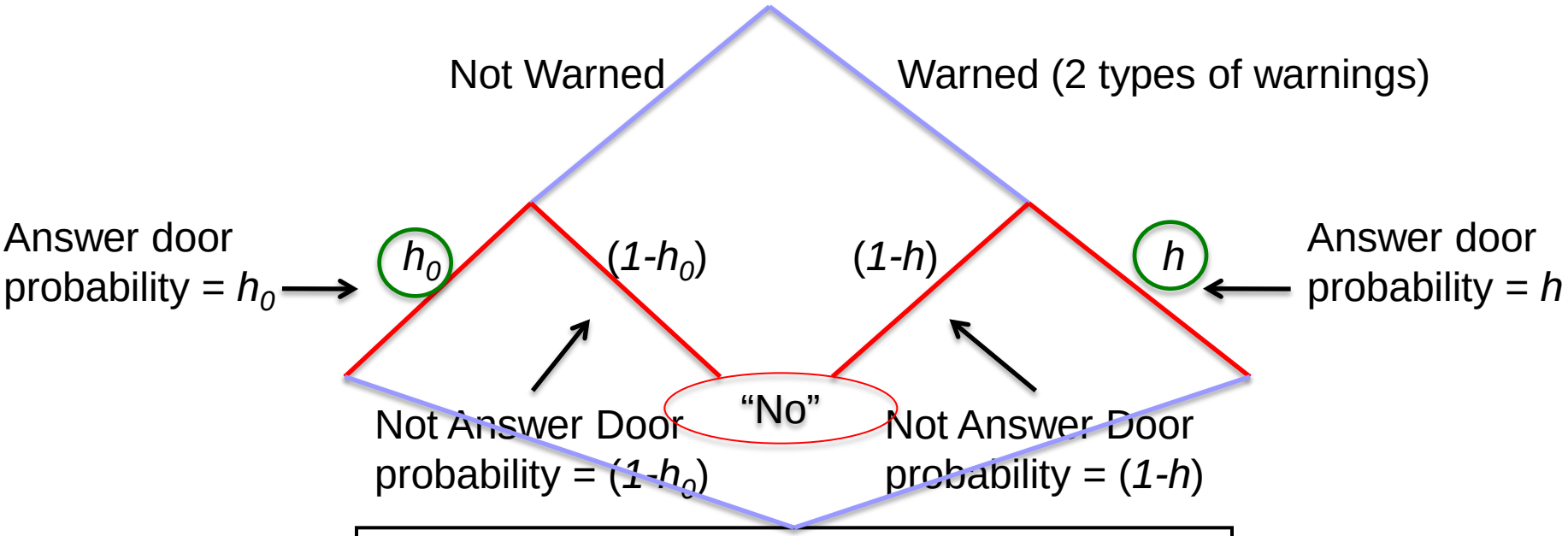
Cost of Δ Probability

h_0 – baseline probability of a household being home and answer the door

Q_{-i} – level of public good other than household (curvature of indirect utility)

NFE Overview

Randomize households into treatments



2x3 Treatment Design:
Price x Descriptive Social Norm

"For instance, did you know that 70% of ***U.S. households*** own at least one CFL?"

For instance, did you know that 70% of ***the people we surveyed in this area*** owned at least one CFL?

Predictions from Model

Decision to Answer Door

(1) No Social Pressure, Some Altruistic Motives

Warned Households Should Answer More Often

(2) Positive Social Pressure, No Altruistic Motives

Warned Households Should Answer Less Often

Decision to Purchase

(1) Conditional on answering door, warned households purchase more often

(2) Probability of purchase rises with increase in social norms

(3) Probability ***and*** amount purchased increase with price decreases

Implementation

- Door-to-door NFE
  - Suburbs of Chicago (Libertyville, Lemont, Roselle, Arlington Heights, Glen Ellyn)
  - Mapped neighborhoods into treatment groups by street
    - Approximately 25 households on a street in a treatment group
  - Hired students to approach households on weekends to sell CFLs
    - Students approach approx. 25 households in an hour time block
    - Typically change to new treatment after each hour
    - 4 hours of work: 10am-11am, 11am-noon, 1pm-2pm and 2pm-3pm
  - Our research team approached households the day prior to student salespersons and hung “door-hangers” on doors announcing arrival the following day in warning treatments

Script

Script:	*Neutral Frame (NF)*
Full Price	
Low Price	

"I am here today to talk to you about reducing your energy usage by using compact fluorescent light bulbs or "CFLs" and to provide you with an opportunity to purchase one."

$1: "May I tell you more about them before offering you up to 2 sets of 4 bulbs for $1.00 for each set, 80% off their normal price of $5.00 each?"

$5: "May I tell you more about them before offering you up to 2 sets of 4 bulbs at their normal price of $5.00 for 4 light bulbs?"

"The most important difference between incandescent and fluorescent light bulbs is that fluorescent lights use about 75% less energy than conventional light bulbs and last about 10 times as long, they can save you a substantial amount of money through the reduction in energy consumption – even given their slightly higher cost."

Further Design Particulars

Script:	*Neutral Frame (NF)*	*Social Norm Low (SNL)*	*Social Norm High (SNH)*
Full Price			
Low Price			

Before stating price:

SNL: "For instance, did you know that 70% of U.S. households own at least one CFL?"

SNH: "For instance, did you know that 70% of the people we surveyed in this area owned at least one CFL?"

Implementation

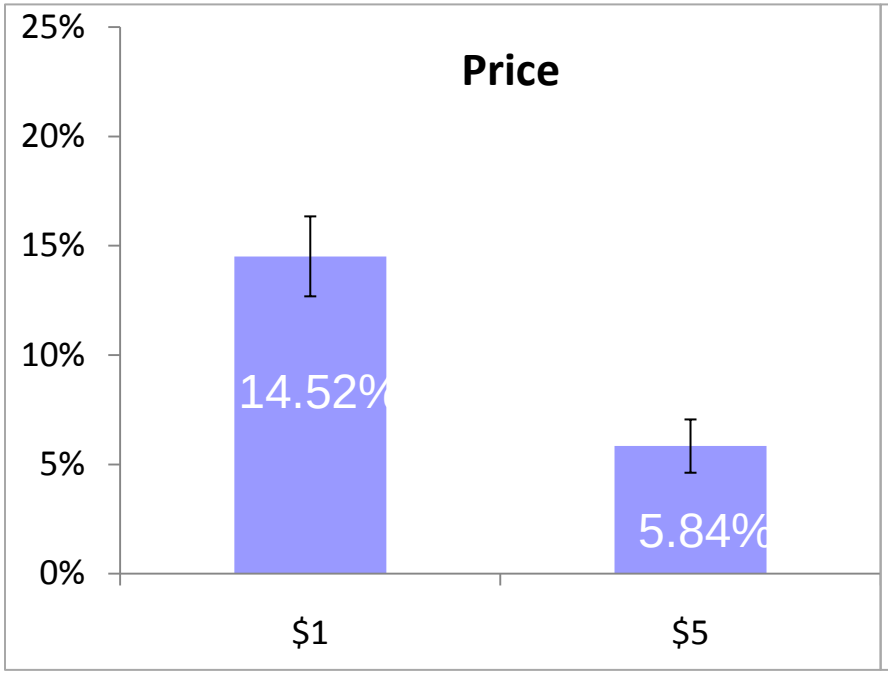
Pressure Level	Price	No Warning	Warning: No Opt Out	Warning: Opt Out
		No. of Doors Knocked On		
Neutral Frame	1	480	474	473
	5	435	546	501
Social Norm: Low	1	447	508	535
	5	493	544	491
Social Norm: High	1	454	469	481
	5	431	511	542
Total		2740	3052	3023

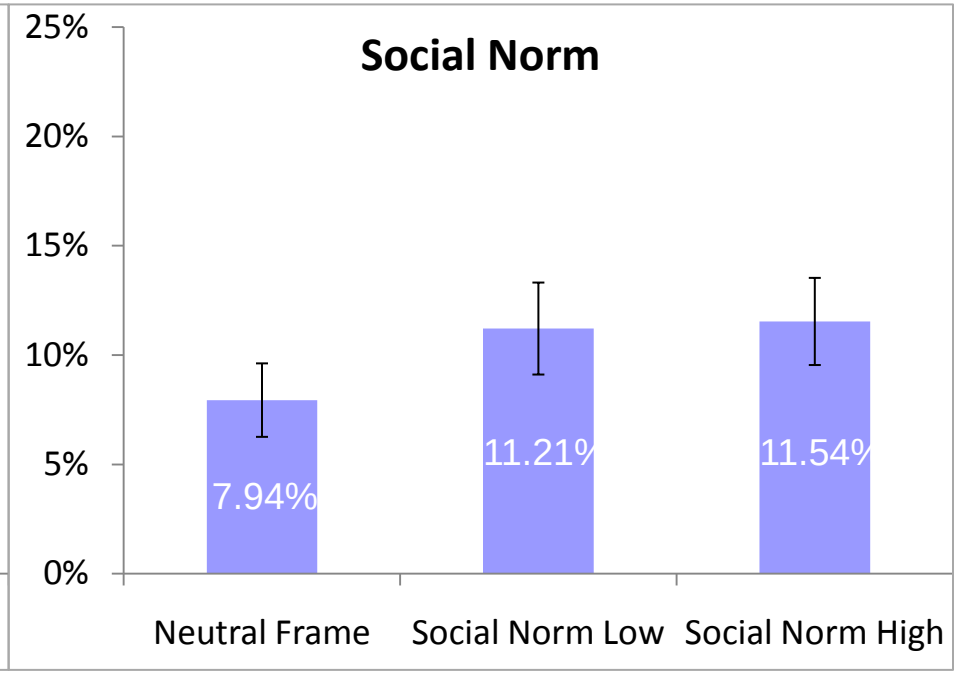
Approached 8,815 houses; we had a door answer rate of 32% and a purchase rate of 10% conditional on answering the door

Results Summary

- About 36% of HH in NW answer door
- HH in warning treatments nearly 17% less likely (~30%) to answer door
- 8.7% of HH in NW purchase at least one packet
- Warning treatment HH purchase at a 32% higher rate (11.5%)

Price and Social Norm Results





Price and Social Norm Results

- In $5 cell: high social norm has the same demand effect as a reduction in price to $1.50
- Our norms worked exclusively on extensive margin

- $5 cell: 33% less likely to purchase a second pack compared to $1 cell.
- Our prices worked on both the extensive and intensive margins

Policy Takeaway

- In this experiment, norms and prices are important complements

- To initially motivate adoption, social norms are a useful tool
- Prices are a better tool to further diffusion of the technology after initial adoption

What about Welfare Estimates?

- While reduced form results are interesting in their own right, we can perform welfare calculations by using structural estimates

Structural Estimation

- Generalized Method of Moments (GMM)
  - 8 parameters, 22 moments

2nd Stage: Purchase decision

$$\max_q U(q) = u(W\text{-}pq) + \boxed{a}v(q,\boxed{Q_{-i}}) - s(q) \qquad s(q) = \boxed{S(\rho)} \cdot 1_{q=0}$$

1st Stage: Avoidance decision

$$\max_{h\in[0,1]} h\cdot[u(W-pq^*) + \boxed{a}v(q^*,\boxed{Q_{-i}}) - s(q^*)] + (1-h)[u(W) + \boxed{a}v(0,\boxed{Q_{-i}})] - c(h;\boxed{h_0})$$

$a \sim N(\mu,\sigma^2)$ – altruism

$S(\rho)$ – social pressure faced by household

h_0 – baseline probability of a household being home and answer the door

Q_{-i} – level of public good other than household (curvature of indirect utility)

r – probability of seeing door-hanger

Preliminary Welfare Estimates

- ~16% of HH received net benefits
- ~84% are negatively affected by our drive

"I should have stayed on the couch"

A. Don't buy but 'pay' S
B. Buy because S larger than utility loss of buying

~in $5 cell, $1.50 cost per HH that answered the door

Conclusions

- Price and Social Norms serve as complements, largely operating on two different margins
- Social Norm “Equivalent Price Elasticity”
  - Large possible ROI
- Discounted potential energy savings could outweigh immediate utility reduction (still in process)
  - Working on the actual usage of CFLs from our campaign and whether that usage affects broader elements of energy consumption

Concluding Thoughts

Lab | Field Experiments | Empirical Models

A deeper economic understanding is possible by taking advantage of the myriad of settings in which economic phenomena present themselves.

In many cases experimentation in small-scale field settings is quite useful in developing a first understanding when observational data is limited or experimentation in more "important" markets is not possible.

After which, one explores how the key features of the studied domain compare to more distant domains.