Behavioral Economics and the Demand for Water

Michael Hanemann
Arizona State University

- Economics
- Implications for water managers

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Origins of new thinking in economics

- Economic models of demand for differentiated commodities (Lancaster model).
- Behavioral economics
- Field experiments

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- Differentiated commodities change the framing of demand modeling in economics.
- Standard view:
  - A global optimization of everything at one point in time. Everything chosen afresh in one choice.
- New view:
  - Tens of thousands of differentiated commodities characterized by their attributes as well as their price.
  - Choices among subsets of items dispersed through time.

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For modeling/theorizing

- Given the numerosity of goods, not credible that all goods are chosen in one swoop.
- Given the numerosity of potential attributes, not credible that all potential attributes are considered at the same time.
- Perception of attributes matters as opposed to "objective" measure of attributes.
- What is an attribute? These, too, are attributes:
  - Not overpaying
  - Not buying a sneaker made in sweatshop in Asia
  - Being ethical in my purchases
- Relative not absolute preferences.
  - Based on norms, expectations
- Hence, behavior (choice) is context-dependent.

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Framing a choice

- What is this choice about?
  - Choice of levels or of differences
    - Should I keep doing the same thing or make a change?
- What are the alternatives I should consider?
  - Consideration set
    - What items I am familiar with?
- What are their relevant attributes?
  - Which attributes are relevant to this choice? Which are salient to me?
- How much do they cost?
- What constraints do I have?

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What leads to changes in behavior?

- Inducing a person to reconsider status quo and consider making a change.
- Modifying the set of alternatives considered.
  - Highlighting choice alternative
  - Ruling out choice alternatives (efficiency standards)
- Modifying the set of attributes considered.
  - Invoking norms, social comparisons
  - Salience switches attributes (including price) on or off.
  - Highlighting attributes (attempting to raise their salience/visibility)
- Modifying the perception of attributes.
  - You thought this was risky. I convinced you it is not risky.
- Changing the price paid.
  - Fixed cost vs operating costs. PACE financing of solar energy.
  - Efficiency Vermont as a role model for water? One-stop shop makes it easy for users to change.

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Not your father's demand function

- This leads to a different – and richer – view of what managers can do to influence water use.
- Your father's demand curve
  - $x = f(p_W, p_O, y)$
- Things wrong with this:
  - Not plausible that income per se influences demand except on secular time scales. Characteristics of the housing stock are the relevant variables .
  - Salience/visibility of price change has no role.
  - Implies a continuous response to price change. Perhaps the response is discontinuous; requires a different model.
  - Price is a blunt instrument. The fact is that almost no water user has any idea of how much water he is using.
    - Econometric evidence that marginal price has no influence.
  - We have little idea of what exactly water users do when they reduce (or increase) their water use. No end use data. Can't track changes in end uses/housing stock characteristics (discrete-choices).

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Housing stock

- Residential water use is mediated by the housing stock (as with electricity).
  - Low-flow toilets, showers.
  - But bath tubs 25% larger. & more indoor fixtures.
- Home renovation
  - Need to model water use in new construction versus existing homes separately.
- Outdoor water use (the last frontier)
  - New development in interior, hotter areas
  - Larger new homes
  - Yards become larger or smaller?
  - Landscaping style greatly affects water use

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Heterogeneity

- If you look at micro-data on water use (residential or otherwise), the striking feature is tremendous heterogeneity among users who otherwise appear to be identical in terms of observed characteristics.
- What might cause the heterogeneity?
  - Salience
  - Inattention

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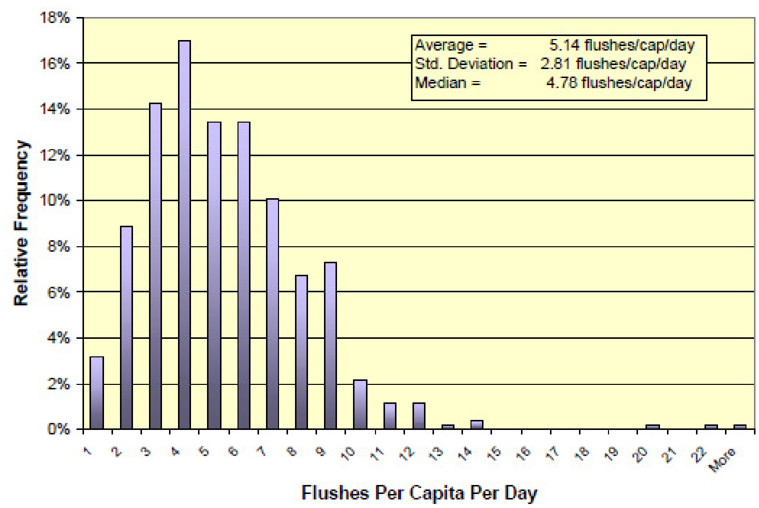
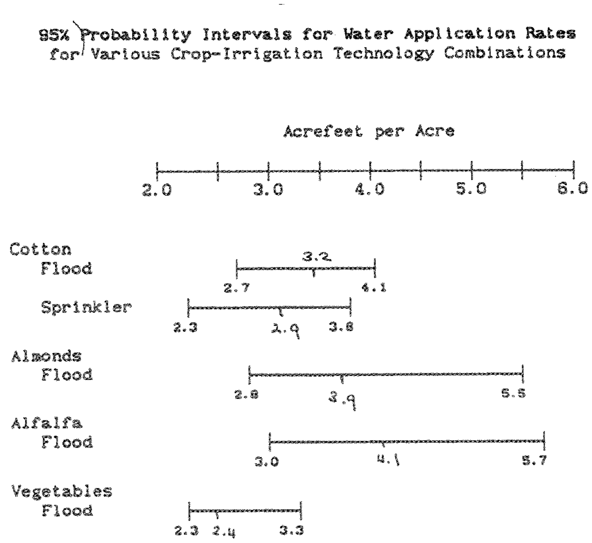


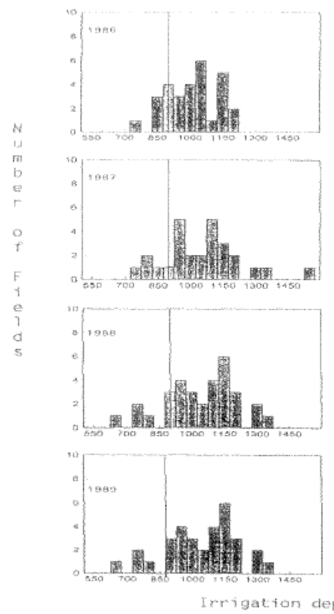
Figure 3.11 Baseline toilet flush frequency distribution, pre-retrofit study group

RESIDENTIAL INDOOR WATER CONSERVATION STUDY: EVALUATION OF HIGH EFFICIENCY INDOOR PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES IN THE EBMUD SERVICE AREA July 2003

Irrigation water use (Kern County CA)



Broadview Irrigation District, CA



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Significance of heterogeneity

- For statistical analysis.
  - Estimating the mean demand is unhelpful.
  - Need to model the shape of the distribution – especially the right tail (quantile regression, regression where semi-variance is a function of regressors).
- For water managers.
  - Goal of conservation program is to change the shape of the distribution (reduce the right tail)
  - This has implications for
    - Rate design
    - Revenue design

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Rate design

- What is the objective
  - Raise revenue
  - Influence behavior
- Alternative principles for rate design
  - Group similar users in same rate block
  - Use rates to influence water use

In each case, these call for very different rate designs

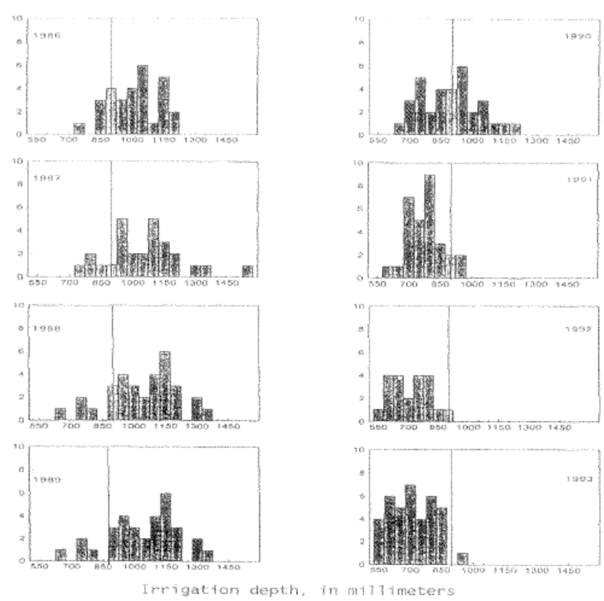
LADWP's block rate

- Keep blocks simple. Just two blocks, but the switch point is different for different homes based on (i) lot size and (ii) climate.
- Switch point chosen to satisfy criteria of (i) fairness and (ii) not being too divergent from your peers. Two criteria employed:
  - 125% of median use of all homes in that category
  - Estimate of indoor use plus reasonable outdoor use
- Expect that most households would be in lower block most months of the year.
  - Not intended to raise a large amount of revenue
- Block rates set aiming at revenue neutrality.
  - Upper block set at estimate of long run marginal cost with replacement water. Summer rate includes peak capacity charge.
  - Lower block set at a bit below average cost, to ensure revenue neutrality.

Results in LADWP

- Water use fell, especially in upper block
  - Specific comparison complicated by fact that rates were adopted in the midst of a drought that ended soon after they were adopted.
  - Similar, and cleaner, effect in Broadview Irrigation District
- Rate structure proved politically popular and has endured for almost 20 years.
- Note: rates included explicit provision for adjustment in drought years.

Before vs after introduction of block rate



With block rates, there are *two* price elasticities of demand. Which is the more important?

$$E\{x_1\} = E\left\{ x_1 \middle| \begin{array}{c}\text{consumption falls} \\ \text{in 1st block}\end{array} \right\} \bullet \Pr\left\{ \begin{array}{c}\text{consumption falls in} \\ \text{1st block}\end{array} \right\}$$

$$+ \; E\left\{ x_2 \middle| \begin{array}{c}\text{consumption falls} \\ \text{in 2nd block}\end{array} \right\} \bullet \Pr\left\{ \begin{array}{c}\text{consumption falls in} \\ \text{2nd block}\end{array} \right\}$$

What happens with a price increase in P_1^2?

- It reduces the level of consumption by those in block 2
- It reduces the probability of *being in* block 2

In other words, a price change affects
Consumption within the given block (the continuous choice)
Switching between blocks (the discrete choice)

Therefore there are price elasticities for *both* components of consumer response. There is some empirical evidence that suggests that the second elasticity is often numerically more important than the first.

Implication

- We need to think differently about modeling demand.
- Instead of a demand function, we need to think of a series of conditional demand functions.
- Discrete choices – switching between one conditional demand and another – may turn out to be more important than continuous choices (variation of use governed by the same conditional demand function).
- Kerry Smith’s work has identified the differences among conditional demands. What we don’t understand – and need to know– is how to model the switching between conditional demands.

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Revenue design

- The distinctive feature of water is that cost structure is dominated by fixed costs (much more so than any other public utility).
- This needs to be reflected in rate design.
- Historically water was financed by fixed charges (connection fee, service fee based on building characteristics or as % of property tax).
- The rationale for volumetric charge is to provide incentive to reduce water use. That is still a valid consideration.
- But the fixed charge component could be increased, and made dependent on fixed features that affect water use (swimming pool, landscaping, irrigation system).

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