Bounded Rationality

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1

Bounded Rationality

- We now know how to test the canonical model of economic decision making

$$C(A) = \max_{x \in A} u(A)$$

- And have demonstrated cases in which it does not work
  - Leaving money on the table
  - Too much choice
  - Decision difficulty

2

Bounded Rationality

$$C(A) = \max_{x \in A} u(A)$$

- Two ways we can adapt the model while remaining within the same framework
  1. Change preferences: What it is that the goal that the DM is trying to achive?
  2. Change constraints: Add additional costs and restrictions to the optimizing problem
- Much of behavioral economics takes approach 1
  - Loss aversion
  - Probability weighting
  - Ambiguity aversion
- Bounded rationality is the study of approach 2

3

Examples of Bounded Rationality

- Costs to acquiring or processing information
  - E.g. Simon [1955], Stigler [1961], Sims [2003]
- Limits on reasoning
  - E.g. Camerer [2004], Crawford [2005]
- Thinking aversion
  - E.g. Ergin and Sarver [2010], Ortoleva [2013]
- Bounded memory
  - E.g. Wilson [2002]
- Automata
  - E.g. Piccione and Rubinstein [1993]
- Semi-Rational Models
  - E.g. Gabaix et al. [2008], Esponda [2008], Rabin and Vayanos [2010], Gabaix [2013],
- Heuristics
  - Tversky and Kahneman [1974], Gigerenzer [2000]

4

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5

Costly Information Acquisition

- The world has a lot of information in it
- The more information we gather/process, the better decisions we will make
- But there are costs associated with gathering and processing information
  - Monetary/effort costs of obtaining the information
  - Opportunity cost of time
  - Opportunity cost of cognitive resources
- Decision maker may choose not to gather/process all available information
  - Looks like they are making 'mistakes'
  - But such behavior may be optimal

6

Costly Information Acquisition

- DM's perception of the world may be different from what we as the research thinks it is
- Example 1: Consideration Sets:
  - We provide a decision maker with a choice set A, but they do not consider all available alternatives
  - Focus their attention on a subset of available alternatives
  - What marketers call a *consideration set*

7

Consideration Set

- Choose the optimal Scotch

8

Consideration Set

- Maybe only consider a subset of drinks to seriously consider
- But how is that set determined?
  - Cheapest brands?
  - Brands that you have heard of?
  - Brands that you have had before?
  - Brands that stand out?
  - At random?
- How many alternatives do they consider?

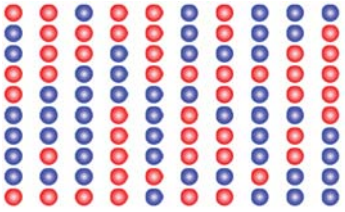
9

Rational Inattention

- Consideration sets a good way to think about choice from a large set of simple alternatives
- What about a small set of complicated alternatives?
  - Deciding which of two houses to buy
  - Deciding which of two job to take?
- The best action may be knowable in principle, but it takes effort to uncover what it is
  - A simple experimental example….

10

Rational Inattention



	State 49	State 51
Act a	$10	$0
Act b	$0	$10

11

Rational Inattention

- Perhaps a better model for these situations is one in which the decision maker gets a noisy signal about the true state of the world
- The higher cost they pay, the better the quality of the signal
  - Spend 10 seconds thinking about the problem, can make an educated guess about the whether there are 49 or 51 red balls
  - Spend 10 minutes and you can count all the balls and know for sure
- How does the decision maker choose how accurate a signal to get?

12

Costly Information Acquisition

- Models of costly information acquisition can (potentially) explain some of the failures of rationality we have discussed
  - Framing Effects
  - Leaving money on the table
  - Status quo bias
  - Random choice

13

An Example

- Do people take into account all the relevant information when making their choices?
- Salience and Taxation: Chetty et al. [2009]
- Consider choice between two goods
  - y: normalized price of 1
  - x: pretax price of p with a sales tax t
    - Total price: (1+t)p
- Let x(p,t) be demand when price is p and tax rate is t
- Standard theory: x(p,t)=x(p(1+t),0)

14

Salience and Taxation

- BUT, prices are usually posted net of tax

- Perhaps changes in tax have a smaller effect on demand than changes in price?

15

Salience and Taxation

- Let
  - $\varepsilon_{x,p} = -\frac{\partial \log x}{\partial \log p}$ be the elasticity of demand wrt price
  - $\varepsilon_{x,t} = -\frac{\partial \log x}{\partial \log 1+t}$ be the elasticity of demand wrt tax
- Hypothesis: $\varepsilon_{x,p} \neq \varepsilon_{x,t}$
- Perform two tests:
  - Compare demand when prices are posted *net of* tax to when they are posted *with* tax
  - Compare the effect of price and tax changes

16

Experiment 1

- Take 1 large supermarket
  - 30% of products have sales tax of 7.375% added at register
- Take three 'impulse purchase' product categories
  - Cosmetics, hair care accessories, deodorants
  - 750 products in total
- Add tags which displayed post tax price (as well as pre tax price)
  - Experiment lasted 3 weeks

17

Experiment 1

- Empirical strategy: 'Difference in Difference'
  - Compare change in demand for treated goods to that of control groups
    - Control group 1: Different toiletries in same aisle of same store
    - Control group 2: All toiletries sold in two similar stores
  - Analysis performed at the 'category level'
    - 13 categories in treatment group
    - 95 in the control group

18

Results

TABLE 3
Effect of Posting Tax-inclusive Prices: DDD Analysis of Mean Quantity Sold

TREATMENT STORE

Period	Control Categories	Treated Categories	Difference
Baseline (2006:1-2006:6)	26.48 (0.22) [8,810]	25.17 (0.37) [754]	-1.31 (0.43) [9,264]
Experiment (2006:6-2006:10)	27.32 (0.87) [295]	23.87 (1.02) [76]	-3.45 (0.64) [304]
Difference over time	0.84 (0.75) [5,795]	-1.30 (0.92) [793]	DD_{TS} = -2.14 (0.68) [6,588]

CONTROL STORES

Period	Control Categories	Treated Categories	Difference
Baseline (2006:1-2006:6)	30.57 (0.24) [11,020]	27.94 (0.30) [1,509]	-2.63 (0.32) [12,529]
Experiment (2006:6-2006:10)	30.76 (0.72) [670]	28.19 (1.06) [76]	-2.57 (1.09) [646]
Difference over time	0.19 (0.64) [11,590]	0.25 (0.92) [1,585]	DD_{CS} = 0.06 (0.96) [13,175]
		DDD Estimate	-2.20 (0.59) [19,764]

Notes: Each cell shows mean quantity sold per category per week, for various subsets of the sample. Standard errors clustered by week in parentheses, number of observations in square brackets. Experimental period spans week 6 in 2006 to week 10 in 2006. Baseline period spans week 1 in 2006 to week 6 in 2006. Lower panel reflects averages across the two control stores.

19

Experiment 2: Alcohol!

- In the US, alcohol is subject to two types of tax
  - Excise tax – included in the posted price
  - Sales tax – added at the register
  - Total price is p(1+t)(1+e)
- These taxes change regularly and distinctly
- Standard theory, should have the same effect on demand
- Estimate

$$\Delta \log x_{i,t} = \alpha + \beta \Delta \log(1+e_{i,t}) + \theta\beta \Delta \log(1+t_{i,t}) + \rho X_{i,t} + \mu_{i,t}$$

20

Summary of Data

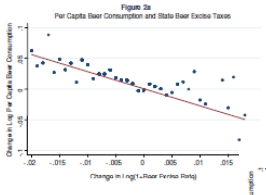
TABLE 5
Summary Statistics for State Beer Consumption, Taxes, and Regulation

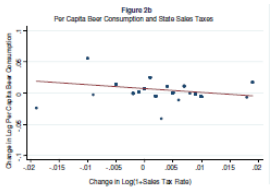
Per-Capita Beer Consumption (cans)	243.2 (46.1)
State Beer Excise Tax ($/case)	0.51 (0.50)
State Beer Excise Tax (percent)	6.5 (6.2)
Sales Tax (percent)	4.3 (1.9)
Drinking Age is 21	0.73 (0.44)
Drunk Driving Standard	0.65 (0.47)
Any Alcohol Regulation Change	0.19 (0.39)
N (number of state-year pairs)	1,666

- 153 changes in sales tax
- 131 changes in excise tax
- Correlation 0.06
- Plenty of independent variation

21

Results





22

Results

TABLE 6
Effect of Excise and Sales Taxes on Beer Consumption

Dependent Variable: Change in Log(per capita beer consumption)

	Baseline (1)	Bus. Cycle (2)	Alc. Regulations (3)	Region Trends (4)
ΔLog(1+Excise Tax Rate)	**-0.88** (0.17)	**-0.91** (0.17)	**-0.89** (0.17)	**-0.71** (0.18)
ΔLog(1+Sales Tax Rate)	**-0.20** (0.30)	**-0.01** (0.30)	**-0.02** (0.30)	**-0.05** (0.30)
ΔLog(Population)	0.03 (0.06)	-0.07 (0.07)	-0.07 (0.07)	-0.09 (0.08)
ΔLog(Income per Capita)		0.22 (0.05)	0.22 (0.05)	0.22 (0.05)
ΔLog(Unemployment Rate)		-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Alcohol Regulation Controls			x	x
Year Fixed Effects	x	x	x	x
Region Fixed Effects				x
F-Test for Equality of Tax Elasticities (Prob>F)	0.05	0.01	0.01	0.06
Sample Size	1,607	1,487	1,487	1,487

Notes: Standard errors, clustered by state, in parentheses. All specifications are estimated on full sample for which data are available (state unemployment rate data is unavailable in early years). Column 3 includes three indicators for whether the state implemented per se drunk driving standards, administrative license revocation laws, or zero tolerance youth drunk driving laws, and the change in the minimum drinking age (measured in years). Column 4 includes fixed effects for each of nine census regions. F-test tests null hypothesis that coefficients on excise and sales tax rate variables are equal.

23

Summary

- Bounded Rationality is the study of economic behavior taking into account cognitive constraints, e.g.
  - Information processing costs
  - Limits on reasoning
  - Limited memory
- Such constraints can lead to a difference between
  - The information presented to a decision maker
  - The information on which they base their decision
- In principle this can explain many violations of 'rationality'
  - Framing Effects
  - Leaving money on the table
  - Status quo bias
  - Random choice
- We have seen that these effects are important in a real world context
  - Under react to taxes that are not salient

24

Summary

- In the following lectures we will study models of bounded rationality,
  - Search and satisficing
  - Rational Inattention
  - Level K thinking
- and its impact on economic behavior
  - Online consumer behavior
  - Pricing by firms
  - Marketing

25