Econ 219B
Psychology and Economics: Applications
(Lecture 3)

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Outline

1. Investment Goods: Health-Club Industry

2. Leisure Goods: Credit Card Industry

3. Leisure Goods: Consumption and Savings

1 Investment Goods: Health-club industry

- DellaVigna, Malmendier, “Paying Not To Go To The Gym”

- Exercise as an investment good

- Present-Bias: Temptation not to attend

Choice of flat-rate vs. per-visit contract

- *Contractual elements:* Per visit fee p, Lump-sum periodic fee L
- *Menu of contracts*
  - Flat-rate contract: $L > 0$, $p = 0$
  - Pay-per-visit contract: $L = 0$, $p > 0$
- *Health club attendance*
  - Immediate cost c_t
  - Delayed health benefit $h > 0$
  - Uncertainty: $c_t \sim G$, c_t i.i.d. $\forall t$.

Attendance decision.

- Long-run plans at time 0:

Attend at $t \iff \beta\delta^t(-p - c_t + \delta h) > 0 \iff c_t < \delta h - p.$

- Actual attendance decision at $t \geq 1$:

Attend at $t \iff -p - c_t + \beta\delta h > 0 \iff c_t < \beta\delta h - p.$ (Time Incons.)

Actual $P(\text{attend}) = G(\beta\delta h - p)$

- Forecast at $t = 0$ of attendance at $t \geq 1$:

Attend at $t \iff -p - c_t + \hat{\beta}\delta h > 0 \iff c_t < \hat{\beta}\delta h - p.$ (Naiveté)

Forecasted $P(\text{attend}) = G(\hat{\beta}\delta h - p)$

Choice of contracts at enrollment

Proposition 1. If an agent chooses the flat-rate contract over the pay-per-visit contract, then

$$\begin{aligned} a(T)\,L \leq \quad & pTG(\beta\delta h) \\ & + (1-\hat{\beta})\delta bT\left(G(\hat{\beta}\delta h) - G(\hat{\beta}\delta h - p)\right) \\ & + pT\left(G(\hat{\beta}\delta h) - G(\beta\delta h)\right) \end{aligned}$$

Intuition:

1. *Exponentials* ($\beta = \hat{\beta} = 1$) pay at most p per expected visit.

2. *Hyperbolic* agents may pay more than p per visit.

   (a) *Sophisticates* ($\beta = \hat{\beta} < 1$) pay for commitment device ($p = 0$). Align actual and desired attendance.

   (b) *Naïves* ($\beta < \hat{\beta} = 1$) overestimate usage.

- Estimate average attendance and price per attendance in flat-rate contracts

TABLE 3—PRICE PER AVERAGE ATTENDANCE AT ENROLLMENT

	Sample: No subsidy, all clubs		
	Average price per month (1)	Average attendance per month (2)	Average price per average attendance (3)
	Users initially enrolled with a monthly contract		
Month 1	55.23	3.45	16.01
	(0.80)	(0.13)	(0.66)
	N = 829	N = 829	N = 829
Month 2	80.65	5.46	14.76
	(0.45)	(0.19)	(0.52)
	N = 758	N = 758	N = 758
Month 3	70.18	4.89	14.34
	(1.05)	(0.18)	(0.58)
	N = 753	N = 753	N = 753
Month 4	81.79	4.57	17.89
	(0.26)	(0.19)	(0.75)
	N = 728	N = 728	N = 728
Month 5	81.93	4.42	18.53
	(0.25)	(0.19)	(0.80)
	N = 701	N = 701	N = 701
Month 6	81.94	4.32	18.95
	(0.29)	(0.19)	(0.84)
	N = 607	N = 607	N = 607
Months 1 to 6	75.26	4.36	17.27
	(0.27)	(0.14)	(0.54)
	N = 866	N = 866	N = 866
	Users initially enrolled with an annual contract, who joined at least 14 months before the end of sample period		
Year 1	66.32	4.36	15.22
	(0.37)	(0.36)	(1.25)
	N = 145	N = 145	N = 145

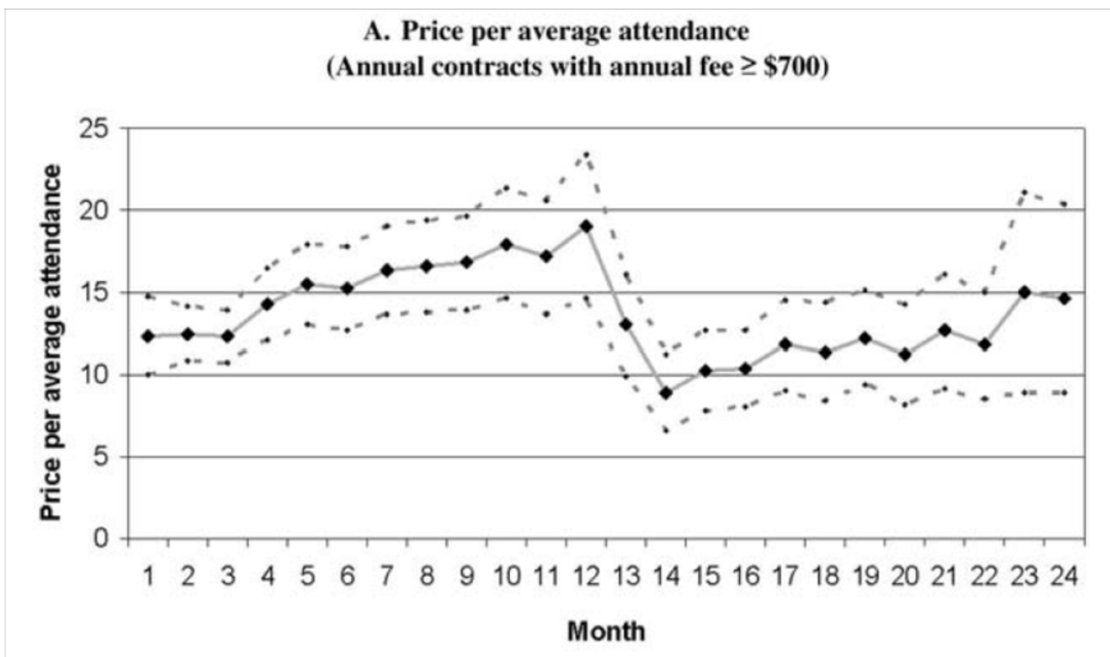
- Result is not due to small number of outliers
- 80 percent of people would be better off in pay-per-visit

TABLE 4—DISTRIBUTION OF ATTENDANCE AND PRICE PER ATTENDANCE AT ENROLLMENT

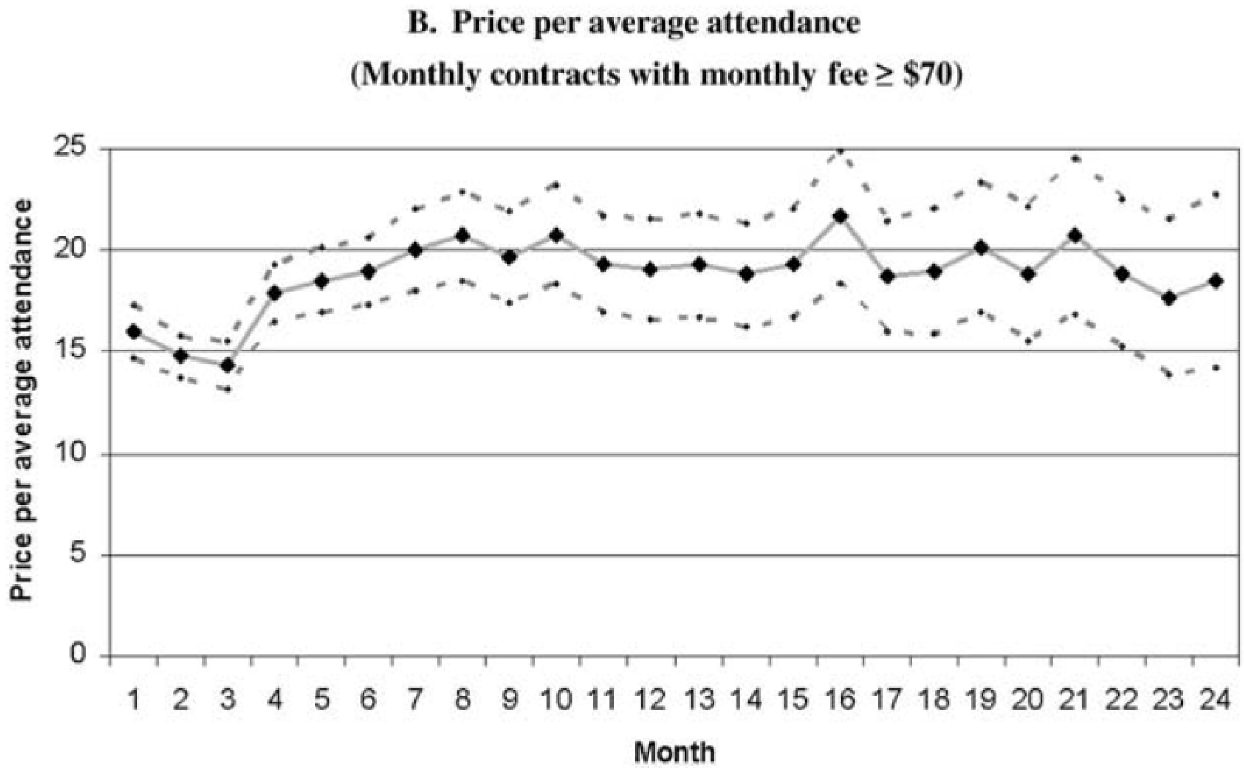
	Sample: No subsidy, all clubs			
	First contract monthly, months 1–6 (monthly fee ≥ \$70)		First contract annual, year 1 (annual fee ≥ \$700)	
	Average attendance per month (1)	Price per attendance (2)	Average attendance per month (3)	Price per attendance (4)
Distribution of measures				
10th percentile	0.24	7.73	0.20	5.98
20th percentile	0.80	10.18	0.80	8.81
25th percentile	1.19	11.48	1.08	11.27
Median	3.50	21.89	3.46	19.63
75th percentile	6.50	63.75	6.08	63.06
90th percentile	9.72	121.73	10.86	113.85
95th percentile	11.78	201.10	13.16	294.51
	N = 866	N = 866	N = 145	N = 145

Choice of contracts over time

- Choice at enrollment explained by sophistication or naiveté
- And over time? We expect some switching to payment per visit
- **Annual contract.** Switching after 12 months



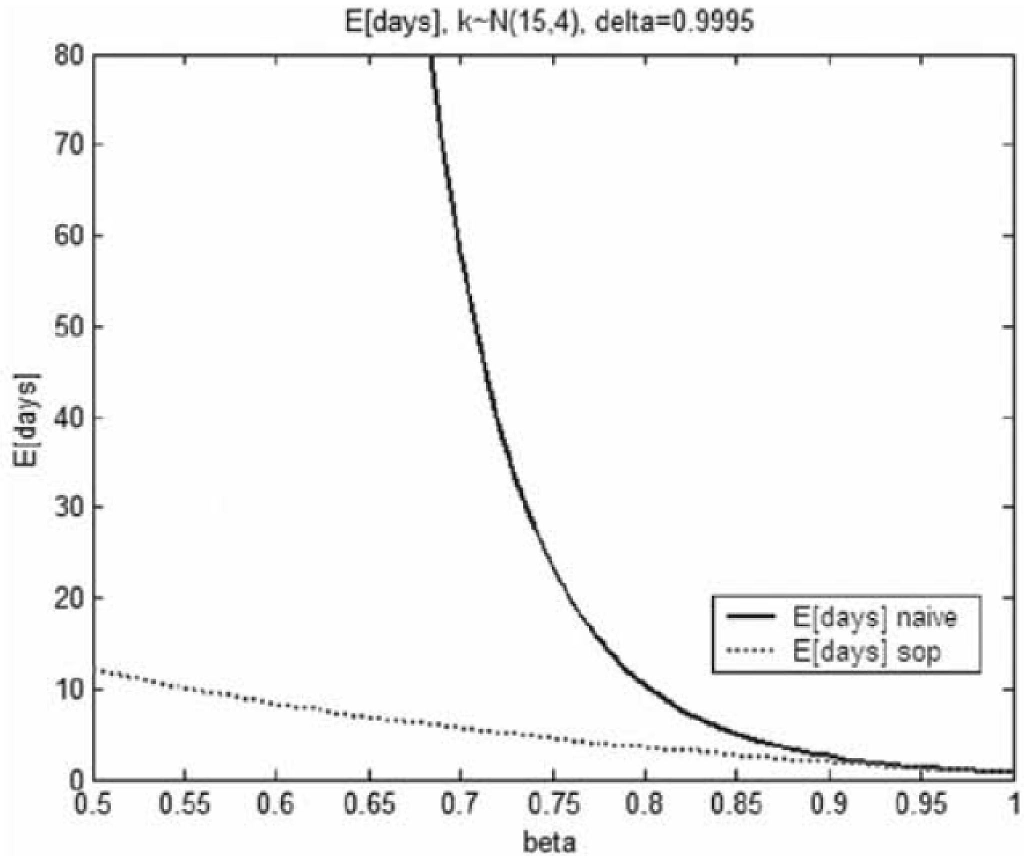
- **Monthly contract.** No evidence of selective switching



- Puzzle. Why the different behavior?

- Simple Explanation – Again the power of defaults
  - Switching out in monthly contract takes active effort
  - Switching out in annual contract is default
- Can model this as we did last time with cost k of effort and benefit b (lower fees)
- In DellaVigna and Malmendier (2006), model with stochastic cost $k\tilde{}N(15,4)$
- Assume $\delta = .9995$ and $b = \$1$ (low attendance – save $1 per day)
- How may days on average would it take between last attendance and contract termination? Observed: 2.31 months

- Calibration for different β and different types



A. Simulated expected number of days before a monthly member switches to payment per visit
Assumptions: cost *k~N(15,4)*, daily savings *s=1*, and daily discount factor delta = 0.9995. The observed average delay is 2.31 months (70 days) (Finding 4)

- Overall:

  - Present-Biased preferences *with* naiveté organize all the facts

  - Can explain magnitudes, not just qualitative patterns

- Alternative interpretations

  - **Overestimation of future efficiency.**

  - **Selection effect.** People that sign in gyms are already not the worst procrastinators

  - **Bounded rationality**

  - **Persuasion**

  - **Memory**

2 Leisure Goods: Credit card industry

- Ausubel, "Adverse Selection in Credit Card Market"
- Joint-venture company-researcher
- Field Experiment: Randomized mailing of two million solicitations!
- Follow borrowing behavior for 21 months
- Variation of:
  - pre-teaser interest rate r_0: 4.9% to 7.9%
  - post-teaser interest rate r_1: Standard - 4% to Standard $+$4%
  - Duration of teaser period T_s (measured in years)

- Part of the randomization – Incredible sample sizes. How much would this cost to run? Millions

TABLE 1: SUMMARY OF MARKET EXPERIMENTS

MARKET EXPERIMENT	MARKET CELL	NUMBER OF SOLICITATIONS MAILED	EFFECTIVE RESPONSE RATE	PERCENT GOLD CARDS	AVERAGE CREDIT LIMIT
MKT EXP I	A: 4.9% Intro Rate 6 months	100,000	1.073%	83.97%	$6,446
MKT EXP I	B: 5.9% Intro Rate 6 months	100,000	0.903%	80.18%	$6,207
MKT EXP I	C: 6.9% Intro Rate 6 months	100,000	0.687%	80.06%	$5,973
MKT EXP I	D: 7.9% Intro Rate 6 months	100,000	0.645%	76.74%	$5,827
MKT EXP I	E: 6.9% Intro Rate 9 months	100,000	0.992%	81.15%	$6,279
MKT EXP I	F: 7.9% Intro Rate 12 months	100,000	0.944%	82.31%	$6,296

- Setting:
  - Credit card offers: (r_0, r_1, T_s)
  - Individual has initial credit card (r_0^0, r_1^0, T_s^0). Balances: b_0 pre-teaser, b_1 post-teaser
- Decision to take-up new credit card:
  - switching cost $k > 0$
  - approx. saving in pre-teaser interest rates (T_s years): $b_0 = T_s \left(r_0^0 - r_0\right) b_0$
  - approx. saving in post-teaser interest rates ($2 - T_s$ years): $b_1 = (2 - T_s) \left(r_1^0 - r_1\right) b_1$
- Net benefit of switching:

$$NB = -k + T_s \left(r_0^0 - r_0\right) b_0 + (2 - T_s) \left(r_1^0 - r_1\right) b_1$$

- Compare cards A and B that differ only in interest rates r_0^A and r_0^B
- Assume $b_0^A = b_0^B = b_0$
- Difference in attractiveness:

$$NB^B - NB^A = T_s \left(r_0^A - r_0^B \right) b_0$$

- Compare cards A and C that differ only in interest rates r_1^A and r_1^C
- Assume $b_1^A = b_1^C = b_1$
- Difference in attractiveness:

$$NB^C - NB^A = (2 - T_s) \left(r_1^A - r_1^C \right) b_1$$

- Compute $NB^C - NB^A$ and $NB^B - NB^A$ using $\hat{b}_0$, $\hat{b}_1$, r_0, r_1

- Switch if $NB + \varepsilon > 0$

- Take-up rate R is function of attractiveness NB:

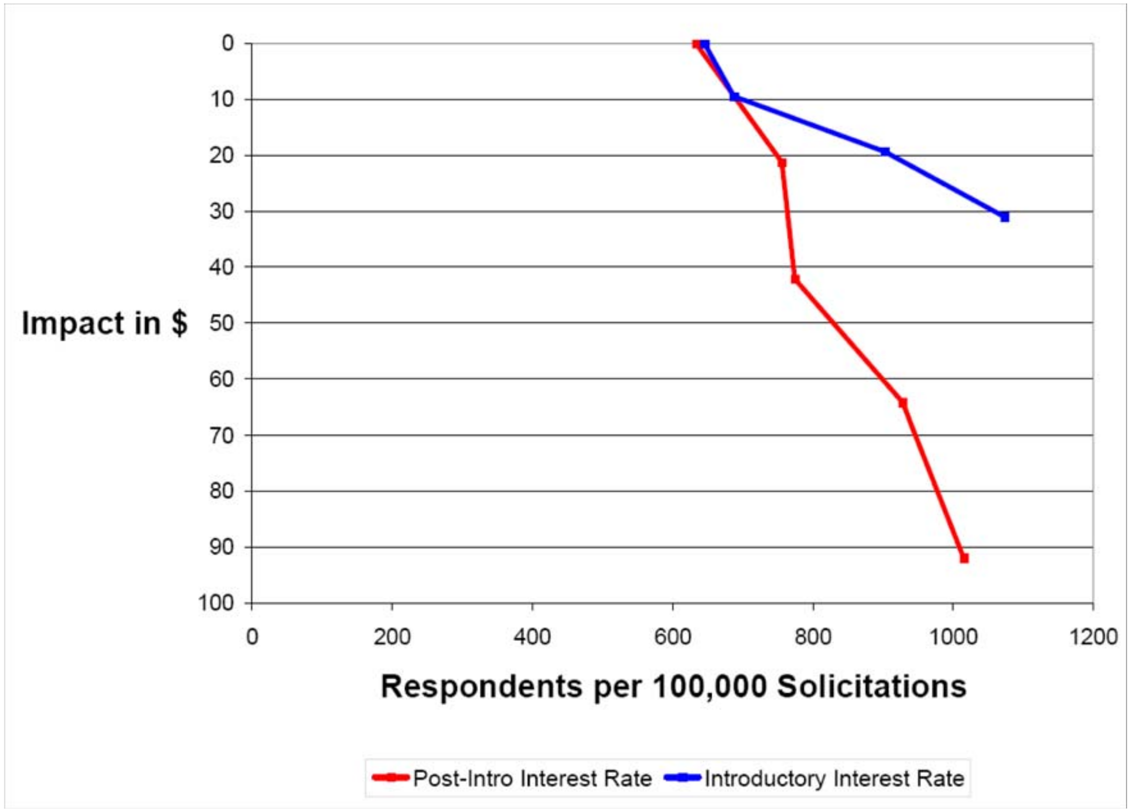
$$R = R(NB), \ R' > 0$$

- Assume R (approximately) linear in a neighborhood of NB^A, that is,

$$R(NB) = R\left(NB^A\right) + R'_{NB}\left(NB - NB^A\right)$$

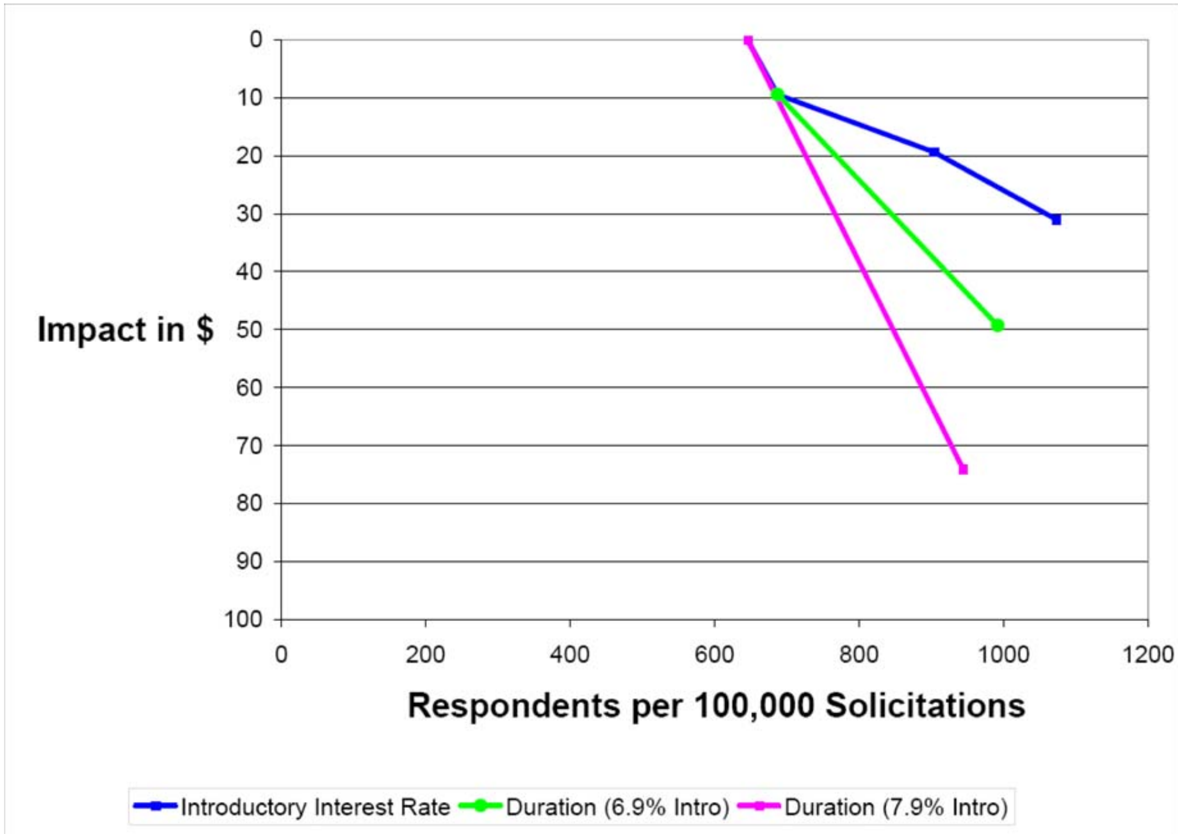
- Plot NB and R for different offers

- Figure 1. Compare offers varying in r_0 (flat line) and in r_1 (steep line)



- Very different slope!

- Figure 2. Vary length of teaser period. Similar findings.



- **Figure 1**. People underrespond to post-teaser interest rate.
- Why?
  - truncation at 21 months?
  - (very) high impatience?
  - sophistication?
  - most plausible: naiveté

- Naive time-inconsistent preferences
- Naives overestimate switching to another card (procrastination)
- Naives underestimate post-teaser borrowing: $b_1 > \hat{b}_1$ and $b_0 = \hat{b}_0$
- Compare cards:

$$NB^B - NB^A = T_s \left(r_0^A - r_0^B \right) b_0$$

and

$$NB^C - NB^A = (2 - T_s) \left(r_1^A - r_1^C \right) \hat{b}_1$$

- Underestimate impact of post-teaser interest rates
- Calibration: $\hat{b}_1 \approx (1/3)\, b_1$

- **Figure 2. Variation in T_s.** People underrespond to length of teaser period

- Why?

- Naive agent overestimates probability of switching to another teaser offer

3 Leisure Goods: Consumption and Savings

- Laibson (1997) to Laibson, Repetto, and Tobacman (2005)
- Leisure Good: Temptation to overconsume at present
- Stylized facts:
  - low liquid wealth accumulation
  - substantial iliquid wealth (housing+401(k)s)
  - extensive credit card borrowing (SCF, Fed, Gross and Souleles 2000)
  - consumption-income excess comovement (Hall and Mishkin, 1982)

TABLE 1

SECOND-STAGE MOMENTS

Description and Name	$\overline{m}_{J_m}$	se($\overline{m}_{J_m}$)
% Borrowing on Visa: *"% Visa"*	0.678	0.015
Mean (Borrowing$_t$ / mean(Income$_t$)): *"mean Visa"*	0.117	0.009
Consumption-Income Comovement: *"CY"*	0.231	0.112
Average weighted $\frac{wealth}{income}$*:* *"wealth"*	2.60	0.13

Source: Authors' calculations based on data from the Survey of Consumer Finances, the Federal Reserve, and the Panel Study on Income Dynamics. Calculations pertain to households with heads who have high school diplomas but not college degrees. The variables are defined as follows: *% Visa* is the fraction of U.S. households borrowing and paying interest on credit cards (SCF 1995 and 1998); *mean Visa* is the average amount of credit card debt as a fraction of the mean income for the age group (SCF 1995 and 1998, weighted by Fed aggregates); *CY* is the marginal propensity to consume out of anticipated changes in income (PSID 1978-92); and *wealth* is the weighted average wealth-to-income ratio for households with heads aged 50-59 (SCF 1983-1998).

- Structural model (building on Gourinchas and Parker, 2002) with:
  - borrowing constraints
  - illiquid assets
  - realistic features of the economy
- Estimation using Method of Simulated Moments
  - Simulate model (cannot solve analytically)
  - Compare simulate moments to estimated moments
- (David Laibson's Slides follow)

3 Model

- We use simulation framework
- Institutionally rich environment, e.g., with income uncertainty and liquidity constraints
- Literature pioneered by Carroll (1992, 1997), Deaton (1991), and Zeldes (1989)
- Gourinchas and Parker (2001) use method of simulated moments (MSM) to estimate a structural model of life-cycle consumption

3.1 Demographics

- Mortality, Retirement (PSID), Dependents (PSID), HS educational group

3.2 Income from transfers and wages

- $Y_t =$ after-tax labor and bequest income plus govt transfers (assumed exog., calibrated from PSID)

- $y_t \equiv \ln(Y_t)$. During working life:

$$y_t = f^W(t) + u_t + \nu_t^W \tag{3}$$

- During retirement:

$$y_t = f^R(t) + \nu_t^R \tag{4}$$

3.3 Liquid assets and non-collateralized debt

- $X_t + Y_t$ represents liquid asset holdings at the beginning of period t.

- Credit limit: $X_t \geq -\lambda \cdot \bar{Y}_t$

- $\lambda = .30$, so average credit limit is approximately \$8,000 (SCF).

3.4 Illiquid assets

- Z_t represents illiquid asset holdings at age t.
- Z bounded below by zero.
- Z generates consumption flows each period of γZ.
- Conceive of Z as having some of the properties of home equity.
- Disallow withdrawals from Z; Z is perfectly illiquid.
- Z stylized to preserve computational tractability.

3.5 Dynamics

- Let I_t^X and I_t^Z represent net investment into assets X and Z during period t

- Dynamic budget constraints:

$$\begin{aligned} X_{t+1} &= R^X \cdot (X_t + I_t^X) \\ Z_{t+1} &= R^Z \cdot (Z_t + I_t^Z) \\ C_t &= Y_t - I_t^X - I_t^Z \end{aligned}$$

- Interest rates:

$$R^X = \begin{cases} R^{CC} & \text{if } X_t + I_t^X < 0 \\ R & \text{if } X_t + I_t^X > 0 \end{cases} ; \qquad R^Z = 1$$

- Three assumptions for $\left[R^X, \gamma, R^{CC}\right]$:

Benchmark:	[1.0375, 0.05, 1.1175]
Aggressive:	[1.03, 0.06, 1.10]
Very Aggressive:	[1.02, 0.07, 1.09]

In full detail, self t has instantaneous payoff function

$$u(C_t, Z_t, n_t) = n_t \cdot \frac{\left(\frac{C_t + \gamma Z_t}{n_t}\right)^{1-\rho} - 1}{1 - \rho}$$

and continuation payoffs given by:

$$\beta \sum_{i=1}^{T+N-t} \delta^i \left(\Pi_{j=1}^{i-1} s_{t+j}\right) (s_{t+i}) \cdot u(C_{t+i}, Z_{t+i}, n_{t+i}) \ldots$$
$$+\beta \sum_{i=1}^{T+N-t} \delta^i \left(\Pi_{j=1}^{i-1} s_{t+j}\right) (1 - s_{t+i}) \cdot B(X_{t+i}, Z_{t+i})$$

- n_t is effective household size: adults+(.4)(kids)

- γZ_t represents real after-tax net consumption flow

- s_{t+1} is survival probability

- $B(\cdot)$ represents the payoff in the death state

3.7 Computation

- Dynamic problem:

$$\max_{I_t^X, I_t^Z} \quad u(C_t, Z_t, n_t) + \beta\delta E_t V_{t,t+1}(\Lambda_{t+1})$$
$$s.t. \text{ Budget constraints}$$

- $\Lambda_t = (X_t + Y_t, Z_t, u_t)$ (state variables)

- Functional Equation:

$$V_{t-1,t}(\Lambda_t) =$$
$$\{s_t[u(C_t, Z_t, n_t) + \delta E_t V_{t,t+1}(\Lambda_{t+1})] + (1 - s_t) E_t B(\Lambda_t)\}$$

- Solve for eq strategies using backwards induction

- Simulate behavior

- Calculate descriptive moments of consumer behavior

4 Estimation

Estimate parameter vector θ and evaluate models wrt data.

- $m_e =$ N empirical moments, VCV matrix $= \Omega$
- $m_s(\theta) =$ analogous simulated moments
- $q(\theta) \equiv (m_s(\theta) - m_e)\,\Omega^{-1}\,(m_s(\theta) - m_e)'$, a scalar-valued loss function
- Minimize loss function: $\hat{\theta} = \arg\min_{\theta} q(\theta)$
- $\hat{\theta}$ is the MSM estimator.
- Pakes and Pollard (1989) prove asymptotic consistency and normality.
- Specification tests: $q(\hat{\theta}) \sim \chi^2(N - \#parameters)$

TABLE 3

BENCHMARK STRUCTURAL ESTIMATION RESULTS

	(1) Hyperbolic	(2) Exponential	(3) Hyperbolic Optimal Wts	(4) Exponential Optimal Wts	(5) Data
Parameter estimates $\hat{\theta}$					
$\hat{\beta}$	0.7031	1.0000	0.7150	1.0000	-
s.e. (i)	(0.1093)	-	(0.0948)	-	-
s.e. (ii)	(0.1090)	-	-	-	-
s.e. (iii)	(0.0170)	-	-	-	-
s.e. (iv)	(0.0150)	-	-	-	-
$\hat{\delta}$	0.9580	0.8459	0.9603	0.9419	-
s.e. (i)	(0.0068)	(0.0249)	(0.0081)	(0.0132)	-
s.e. (ii)	(0.0068)	(0.0247)	-	-	-
s.e. (iii)	(0.0010)	(0.0062)	-	-	-
s.e. (iv)	(0.0009)	(0.0056)	-	-	-
Second-stage moments					
% Visa	0.634	0.669	0.613	0.284	0.678
mean Visa	0.167	0.150	0.159	0.049	0.117
CY	0.314	0.293	0.269	0.074	0.231
wealth	2.69	-0.05	3.22	2.81	2.60
Goodness-of-fit					
$q(\hat{\theta},\hat{\chi})$	67.2	436	2.48	34.4	-
$\xi(\hat{\theta},\hat{\chi})$	3.01	217	8.91	258.7	-
p-value	0.222	$<$1e-10	0.0116	$<$2e-7	-

Source: Authors' calculations.

Note on standard errors: (i) includes both the first stage correction and the simulation correction, (ii) includes just the first stage correction, (iii) includes just the simulation correction, and (iv) includes neither correction.

TABLE 4

ROBUSTNESS

	(1) Benchmark	(2) $\gamma = 3.38\%$	(3) $\gamma = 6.59\%$	(4) $r^{CC} = 10\%$	(5) $r^{CC} = 13\%$	(6) $\rho = 1$	(7) $\rho = 3$
Hyperbolic							
Parameter Estimates $\hat{\theta}$							
$\hat{\beta}$	0.7031	0.5071	0.8024	0.7235	0.6732	0.8186	0.5776
s.e. (i)	(0.1093)	(0.0441)	(0.0614)	(0.1053)	(0.1167)	(0.0959)	(0.1339)
$\hat{\delta}$	0.9580	0.9731	0.9425	0.9567	0.9595	0.9610	0.9545
s.e. (i)	(0.0068)	(0.0188)	(0.0093)	(0.0071)	(0.0045)	(0.0037)	(0.0096)
Goodness-of-fit							
$q(\hat{\theta}, \hat{\chi})$	67.2	108.4	49.7	64.1	70.7	63.0	67.7
$\xi(\hat{\theta}, \hat{\chi})$	3.01	16.79	5.27	12.09	10.97	7.97	1.85
p-value	0.222	0.0002	0.0717	0.0024	0.0041	0.0186	0.3965
Exponential							
Parameter Estimates $\hat{\theta}$							
$\hat{\beta}$	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
s.e. (i)	-	-	-	-	-	-	-
$\hat{\delta}$	0.8459	0.8459	0.8459	0.8520	0.8354	0.8924	0.7841
s.e. (i)	(0.0249)	(0.0249)	(0.0250)	(0.0267)	(0.0262)	(0.0204)	(0.0357)
Goodness-of-fit							
$q(\hat{\theta}, \hat{\chi})$	435.6	435.6	435.6	434.7	436.6	438.1	435.5
$\xi(\hat{\theta}, \hat{\chi})$	217	217	263	177	339	349	310
p-value	<1e-10	<1e-10	<1e-10	<1e-10	<1e-10	<1e-10	<1e-10

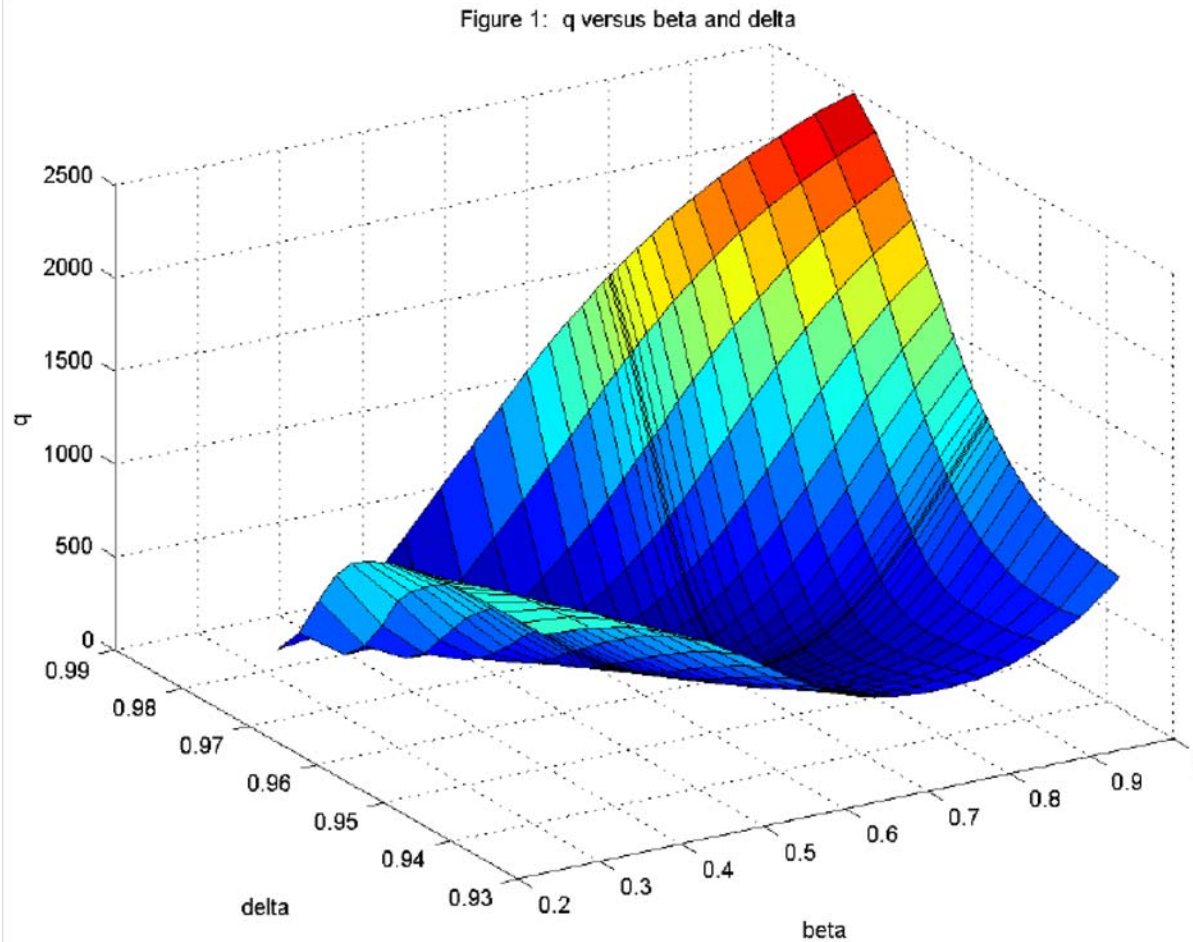


Figure 1: This figure plots the MSM objective function with respect to beta and delta under the paper's benchmark assumptions. The objective, q, equals a weighted sum of squared deviations of the empirical moments from the moments predicted by the model. Lower values of q represent a better fit of the model, and the (beta,delta) pair that minimizes q is the MSM estimator.

4 Next Lecture

- Finish discussion of Present Bias
  - Ashraf et al. (2006) paper
  - A brief overview of the rest of the literature
- Reference-Dependence Preferences
  - Introduction
  - Endowment Effect / Effect of Experience
  - Financial markets: Disposition Effect