# Econ 219B
# Psychology and Economics: Applications
# (Lecture 8)

Stefano DellaVigna

March 17, 2010

Outline

1. Investment Goods: Exercise
2. Leisure Goods: Credit Card Borrowing
3. Leisure Goods: Consumption and Savings I (Life-cycle)
4. Leisure Goods: Consumption and Savings II (Commitments)
5. Methodology: Errors in Applying Present-Biased Preferences

6. Non-Standard Beliefs

7. Overconfidence I

# 1 Investment Goods: Exercise

- DellaVigna, Malmendier, “Paying Not To Go To The Gym”, *American Economic Review*

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

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

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

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

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

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

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

**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 |

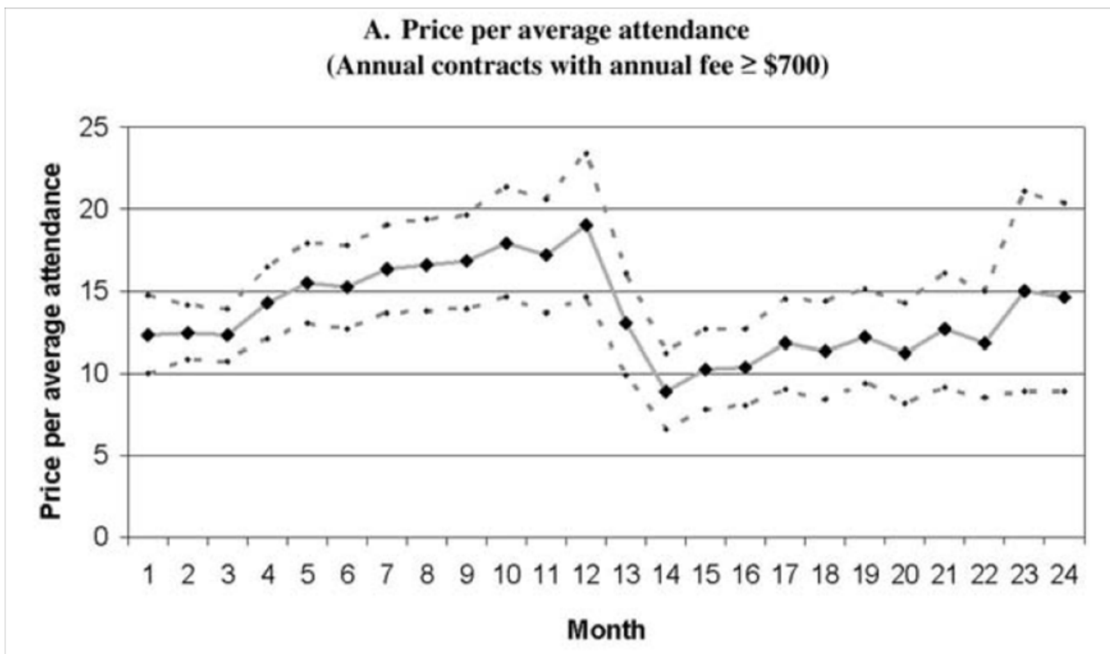
- Result is not due to small number of outliers
- 80 percent of people would be better off in pay-per-visit

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

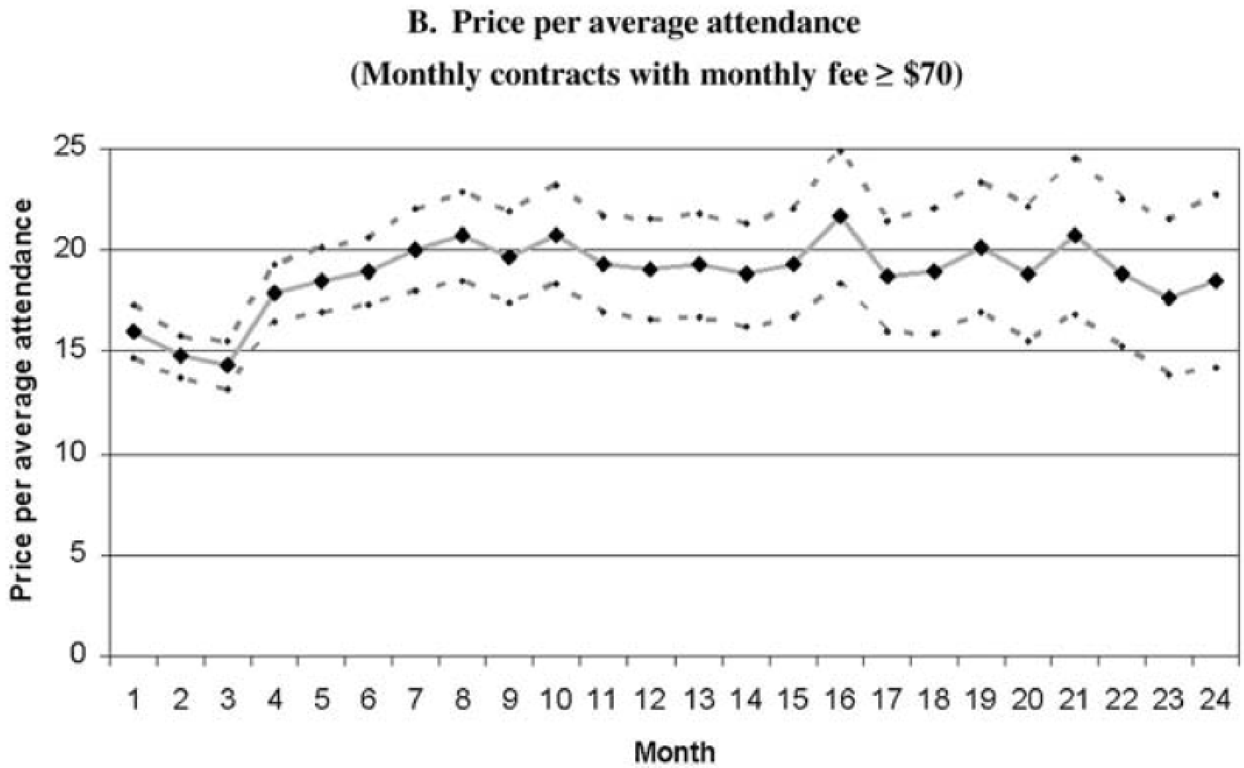
| | Sample: No subsidy, all clubs | | | |
|---|---|---|---|---|
| | First contract monthly, months 1–6 (monthly fee ≥ \$70) | | First contract annual, year 1 (annual fee ≥ \$700) | |
| | Average attendance per month (1) | Price per attendance (2) | Average attendance per month (3) | Price per attendance (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



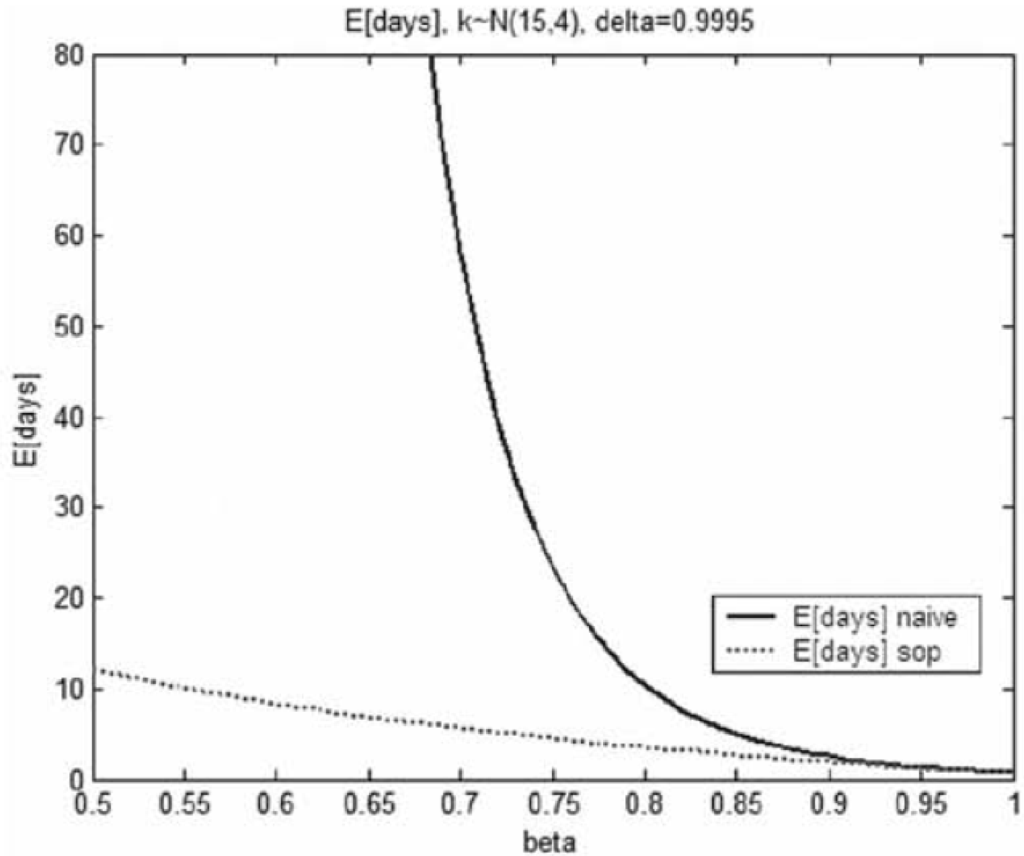
- **Monthly contract.** No evidence of selective switching




- 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
- Model this as for 401(k)s 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 $\beta$ 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
  - Acland and Levy (2009) elicit incentivized expectations of future gym attendance with 'p-coupons': significant over-estimation
- 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 Borrowing

- Ausubel, “Adverse Selection in Credit Card Market", 1999
- 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 |

- Another set of experiments:

| | | | | | |
|---|---|---|---|---|---|
| MKT EXP III | A: Post-Intro Rate Standard - 4% | 100,000 | 1.015% | 82.96% | $5,666 |
| MKT EXP III | B: Post-Intro Rate Standard - 2% | 100,000 | 0.928% | 77.69% | $5,346 |
| MKT EXP III | C: Post-Intro Rate Standard + 0% | 100,000 | 0.774% | 76.87% | $5,167 |
| MKT EXP III | D: Post-Intro Rate Standard + 2% | 100,000 | 0.756% | 76.98% | $5,265 |
| MKT EXP III | E: Post-Intro Rate Standard + 4% | 100,000 | 0.633% | 73.62% | $5,095 |

- Setting:
  - Individual has initial credit card $(r_0^0, r_1^0, T_s^0)$. Balances: $b_0$ pre-teaser, $b_1$ post-teaser
  - Credit card offers: $(r_0', r_1', T_s')$
- Decision to take-up new credit card:
  - switching cost $k > 0$
  - approx. saving in pre-teaser rates ($T_s$ years): $T_s \left(r_0' - r_0^0\right) b_0$
  - approx. saving in post-teaser rates ($21/12 - T_s$ years): $(21/12 - T_s)\,(r_1' - r_1)b_1$
- Net benefit of switching:

$$NB' = -k + T_s \left(r_0' - r_0^0\right) b_1 + (21/12 - T_s) \left(r_1' - r_1^0\right) b_1$$

- Switch if $NB + \varepsilon > 0$

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

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

- Compare take-up rate of card $i$, $R^i$, to take-up rate of Standard Card $St$, $R^{St}$

  - Standard Card (6.9% followed by 16%) (Card C above)

- Assume $R$ (approximately) linear in a neighborhood of $NB^{St}$, that is,

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

- Compare cards $Pre$ and $St$ that differ only in interest rate $r_0$ (pre-teaser)
- Assume $b_0^{Pre} = b_0^{St} = b_0$ (Pre-teaser balance ) $\approx \$2,000$
- Difference in attractiveness:

$$R\left(NB^{Pre}\right) - R\left(NB^{St}\right) = R'_{NB} T_s \left(r_0^{Pre} - r_0^{St}\right) b_0$$

  - Pre-Teaser Offer (Card A): (4.9% followed by 16%)
    - $NB^{Pre} - NB^{St} \approx 6/12 * 2\% * \$2,000 = \$20$
    - $R\left(NB^{Pre}\right) - R\left(NB^{St}\right) = 386$ out of 100,000

- Compare cards $Post$ and $St$ that differ only in interest rate $r_1$ (post-teaser)

- Assume $b_1^{Post} = b_1^{St} = b_1$ (Post-teaser balance) $\approx \$1,000$

- Difference in attractiveness:

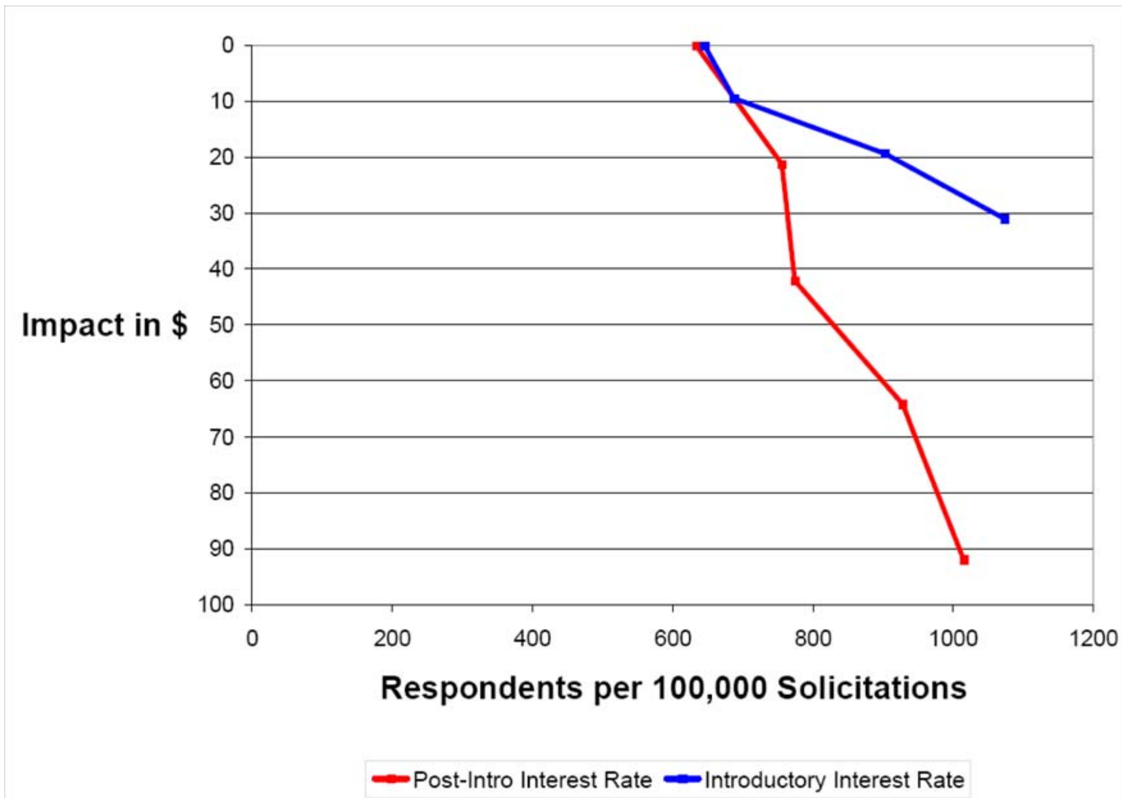
$$R(NB^{Post}) - R(NB^{St}) = R'_{NB}\,(21/12 - T_s)\left(r_1^{Post} - r_1^{St}\right) b_1$$

  - Post-Teaser Offer (Card B in Exp. III): (6.9% followed by 14%)
    * $NB^{Post} - NB^{St} \approx 15/12 * 2\% * \$1000 = \$25$
    * $R(NB^{Post}) - R(NB^{St}) =$ 154 out of 100,000

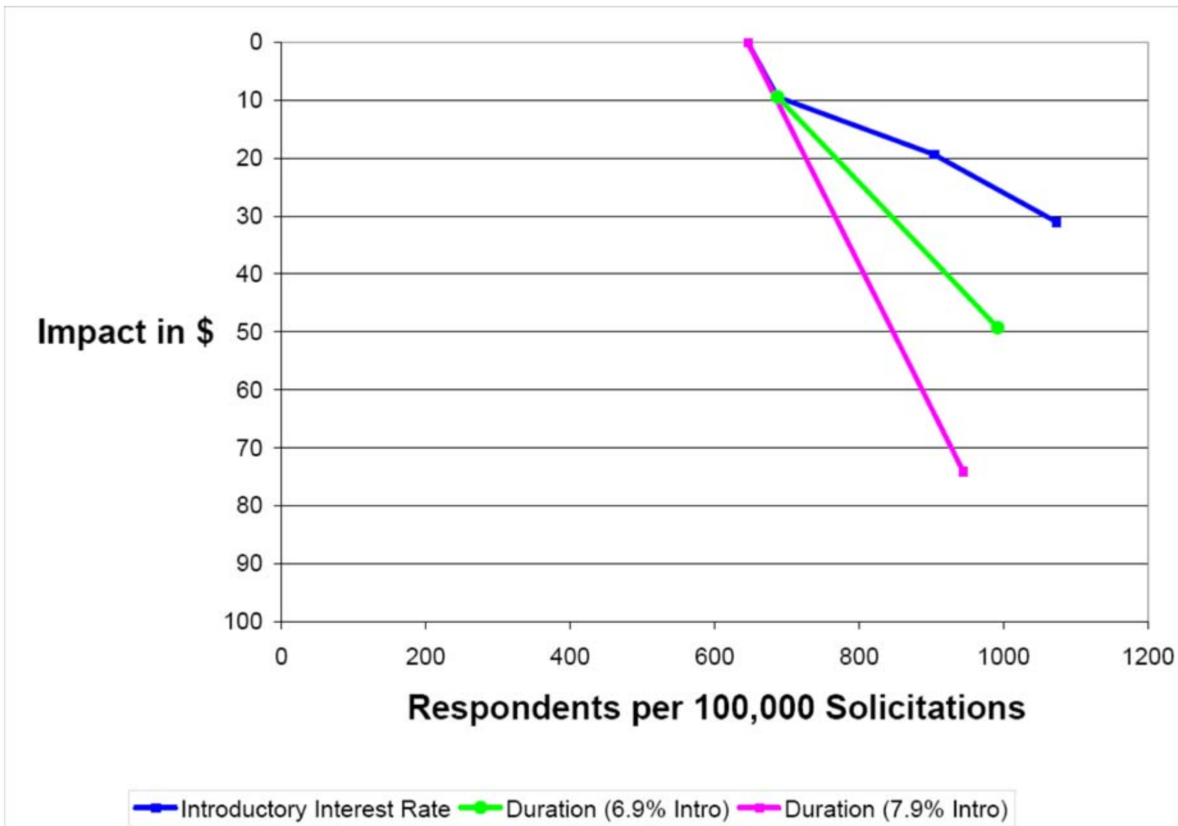
- Puzzle:
  - $NB^{Post} - NB^{St} > NB^{Pre} - NB^{St}$
  - But $R(NB^{Pre}) - R(NB^{St}) >> R(NB^{Post}) - R(NB^{St})$

- Plot $NB$ and $R(NB)$ 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: $\hat{b}_1 < b_1$ and $\hat{b}_0 = b_0$
- Compare cards:

$$NB^{Pre} - NB^{St} = T_s \left( r_0^{Pre} - r_0^{St} \right) b_0$$

and

$$\widehat{NB}^{Post} - \widehat{NB}^{St} = (21/12 - T_s) \left( r_1^{Post} - r_1^{St} \right) \hat{b}_1$$

- 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 I

- Laibson (1997) to Laibson, Repetto, and Tobacman (2007)
- Leisure Good: Temptation to overconsume at present
- Stylized facts:
  - Low liquid wealth accumulation
  - Extensive credit card borrowing (SCF, Fed, Gross and Souleles 2000)
  - Consumption-income excess comovement (Hall and Mishkin, 1982)
  - Substantial illiquid wealth (housing+401(k)s)

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).

- Reduced-form evidence here not sufficient
- Life-cycle consumption model (Gourinchas and Parker, 2004)
- Assume realistic features:
  - borrowing constraints
  - illiquid assets
  - bequests...

- Two steps of estimation: of MSM (Method of Simulated Moments)

  1. Estimate ('calibrate') auxiliary parameters
     - Interest rate
     - Mortality
     - Income shocks

  2. Estimate main parameters $(\beta, \delta)$ using Method of Simulated Moments

  – * Simulate model (cannot solve analytically)

     * Choose parameters $(\hat{\beta}, \hat{\delta})$ that minimize distance of simulated moments to estimated moments

     * Take into account uncertainty in estimates of 1st stage

- (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 $\gamma Z$.
- 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:

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

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

- $\gamma Z_t$ 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 $\theta$ 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 |

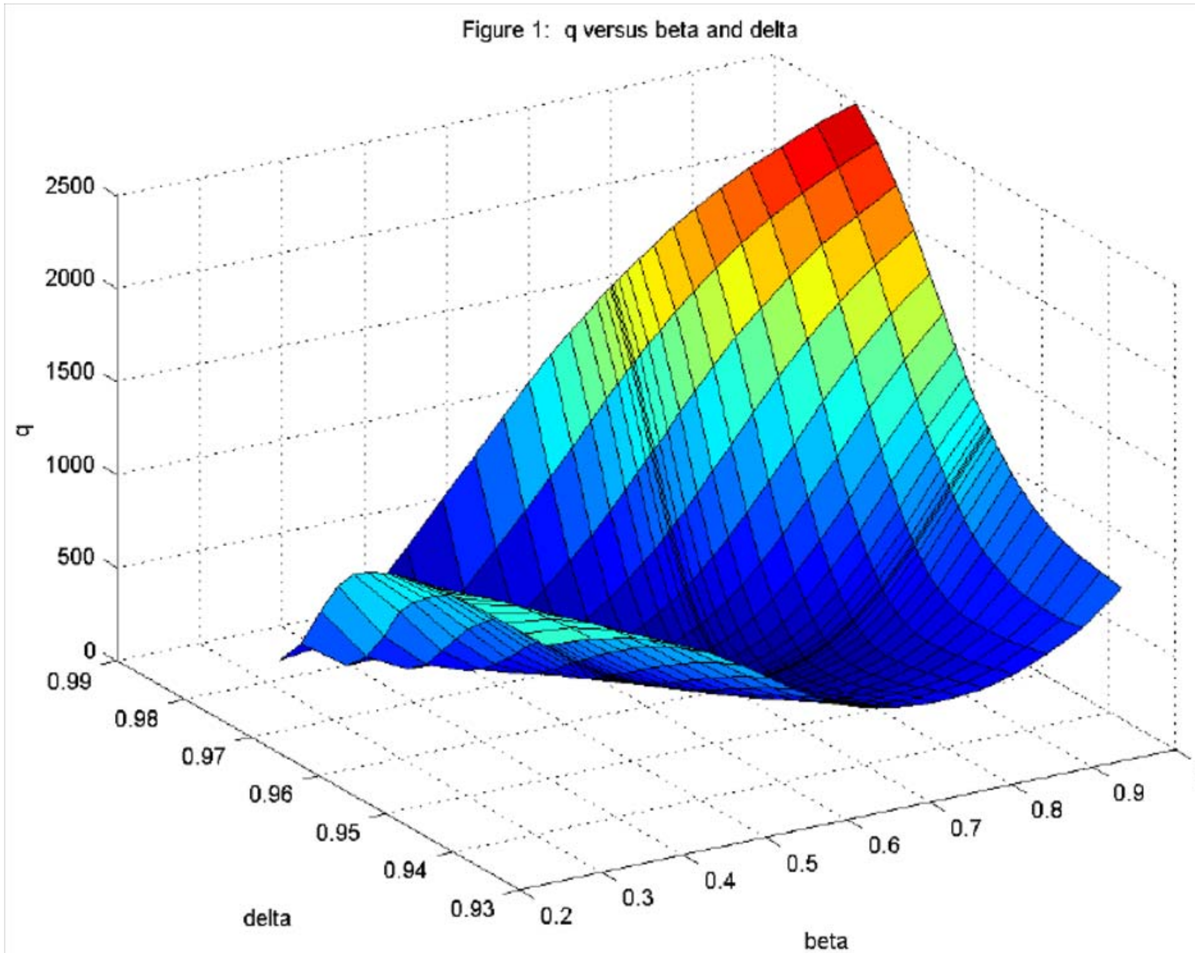



Figure 1: This figure plots the MSM objective function with respect to beta and delta under the paper's benchmark assumptions. The objective, q, equals a weighted sum of squared deviations of the empirical moments from the moments predicted by the model. Lower values of q represent a better fit of the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

# 4 Leisure Goods: Commitments and Savings II

- Ashraf, Karlan, and Yin (2005), *Quarterly Journal of Economics*
  - Different Methodology: Field Experiment
  - Different Setting: Philippines

- Three treatments:
  - SEED Treatment (N=842): Encourage to save, Offer commitment device (account with savings goal)
  - Marketing Treatment (N=466): Encourage to save, Offer no commitment
  - Control Treatment (N=469)

- Evaluation:
  - Compare SEED to Marketing Treatment: Effect of Commitment Device in addition to encouragement
  - Measure the effect on total savings (also on non-committed account) – This was not true in 401(k) studies
- SEED Treatment:
  - Out of 842 treated people, 202 take up SEED
  - 167 also got lock-up box (did not observe savings there)

- Effect of SEED Treatment on Total Savings, Compared to Marketing
  - (Remember: Include all 842 people, Intent-to-Treat)
  - *Share of people with increased Balances*: 5.6 percentage (33.3 percent in SEED and 27.7 in Marketing)
  - *Share of people with increased Balances by at least 20 percent*: 6.4 percentage points
  - *Total Balances*: 287 Pesos after 6 months (not significant)
- To compute Treatment-on-The-Treated, divide by 202/842
  - Take into account no effect on non-takers (by assumption)

TABLE VI
Impact on Change in Savings Held at Bank
OLS, Probit

INTENT TO TREAT EFFECT

| | OLS | | | | Probit | | | |
|---|---|---|---|---|---|---|---|---|
| Length | 6 months | | 12 months | | 12 months | | | |
| Dependent Variable: | Change in Total Balance | Change in Total Balance | Change in Total Balance | Change in Total Balance | Binary Outcome = 1 if Change in Balance > 0% | Binary Outcome = 1 if Change in Balance > 0% | Binary Outcome = 1 if Change in Balance > 20% | Binary Outcome = 1 if Change in Balance > 20% |
| Sample | All | Commitment & Marketing Only | All | Commitment & Marketing Only | All | Commitment & Marketing Only | All | Commitment & Marketing Only |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Commitment Treatment | 234.678* | 49.828 | 411.466* | 287.575 | 0.102*** | 0.056** | 0.101*** | 0.064*** |
| | (101.748) | (156.027) | (244.021) | (228.523) | (3.82) | (0.026) | (0.022) | (0.021) |
| Marketing Treatment | 184.851 | | 123.891 | | 0.048 | | 0.041 | |
| | (146.982) | | (153.440) | | (1.56) | | (0.027) | |
| Constant | 40.626 | 225.476* | 65.183 | 189.074** | | | | |
| | (61.676) | (133.405) | (124.215) | (90.072) | | | | |
| Observations | 1777 | 1308 | 1777 | 1308 | 1777 | 1308 | 1777 | 1308 |
| R-squared | 0.00 | 0.00 | 0.00 | 0.00 | | | | |

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. The dependent variable in the first two column is the change in total savings held at the Green Bank after six months. Column (1) regresses chnage in total savings balances on indicators for assignment in the commitment- and marketing-treatment groups. The omitted group indicator in this regression corresponds to the control group. Column (2) shows the regression restricting the sample to commitment- and marketing-treatment groups. Columns (3) and (4) repeat this regression, using change in savings balances after 12 months as a dependent variable. The dependent variable in columns (5)-(8) is a binary variable equal to 1 if balances increased by x%. 154 clients had pre-intervention a savings balance equal to zero. 24 of them had positive savings after 12 months. These individuals were coded as "one," and those that remain at zero were coded as zero for the outcome variables for columns (5) through (8). Exchange rate is 50 pesos for US $1.00.

- In addition, examine correlation with a survey response to hyperbolic-discounting-type question:
  - Preference between 200 Pesos now and in 1 month
  - Preference between 200 Pesos in 6 months and in 7 months

TABLE III

Tabulations of Responses to Hypothetical Time Preference Questions

| | | | Indifferent between 200 pesos in 6 months and X in 7 months | | | |
|---|---|---|---|---|---|---|
| | | | Patient X<250 | Somewhat Impatient 250<X<300 | Most Impatient 300<X | Total |
| Indifferent between 200 pesos now and X in one month | Patient | X<250 | 606<br>34.4% | 126<br>7.2% | 73<br>4.1% | 805<br>45.7% |
| | Somewhat Impatient | 250<X<300 | 206<br>11.7% | 146<br>8.3% | 59<br>3.3% | 411<br>23.3% |
| | Most Impatient | 300<X | 154<br>8.7% | 93<br>5.3% | 299<br>17% | 546<br>31% |
| | Total | | 966<br>54.8% | 365<br>20.7% | 431<br>24.5% | 1,762<br>100% |

(light grey) "Hyperbolic": More patient over future tradeoffs than current tradeoffs

(dark grey) "Patient Now, Impatient Later": Less patient over future tradeoffs than current tradeoffs.

(hatched) Time inconsistent (direction of inconsistency depends on answer to open-ended question).

- On average, evidence on hyperbolic-discounting-type preferences
- Interesting idea: Correlate survey response with response to treatment (also in Fehr-Goette paper next lecture)
- Evidence of correlation for women, not for men

TABLE V
Determinants of SEED Takeup
Probit

| | (1) All | (2) All | (3) Female | (4) Male |
|---|---|---|---|---|
| Time inconsistent | 0.125* | 0.005 | 0.158* | 0.046 |
| | (0.067) | (0.080) | (0.085) | (0.098) |
| Impatient, Now versus 1 Month | -0.030 | -0.039 | -0.036 | -0.041 |
| | (0.050) | (0.050) | (0.062) | (0.075) |
| Patient, Now versus 1 Month | 0.076 | 0.070 | 0.035 | 0.119 |
| | (0.072) | (0.072) | (0.089) | (0.110) |
| Impatient, 6 months versus 7 Months | 0.097 | 0.108* | 0.124 | 0.078 |
| | (0.065) | (0.065) | (0.087) | (0.091) |
| Patient, 6 months versus 7 Months | 0.015 | 0.022 | 0.057 | -0.021 |
| | (0.064) | (0.064) | (0.081) | (0.093) |

- Growing literature on offering commitment devices
- Typical set-up:
  - Treatment group gets offered commitment device
  - Control group does not
  - Final outcome is measure for both groups
- Outcomes:
  - Smoking cessation (Gine, Karlan, and Zinman, 2010)
  - Limiting online gaming (Chow, 2010 and Acland and Chow, 2010)
  - Health-club attendance (Royer and Sydnor, 2010)

# 5 Methodology: Errors in Applying Present-Biased Preferences

- Present-Bias model very successful
- Quick adoption at cost of incorrect applications
- Four common errors

- **Error 1. Procrastination with Sophistication**
  - 'Self-Control leads to Procrastination'
  - This is not accurate in two ways
  - *Issue 1.*
    * $(\beta, \delta)$ Sophisticates do not delay for long (see our calibration)
    * Need Self-control + Naiveté (overconfidence) to get long delay
  - *Issue 2.* (Definitional issue) We distinguished between:
    * Delay. Task is not undertaken immediately
    * Procrastination. Delay systematically beyond initial expectations
    * Sophisticates and exponentials do not procrastinate, they *delay*

- **Error 2. Naives with Yearly Decisions**
  - 'We obtain similar results for naives and sophisticates in our calibrations'
  - Example 1. Fang, Silverman (2007)
  - Single mothers applying for welfare. Three states:
    1. Work
    2. Welfare
    3. Home (without welfare)
  - Welfare dominates Home – So why so many mothers stay Home?

| Choice at $t-1$ | Choice at $t$ | | |
|---|---|---|---|
| | Welfare | Work | Home |
| Welfare | | | |
| Row % | 84.3 | 3.5 | 12.3 |
| Column % | 76.7 | 6.3 | 17.9 |
| Work | | | |
| Row % | 5.3 | 79.3 | 15.3 |
| Column % | 2.6 | 76.4 | 12.1 |
| Home | | | |
| Row % | 28.3 | 12.0 | 59.7 |
| Column % | 20.7 | 17.3 | 70.0 |

- – Model:
  - ∗ Immediate cost $\phi$ (stigma, transaction cost) to go into welfare
  - ∗ For $\phi$ high enough, can explain transition
  - ∗ Simulate Exponentials, Sophisticates, Naives

- However: Simulate decision at **yearly** horizon.
- BUT: At yearly horizon naives do not procrastinate:
  - Compare:
    - Switch now
    - Forego *one year* of benefits and switch next year
- Result:
  - Very low estimates of $\beta$
  - Very high estimates of switching cost $\phi$
  - Naives are same as sophisticates

| Parameters | | (1) Time Consistent | | (2) Present-Biased (sophisticated) | | (3) Present-Biased (Naive) | |
|---|---|---|---|---|---|---|---|
| | | Estimate | S.E. | Estimate | S.E. | Estimate | S.E. |
| Preference Parameters | | | | | | | |
| Discount Factors | $\beta$ | 1 | n.a. | 0.33802 | 0.06943 | 0.355 | 0.0983 |
| | $\delta$ | 0.41488 | 0.07693 | 0.87507 | 0.01603 | 0.868 | 0.02471 |
| Net Stigma | $\phi^{(1)}$ | 7537.04 | 774.81 | 8126.19 | 834.011 | 8277.46 | 950.77 |
| (by type) | $\phi^{(2)}$ | 10100.9 | 1064.83 | 10242.01 | 955.878 | 10350.20 | 1185.27 |
| | $\phi^{(3)}$ | 13333.2 | 1640.18 | 12697.25 | 1426.40 | 12533.69 | 1685.92 |

- – Conjecture: If allowed daily or weekly decision, would get:
    - ∗ Naives fit much better than sophisticates
    - ∗ $\beta$ much closer to 1
    - ∗ $\phi$ much smaller

– Example 2. Shui and Ausubel (2005) –> Estimate Ausubel (1999)

* Cost $k$ of switching from credit card to credit card
* Again: Assumption that can switch only every quarter
* Results of estimates (again):
  - Quite low $\beta$
  - Naives do not do better than sophisticates
  - Very high switching costs

Table 4: Estimated Parameters [a]

| | Sophisticated Hyperbolic | Naive Hyperbolic | Exponential |
|---|---|---|---|
| $\beta$ | 0.7863<br>(0.00192) | 0.8172<br>(0.003) | |
| $\delta$ | 0.9999<br>(0.00201) | 0.9999<br>(0.0017) | 0.9999<br>(0.00272) |
| $k$ | 0.02927<br>\$293<br>(0.00127) | 0.0326<br>\$326<br>(0.00139) | 0.1722<br>\$1,722<br>(0.0155) |

- **Error 3. Present-Bias over Money**
  - 'We offer the choice between \$10 today and \$15 in a week'
  - Experiments supporting $(\beta, \delta)$ usually of the above type (from Ainslie, 1956 to Benhabib, Bisin, and Schotter, 2006 and Andreoni and Sprenger, 2009)
  - BUT: Discounting applies to consumption, not income (Mulligan, 1999):

$$U_0 = u(c_0) + \beta\delta Eu(c_1) + \beta\delta^2 Eu(c_2)$$

  - Assume that individual consume the \$10 in the future –> Then the choice is between
    * $u(10)$
    * $\beta\delta Eu(15)$
  - Credit constraints –> Consume immediately, remove this problem to good extent (but confound with another problem)
  - In addition: Uncertainty over future shocks, not in present

- Ideally: Do experiments with goods to be consumed right away:
  * Low- and High-brow movies (Read and Loewenstein, 1995)
  * Squirts of juice for thirsty subjects (McClure et al., 2005)
- Same problem applies to models
  * Notice: Transaction costs of switching $k$ in above models are real effort, apply immediately
  * Effort cost $c$ of attending gym also 'real' (not monetary)
  * Consumption-Savings models: Utility function of consumption $c$, not income $I$

- **Error 4. Getting the Intertemporal Payoff Wrong**
  - 'Costs are in the present, benefits are in the future'
  - $(\beta, \delta)$ models very sensitive to timing of payoffs
  - Sometimes, can easily turn investment good into leisure good
  - Need to have strong intuition on timing
  - Example: Carrillo (1999) on nuclear plants as leisure goods
    * Immediate benefits of energy
    * Delayed cost to environment
  - BUT: 'Immediate' benefits come after 10 years of construction costs!

# 6 Non-Standard Beliefs

- So far, focus on non-standard utility function $U\left(x_i^t|s_t\right)$ as deviations from standard model:

$$\max_{x_i^t \in X_i} \sum_{t=0}^{\infty} \delta^t \sum_{s_t \in S_t} p(s_t)\, U\left(x_i^t|s_t\right)$$

- Non-standard preferences
  - Self-Control Problems $(\beta, \delta)$
  - Reference Dependence $\left(U\left(x_i^t|s_i, r\right)\right)$
  - Social Preferences $(U(x_i, x_{-i}|s))$

- Today: Non-Standard Beliefs:

$$\max_{x_i^t \in X_i} \sum_{t=0}^{\infty} \delta^t \sum_{s_t \in S_t} \tilde{p}(s_t) U\left(x_i^t | s_t\right)$$

  where $\tilde{p}(s_t)$ is the subjective distribution of states $S_i$ for agent.

- Distribution for agent differs from actual distribution: $\tilde{p}(s_t) \neq p(s_t)$

- Three main examples:

  1. *Overconfidence*. Overestimate one's own skills (or precision of estimate): $\tilde{p}(good\ state_t) > p(good\ state_t)$
  2. *Law of Small Numbers.* Gambler's Fallacy and Overinference in updating $\tilde{p}(s_t | s_{t-1})$
  3. *Projection Bias.* Expect future utility $\widetilde{U}\left(x_i^t | s_t\right)$ to be too close to today's

# 7 Overconfidence I

- Overconfidence is of at least two types:
  - Overestimate one's ability (also called *overoptimism*)
  - Overestimate the precision of one's estimates (also called *overprecision*)
- Psychology: Evidence on overconfidence/overoptimism
  - **Svenson (1981):** 93 percent of subjects rated their driving skill as above the median, compared to the other subjects in the experiment
  - **Weinstein (1980):** Most individuals underestimate the probability of negative events such as hospitalization
  - **Buehler-Griffin-Ross (1994):** Underestimate time needed to finish a project

- Economic experiment: **Camerer and Lovallo (AER, 1999)**
  - Experimental design:
    - Initial endowment: \$10
    - Simultaneous entry decision: enter –> play game or stay out –> payoff 0
    - Parameter $c$ for entry payoffs:
      - Top $c$ entrants share \$50
      - Bottom $n - c$ entrants get $-$\$10

TABLE 1—RANK-BASED PAYOFFS

| | Payoff for successful entrants as a function of "c" | | | |
|---|---|---|---|---|
| Rank | 2 | 4 | 6 | 8 |
| 1 | 33 | 20 | 14 | 11 |
| 2 | 17 | 15 | 12 | 10 |
| 3 | | 10 | 10 | 8 |
| 4 | | 5 | 7 | 7 |
| 5 | | | 5 | 6 |
| 6 | | | 2 | 4 |
| 7 | | | | 3 |
| 8 | | | | 2 |

- – $n = 12, 14, 16$ subjects
  – Within-subject variation in games played if entry: chance or skill (trivia, puzzles)
  – Only feedback: Total number of entrants
  – Paid at the end of game for one randomly-determined round (no feedback on performance)

TABLE 3—DESCRIPTION OF EXPERIMENTS

| Experiment # | Sample | $n$ | Selection procedure | Rank order |
|---|---|---|---|---|
| 1 | Chicago, undergraduates | 12 | random | R/S |
| 2 | Chicago, undergraduates | 14 | random | S/R |
| 3 | Wharton, undergraduates | 16 | random | R/S |
| 4 | Wharton, undergraduates | 16 | random | S/R |
| 5 | Wharton, undergraduates | 16 | self-selection | R/S |
| 6 | Wharton, undergraduates | 16 | self-selection | S/R |
| 7 | Chicago, M.B.A.'s | 14 | self-selection | R/S |
| 8 | Wharton, M.B.A.'s | 14 | self-selection | S/R |

- Optimal decision for risk-neutral players in chance game
  - Assume $e$ players enter and $n-e$ stay out
  - Probability of being in top group $p = c/e$ (with $c \geq e$)
  - average payoff of entry is

$$\pi_E = p\frac{50}{c} - (1-p)\,10 = \frac{c}{e}\frac{50}{c} - \frac{e-c}{e}10 = \frac{50 - 10\,(e-c)}{e}$$

  - average payoff of exit $\pi_E = 0$
  - Enter is Best Response if $50 - 10\,(e-c) \geq 0$ or $e \leq 5 + c$
  - Asymmetric Nash Equilibria: $e_C^* = c + 4$ or $e_C^* = c + 5$ players enter
  - Group profits should be 10 (if $e^* = c + 4$) or 0 (if $e^* = c + 5$)
- Games of skill –> If overconfidence, overestimate chance of winning $p$ –> Too much entry $e_S^*$

– Luck: Higher profits than in Nash eq. –> Too little entry (Risk av.?)

– Skill: Lower profits (but still $>$0), Profits$<$0 with selection (Exp. 5-8)

Profit for random-rank condition

| | | Rounds | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Experiment # | *n* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
| 1 | 12 | 50 | 50 | 20 | 30 | 40 | 30 | 20 | 50 | 30 | 40 | 20 | 40 | 420 |
| 2 | 14 | 0 | −10 | 10 | 20 | −10 | 10 | 20 | 10 | 0 | 0 | 30 | 20 | 100 |
| 3 | 16 | 10 | 50 | 20 | 40 | 10 | 20 | 30 | 40 | 20 | 40 | 30 | 20 | 330 |
| 4 | 16 | 0 | 10 | 10 | 20 | 10 | −10 | 0 | 10 | 20 | 10 | 0 | 20 | 100 |
| 5 | 16 | 20 | 10 | 10 | 10 | 0 | 0 | 30 | 20 | −10 | 0 | 0 | 0 | 90 |
| 6 | 16 | 30 | 20 | 10 | 0 | −10 | 30 | 20 | 10 | 10 | 30 | 10 | 20 | 180 |
| 7 | 14 | 10 | 20 | 40 | 20 | 30 | 40 | −30 | 40 | 10 | 0 | 0 | 20 | 200 |
| 8 | 14 | 20 | 10 | 0 | 30 | 30 | 0 | 10 | 10 | 20 | 10 | 20 | 40 | 200 |

Profit for skill-rank condition

| | | Rounds | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Experiment # | *n* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
| 1 | 12 | 50 | 0 | 20 | 10 | 30 | 10 | 20 | 10 | 40 | 10 | 10 | 30 | 240 |
| 2 | 14 | 0 | −10 | 10 | 20 | −10 | 10 | 20 | 10 | 0 | 0 | 30 | 20 | 100 |
| 3 | 16 | 10 | 20 | 10 | 20 | 0 | 10 | 20 | 10 | 10 | 30 | 20 | 10 | 180 |
| 4 | 16 | 0 | 0 | 20 | 20 | 10 | −30 | 10 | −10 | −10 | 10 | −20 | 0 | 0 |
| 5 | 16 | −30 | −20 | −20 | −10 | −40 | −10 | −30 | 0 | −30 | −10 | −20 | 0 | −220 |
| 6 | 16 | 10 | −40 | −20 | −30 | −10 | −30 | −10 | −20 | −20 | −10 | 0 | 0 | −180 |
| 7 | 14 | −40 | −10 | −10 | 0 | −20 | −10 | −40 | 0 | 0 | 0 | −10 | 0 | −140 |
| 8 | 14 | 10 | −10 | −10 | −10 | −20 | −20 | −20 | 0 | −20 | 10 | −20 | −20 | −130 |

- Overconfidence about own performance *relative* to others
  - Overconfidence about own ability?
  - Or underestimation of entry of others?
- Forecasts of people about entry of others:
  - forecast 0.3 entrants too high in chance game;
  - forecast 0.5 entrants too low in skill game;
  - (some underestimation of entry of others)

- Applications in the field of overconfidence/overoptimism

- **Example 1. Overconfidence about self-control by consumers ($\hat{\beta} > \beta$)**

  – Evidence on self-control supports idea of naiveté

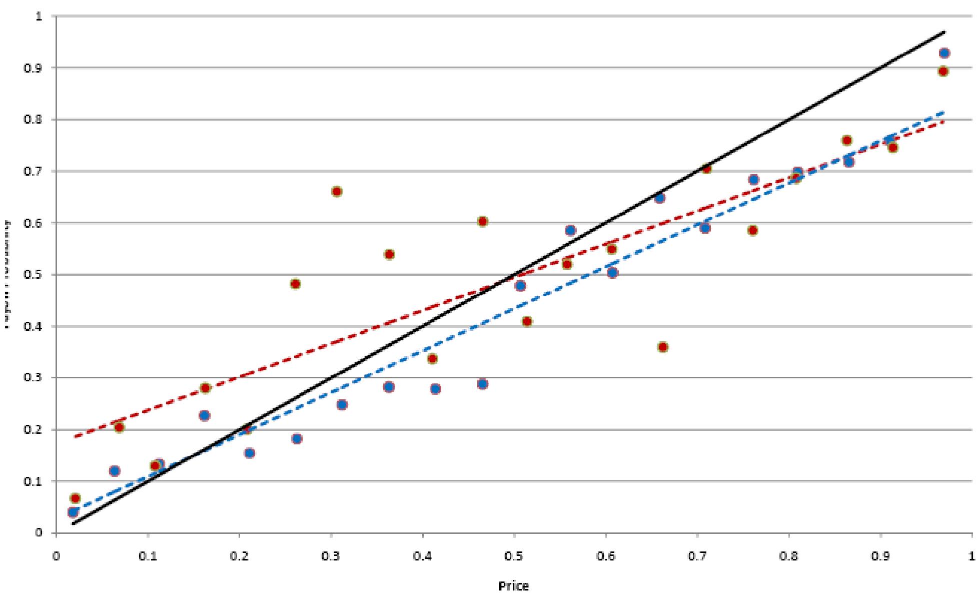
    ∗ Status-quo bias (Madrian-Shea, 1999)

    ∗ Response to teaser rates (Ausubel, 1999)

    ∗ Health-club behavior (DellaVigna-Malmendier, 2006)

- **Example 2. Overconfidence for employees: Cowgill, Wolfers, and Zitzewitz (2008)**
  - Prediction markets of Google employees (with raffle tickets for total of \$10,000 per quarter in payoffs)
  - Data: years 2005-2007, 1,463 employees placed $\geq$ 1 trade

Figure 2. Prices and Probabilities in Two and Five-outcome Markets




Trades in two (red) and five-outcome (blue) markets (22,452and 42,416, respectively) are sorted into 20 bins according to price (i.e., 0-5, 5-10, etc.), and then average price and payoff probability for the bin is plotted. Dashed lines plot regression equations using OLS.

- – Securities not related to Google correctly priced on average
  – Securities with implications for Google: Substantial overconfidence for two-outcome security, Less so for five-outcome security

**Table 5. Optimistic bias in the Google markets**

| | Obs. | Avg price | Avg payoff | Return (SE) | |
|---|---|---|---|---|---|
| All markets | 70,706 | 0.357 | 0.342 | -0.015*** | (0.003) |
| Markets with implication for Google | 37,910 | 0.310 | 0.293 | -0.017*** | (0.004) |
| Two-outcome markets with implication for Google | 9,023 | 0.509 | 0.492 | -0.017*** | (0.006) |
| Best outcome for Google | 4,556 | 0.456 | 0.199 | -0.256*** | (0.063) |
| Worst | 4,467 | 0.563 | 0.790 | 0.227*** | (0.064) |
| Five-outcome markets with implication for Google | 26,511 | 0.239 | 0.222 | -0.017*** | (0.005) |
| Best outcome for Google | 5,592 | 0.244 | 0.270 | 0.027 | (0.040) |
| 2nd | 5,638 | 0.271 | 0.246 | -0.025 | (0.066) |
| 3rd | 5,539 | 0.296 | 0.179 | -0.118** | (0.053) |
| 4th | 5,199 | 0.206 | 0.178 | -0.028 | (0.041) |
| Worst | 4,543 | 0.162 | 0.236 | 0.074 | (0.056) |

- Survey evidence suggests phenomenon general
- **Oyer and Schaefer, 2005; Bergman and Jenter, 2007**
  - Overconfidence of employees about own-company performance is leading explanation for provision of stock options to rank-and-file employees
  - Stock options common form of compensation: (Black and Scholes) value of options granted yearly to employees in public companies over $400 (about one percent of compensation) in 1999 (Oyer and Schaefer, 2005)
  - Incentive effects unlikely to explain the issuance: contribution of individual employee to firm value very limited
  - Overconfidence about own-company performance can make stock options an attractive compensation format for employers
  - Sorting contributes: Overconfidence plausible since workers overconfident about a company sort into it

- However, **Bergman and Jenter (2007):** employees can also purchase shares on open market, do not need to rely on the company providing them
  - Under what conditions company will still offer options to overconfident employees?
  - Also, why options and not shares in company?
  - **Bergman and Jenter (2007):** option compensation is used most intensively by company when employees more likely to be overconfident based on proxy (past returns)

# 8 Next Lecture

- Overconfidence: Managers

- Overconfidence: Overprecision

- Law of Small Numbers

- Projection Bias

- Non-Standard Decision-Making

- Limited Attention I