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

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Outline

1. Investment Goods: Exercise II
2. Investment Goods: Job Search
3. Investment Goods: Work Effort
4. Investment Goods: Delay with Deadline
5. Leisure Goods: Credit Card Borrowing
6. Leisure Goods: Consumption and Savings
7. Leisure Goods: Commitment and Savings
8. Leisure Goods: Drinking
9. Methodology: Commitment Field Experiments

Section 1
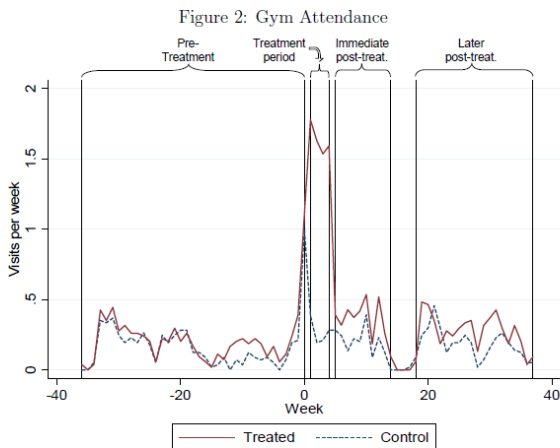
Investment Goods: Exercise II

Explanation

- Present-Biased preferences *with* naiveté explains magnitudes, not just qualitative patterns
  - Related: **Acland and Levy** (*MS* 2015) field experiment
    - Pay a treatment group $100 to attend the gym for 4 weeks
    - Control group not paid
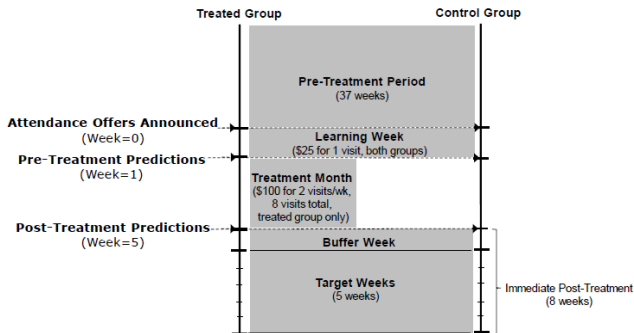
Results

- Moderate habit formation (as in **Charness and Gneezy** *EMA*)

Figure 2: Gym Attendance

Notes: Average weekly gym attendance, by treatment group status. Weeks in which a subject received a p-coupon for attendance are omitted from this figure.

Expectation of Future Attendance

- Also: Elicit expectation of future attendance as WTP for
  p-coupons
  - How much are you willing to pay for coupon below?
  - Also elicit unincentivized forecasts

For each question, check which option you prefer, A or B.

	Option A			**Option B**
1. Would you prefer	☐	$1 for certain, paid Monday, Oct 20.	or	☐	The Daily RSF-Reward Certificate shown above.
2. Would you prefer	☐	$2 for certain, paid Monday, Oct 20.	or	☐	The Daily RSF-Reward Certificate shown above.
3. Would you prefer	☐	$3 for certain, paid Monday, Oct 20.	or	☐	The Daily RSF-Reward Certificate shown above.

Clear Evidence of Naiveté

- Evidence of naiveté consistent with DVM
  - Also some evidence of projection bias (see later lectures)

Table 2: Misprediction of attendance — Predicted and actual target-week attendance.

	Control group			Treatment group		
	Coupon Value $p > 0$	Un-Incent'd $p > 0$	Un-Incent'd $p = 0$	Coupon Value $p > 0$	Un-Incent'd $p > 0$	Un-Incent'd $p = 0$
Pre-trmt prediction (Pre)	3.868	4.053	1.453	3.63	3.963	1.333
Post-trmt prediction (Post)	3.395	3.614	1.058	3.185	3.056	1.313
Actual attendance	1.561	1.561	0.264	1.463	1.463	0.396
Pre minus Actual	2.307	2.491	1.189	2.167	2.500	0.934
(St. Error)	(0.297)	(0.235)	(0.153)	(0.350)	(0.318)	(0.189)
Post minus Actual	1.833	2.053	0.774	1.722	1.593	0.917
(St. Error)	(0.321)	(0.299)	(0.142)	(0.315)	(0.299)	(0.171)
Pre minus Post	0.474	0.439	0.415	0.444	0.907	0.021
(St. Error)	(0.159)	(0.179)	(0.160)	(0.243)	(0.220)	(0.135)
No. of observations	57	57	53	54	54	48

Notes: Coupon value refers to subjects' valuations of coupon-week p-coupons divided by the face value of those coupons. Un-incent'd refers to subjects' un-incentivized predictions of target-week attendance, and is separated into coupon weeks ($p > 0$) and zero weeks ($p = 0$).

Section 2

Investment Goods: Job Search

DellaVigna and Paserman (*JOLE* 2005)

- Stylized facts:
  - time devoted to job search by unemployed workers: 9 hours/week
    - search effort predicts exit rates from unemployment better than reservation wage choice
  - Model with costly search effort and reservation wage decision:
    - search effort — immediate cost, benefits in near future — driven by β
    - reservation wage — long-term payoffs — driven by δ
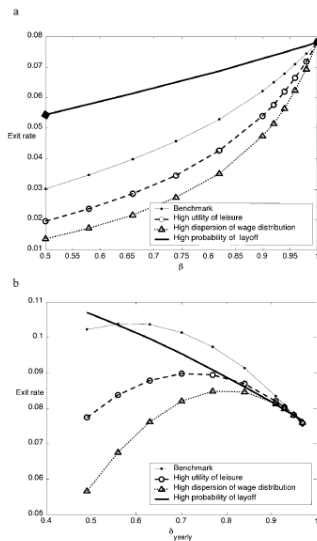
Correlations

- Correlation between measures of impatience (smoking, impatience in interview, vocational clubs) and job search outcomes:
    - Impatience $\uparrow \implies$ search effort $\downarrow$
        - Impatience $\uparrow \implies$ reservation wage $\longleftrightarrow$
        - Impatience $\uparrow \implies$ exit rate from unemployment $\downarrow$
    - Impatience captures variation in β
    - Sophisticated or naive – does not matter
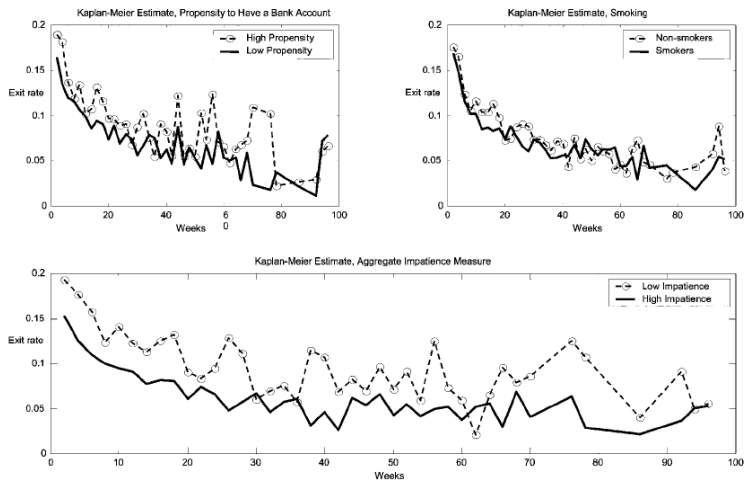
Correlations

Fig. 3.—Exit rates in the NLSY

Paserman (*EJ* 2008)

- Structural model estimated by max. likelihood
  - Estimation exploits non-stationarity of exit rate from unemployment

Table 2: Estimated Model Parameters [†]

		Low Wage Sample Lognormal	Medium Wage Sample		High Wage Sample Lognormal
		Lognormal	Lognormal	Normal	Lognormal
Discounting Parameters					
	β	**0.4021**	**0.4833**	**0.8140**	**0.8937**
		(0.1075)	**(0.1971)**	**(0.1672)**	**(0.1441)**
	δ	0.9962	1.0000*	1.0000*	0.9989
		(0.1848)	(0.0001)	(0.0019)	(0.1798)
Value of time when unemployed					
	b_0	-141.61	-164.31	-7.38	-308.78
		(61.16)	(61.43)	(16.54)	(193.53)

Section 3

Investment Goods: Work Effort

"Self-Control at Work"

Kaur, Kremer, and Mullainathan, "Self Control at Work." *JPE* 2015

- Setting: workers in India who are paid a piece rate w in a weekly paycheck
- Since effort at work is immediate and benefits delayed, effort at work is an investment good
- $\left(\beta, \hat{\beta}, \delta\right)$ model, with $\delta = 1$
- Consider effort at work e, which costs $-c(e)$, with $c' > 0$, $c'' > 0$
- Assume for special case $c(e) = \gamma e^2 / 2$

Model

- Two states:
    - high output y_H with probability $e \rightarrow$ pay w_H
    - low output y_L with probability $1 - e \rightarrow$ pay w_L
    - Notice: this is only local approximation, for $e \in [0, 1]$
- Pay at $t = 2$
- If working at $t = 1$, maximize

$$\max_{e_1} \beta \left[e_1 w_H + (1 - e_1) w_L \right] - c(e_1)$$

- f.o.c.

$$\beta \left[w_H - w_L \right] - c'(e_1^*) = 0$$

- Effort e_1^* increases in $w_H - w_L$ and in β

Model

- Special case:

$$e_1^* = \frac{\beta \left[w_H - w_L \right]}{\gamma}$$

- If working at $t = 2$ (same period as paydate), optimal effort e_2^* solves

$$\max_{e_2} \left[e_2 w_H + (1 - e_2) w_L \right] - c(e_2)$$

and thus (for the special case)

$$e_2^* = \frac{w_H - w_L}{\gamma}$$

- **Prediction 1.** Effort is higher near payday for $\beta < 1$ (independent of $\hat{\beta}$)

- From $t = 0$ perspective, (perceived) utility V_0 from working at $t = 1$ is

$$V_0 = e_1^* w_H + (1 - e_1^*) w_L - c(e_1^*)$$

Model

- Effect of altering w_L on $t = 0$ (expected) welfare V_0 is

$$
\begin{aligned}
\frac{dV_0}{dw_L} &= (1 - e_1^*) + \frac{de_1^*}{dw_L} \left[[w_H - w_L] - c'(e_1^*) \right] = \\
&= (1 - e_1^*) + \frac{de_1^*}{dw_L} \left[\left(1 - \hat{\beta} \right) [w_H - w_L] \right]
\end{aligned}
$$

  - First term is direct effect on pay: lowering w_L lowers pay and thus welfare
  - The second term is the effect on incentive, which is zero for $\beta = \hat{\beta} = 1$, by the envelope theorem – but envelope theorem does not apply for $\hat{\beta} < 1$. Indeed, second term is negative
  - Notice that it is $\hat{\beta}$ which matters, since this is the value function from the $t = 0$ perspective

Model

- Special case for $\hat{\beta} = \beta$:

$$\frac{dV_0}{dw_L} = 1 - \frac{\beta \left[w_H - w_L \right]}{\gamma} - \frac{\beta \left(1 - \beta \right) \left[w_H - w_L \right]}{\gamma}$$

  - Second term becomes large as β goes below 1 and is highest at $\beta = 1/2$
  - If large enough, individual wants commitment device, prefers w_L low

- **Prediction 2.** Individual with $\beta < 1$ may prefer commitment device (low w_L)

- **Prediction 3.** If there are both types with $\beta = 1$ and $\beta < 1$, demand for commitment should be associated with a payday cycle

Experiment

- Field experiment in India
    - Randomization of pay date (Tu, Th, Sa) to test proposition 1 unconfounded with day-of-week effects
    - Randomization of availability of commitment device: get paid $w/2$ instead of w if miss production target
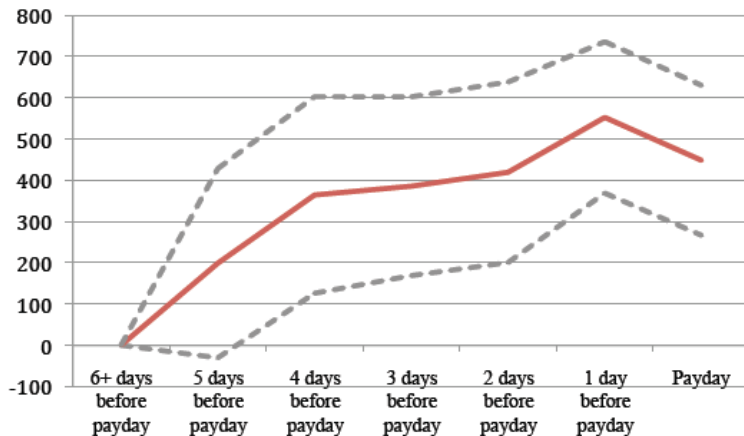   - Randomization of whether choice is made evening before, or morning of

Figure 1
Incentive Contracts
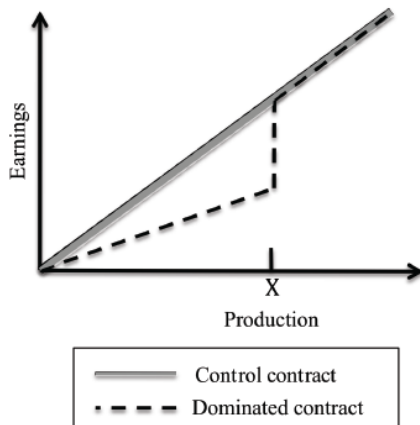
Predictions

- **Prediction 1.** Evidence of pay cycle in effort

Figure 2
Production over the Pay Cycle

Predictions

- **Prediction 2.** Quite significant take-up of commitment contract

Figure 3
Take-up of Dominated Contracts: Distribution of Worker Means

Results

Table 4
Treatment Effects of Contract Assignment on Worker Production

Observations	Dependent variable: Production				Dependent variable: Attendance			
	All obs	All obs	Control & Choice	Control & Choice	All obs	All obs	Control & Choice	Control & Choice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Assignment to choice	111		120		0.007		0.007	
	(59)*		(59)**		(0.009)		(0.009)	
Assignment to evening choice		150		156		0.01		0.014
		(69)**		(69)**		(0.01)		(0.010)
Assignment to morning choice		73		84		-0.00		0.001
		(69)		(69)		(0.01)		(0.010)
Assignment to low target	3	3			-0.002	-0.00		
	(90)	(90)			(0.013)	(0.01)		
Assignment to medium target	213	213			-0.006	-0.01		
	(91)**	(91)**			(0.013)	(0.01)		
Assignment to high target	335	334			-0.005	-0.01		
	(150)**	(150)**			(0.019)	(0.02)		
Worker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seat fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lag production controls	Yes	Yes	Yes	Yes	No	No	No	No
Observations	8423	8423	6310	6310	8423	8423	6310	6310
R2	0.59	0.59	0.60	0.60	0.15	0.15	0.11	0.11
Dependent variable mean	5337	5337	5311	5311	0.88	0.88	0.88	0.88
Proportion choosing a positive target (conditional on attendance)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Proportion choosing a positive target (target=0 when absent)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28

Predictions

- **Prediction 3.** Correlation between payday effect and take-up of commitment, as well as with productivity effect

Table 5
Heterogeneity in Take-up of Dominated Contracts: Correlation with Payday Impact

Dependent variable	Target level chosen	Positive target indicator
	(1)	(2)
High payday production impact	353	0.138
	(129)***	(0.044)***
Seat fixed effects	Yes	Yes
Date fixed effects	Yes	Yes
Lag production controls	Yes	Yes
Observations	4098	4098
R2	0.22	0.20
Dependent variable mean	759	0.28

Results

Table 6
Heterogeneity in Contract Treatment Effects: Correlation with Payday Impact

Dependent variable	Production (1)	Production (2)	Production (3)	Attendance (4)	Attendance (5)	Attendance (6)
Assignment to choice	118	-69	-146	0.007	-0.016	-0.028
	(60)*	(74)	(84)*	(0.009)	(0.010)	(0.011)**
Assignment to choice * High payday production impact		482	735		0.058	0.091
		(126)***	(144)***		(0.019)***	(0.022)***
Assignment to choice * Payday			401			0.064
			(179)**			(0.024)***
Assignment to choice * Payday * High payday production impact			-1314			-0.178
			(288)***			(0.041)***
Assignment to a target	153	-35	-48	-0.003	-0.019	-0.024
	(71)**	(86)	(96)	(0.010)	(0.012)*	(0.013)*
Assignment to a target * High payday production impact		483	673		0.042	0.066
		(148)***	(168)***		(0.022)*	(0.025)***
Assignment to a target * Payday			68			0.026
			(219)			(0.029)
Assignment to target * Payday * High payday production impact			-972			-0.120
			(348)***			(0.049)***
Payday			-183			-0.009
			(153)			(0.021)
High payday impact * Payday			1178			0.164
			(234)***			(0.032)***
Worker fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Seat fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Lag production controls	Yes	Yes	Yes	No	No	No
Observations	8240	8240	8240	8240	8240	8240
R2	0.60	0.59	0.59	0.11	0.11	0.11
Dependent variable mean	5355	5355	5355	0.875	0.875	0.875

Summary

- Evidence very consistent with model of self-control problems and (at least partial) sophistication
- Discount factor is not $\beta - \delta$, but smoother decay (true hyperbolic)
- Significant demand of commitment device – different than some of other settings, see later
- Correlation with underlying measure of self-control
- Great evidence in important setting

Section 4

Investment Goods: Delay with Deadline

Setting

- Consider as individual that has to do an unpleasant task, with a fixed deadline
- Examples:
    - Paying a traffic fine (Heffetz, O'Donoghue, and Schneider, 2016)
    - Filing taxes (Martinez, Meier, and Sprenger, 2017; Benzarti, 2016)
    - Finding a job by the deadline (job search papers)
- What can we infer from spike at deadline?

Paying a Traffic fine with multiple deadlines
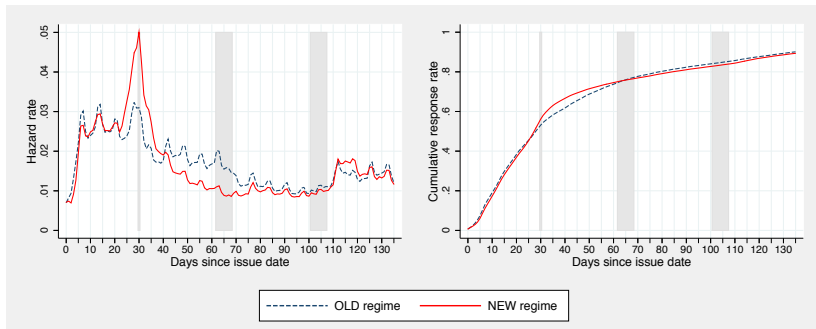
Figure 1: Hazard Rates and Cumulative Response Rates in OLD vs. NEW Regimes. Note: All tickets have a first deadline at day 30, second deadline at days 62-68, and third deadline at days 101-107, indicated by the shaded areas (the latter two deadlines are a range because they depend on ticket-issuance day of the week). First notification letter is received around day 40 (OLD) vs. day 20 (NEW). Based on 3,355,094 (OLD) and 3,020,357 (NEW) observations; see details in Section 3.

Filing Taxes by April 15
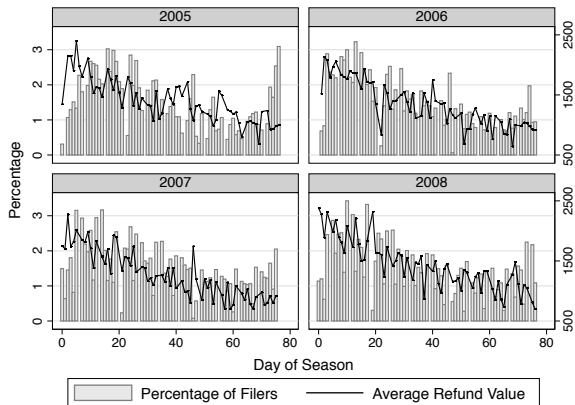
Notes: 2005-2008 percentage of filers on each day of tax season (gray bars) and average refund value for filers on each day (black line).

Figure 1: Filing Times and Refund Values

Inference

- What can we learn from extent of last-minute completion?
- If there is a lot of last-minute completion, does that indicate procrastination?
- Or could it indicate a particular distribution of the cost of doing the action?
- Heffetz, O'Donoghue, and Schneider, 2016:
  - Use multiple traffic fines
  - There are types that delay more on multiple traffic ticket infractions
- Martinez, Meier, and Sprenger (2017)
  - Structural estimation of time preference parameters using also variation in amount of tax refund and delay in refund

Section 5

Leisure Goods: Credit Card Borrowing

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)

Design

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

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

TABLE 1: SUMMARY OF MARKET EXPERIMENTS

Design

- 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

Model

- 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): $(21/12 - T_s) \left(r_1' - r_1 \right) b_1$
- Net benefit of switching:

$$NB' = -k + T_s \left(r_0' - r_0^0 \right) b_0 + (21/12 - T_s) \left(r_1' - r_1^0 \right) b_1$$

Model

- Switch if $NB + \varepsilon > 0$
- Take-up rate R is function of attractiveness NB:

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

- 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,

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

Model

- 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

Model

- 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) $\approx \$1,000$
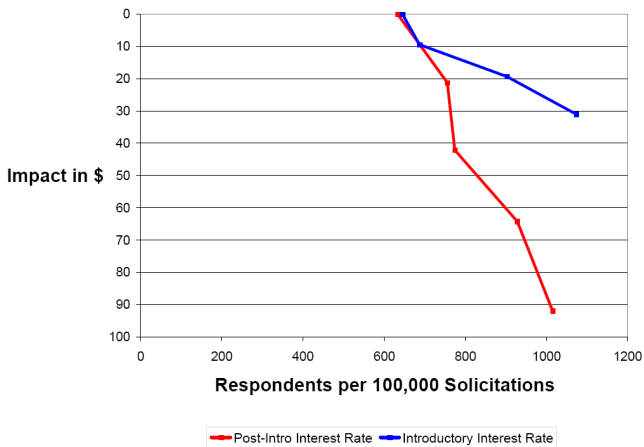- Difference in attractiveness:

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

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

Results

- Plot NB and $R(NB)$ for different offers
- Compare offers varying in r_0 (flat line) and in r_1 (steep line)

Results

- People underrespond to post-teaser interest rate.
- Most likely explanation: Present Bias + Naivete
    - Naives overestimate switching to another card (procrastination)
    - $\rightarrow$ 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

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

- Calibration: $\hat{b}_1 \approx (1/3) b_1 \rightarrow$ Underestimation of borrowing by a factor of 3

Section 6

Leisure Goods: Consumption and Savings

Introduction

- 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	$\overline{m}_{J_m}$	$\text{se}(\overline{m}_{J_m})$
% 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...
- David Laibson's slides to follow

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:

$$y_t = f^W(t) + u_t + \nu_t^W \qquad (3)$$

- During retirement:

$$y_t = f^R(t) + \nu_t^R \qquad (4)$$

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:

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

- 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: $q(\hat{\theta}) \sim \chi^2(N - \#parameters)$

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

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

  2. Estimate main parameters (β, δ) 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

TABLE 3
BENCHMARK STRUCTURAL ESTIMATION RESULTS

	(1)	(2)	(3)	(4)	(5)
	Hyperbolic	Exponential	Hyperbolic Optimal Wts	Exponential Optimal Wts	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					
$q(\hat{\theta}, \tilde{\chi})$	67.2	436	2.48	34.4	-
$\xi(\hat{\theta}, \tilde{\chi})$	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

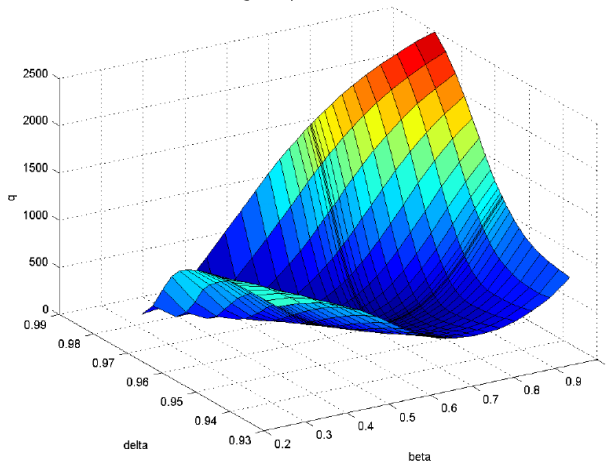|	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Benchmark	$\gamma = 3.38\%$	$\gamma = 6.59\%$	$r^{CC} = 10\%$	$r^{CC} = 13\%$	$\rho = 1$	$\rho = 3$
Hyperbolic							
Parameter Estimates $\hat{\theta}$							
$\hat{\beta}$	0.7031	0.5071	0.8024	0.7235	0.6732	0.8186	0.5776
s.e. (i)	(0.1093)	(0.0441)	(0.0614)	(0.1053)	(0.1167)	(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.

Section 7

Leisure Goods: Commitment and Savings

Ashraf, Karlan, and Yin (2005), *QJE*

- Different Methodology: Commitment Device 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)

Results

- **Result 1. Take-up of commitment device** (in SEED Treatment):
    - Out of 842 treated people, 202 take up SEED $\rightarrow$ Take up of 24%
    - 167 also got lock-up box (did not observe savings there)
- **Result 2. Effect of Availability of Commitment on Total Savings** (including funds in non-committed account)
    - Compare SEED to Marketing (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

Results

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 change in total savings balance 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.

Results

- 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
  - On average, evidence of hyperbolic-discounting-type preferences

TABLE III
Tabulations of Responses to Hypothetical Time Preference Questions

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

"Hyperbolic": More patient over future tradeoffs than current tradeoffs

"Patient Now, Impatient Later": Less patient over future tradeoffs than current tradeoffs.

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

Results: Selection

- **Result 3. Who takes up the Commitment device?**
- Correlate survey response with commitment take-up (see also Fehr-Goette paper)
- 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)

Section 8

Leisure Goods: Drinking

Schilbach (2015)

Consider population with high levels of drinking while working

- Offer incentives to not drink during work hours
- Examine impact on
  - Drinking during work hours
  - Drinking after work hours
  - Earnings
  - Savings with (and without) savings commitment
- Frank's slides follow

Heavily concentrated alcohol consumption in India
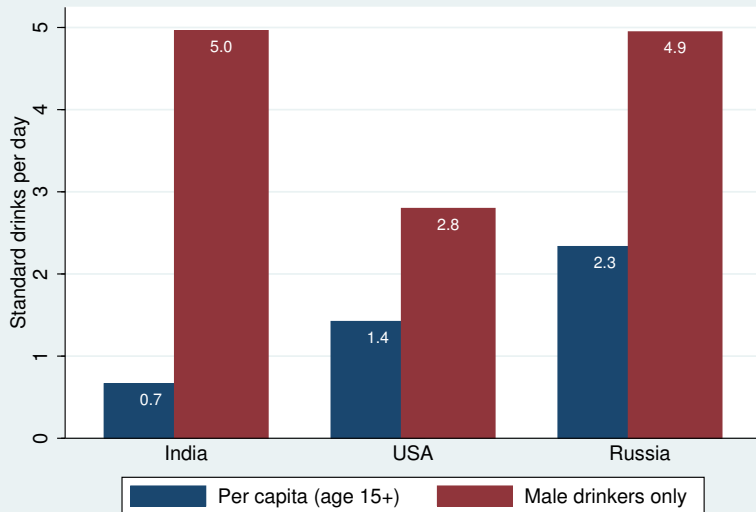
Source: WHO (2014), WHO (2001), own calculation.

Study sample

- Cycle-rickshaw peddlers in Chennai
  - 35 years old, 5 years of education
  - 80% are married, 2 children
  - Average daily labor incomes of about Rs. 300 ($5)
- Alcohol consumption
  - Individuals drink (almost) every day, usually alone.
  - A third of labor incomes spent on hard liquor (>80 proof)
  - Individuals drink over 5 standard drinks per day.
  - High levels of intoxication, often during the day
  - 80% say they would be better off if all liquor stores closed.

  ▸ SELECTION TABLE

Experimental design

- 229 individuals paid to visit study office for 20 days
- Daily visits any time between 6 pm and 10 pm
- Measure blood-alcohol content (BAC) using breathalyzer test
- Short survey
    - Labor market outcomes
    - Alcohol consumption
    - Expenditure patterns
- Opportunity to save money at study office

Financial incentives for sobriety: three treatment groups

(I) **Control Group:** unconditional payments

- Paid Rs. 90 regardless of BAC

(II) **Incentive Group:** monetary incentives to show up sober

- Paid Rs. 60 if BAC > 0
- Paid Rs. 120 if BAC $= 0$

(III) **Choice Group**

- Choice between incentives and unconditional payments

▸ BALANCE TABLES

Experimental design
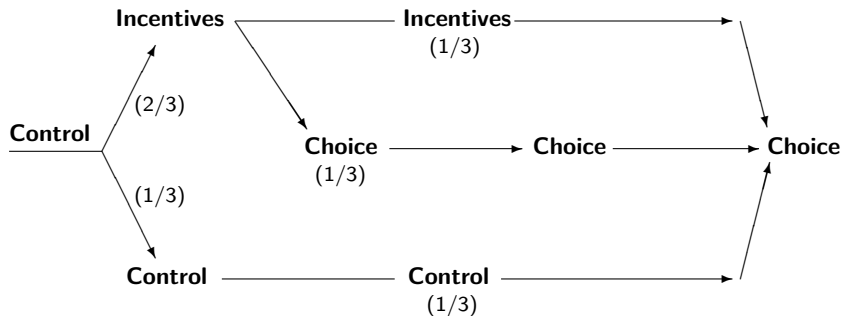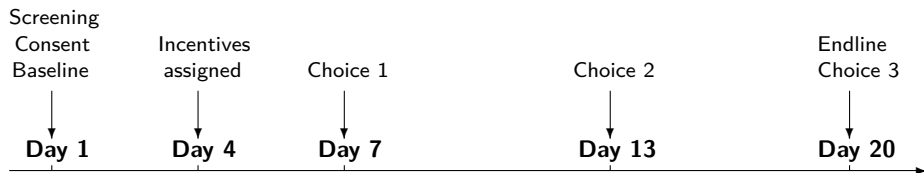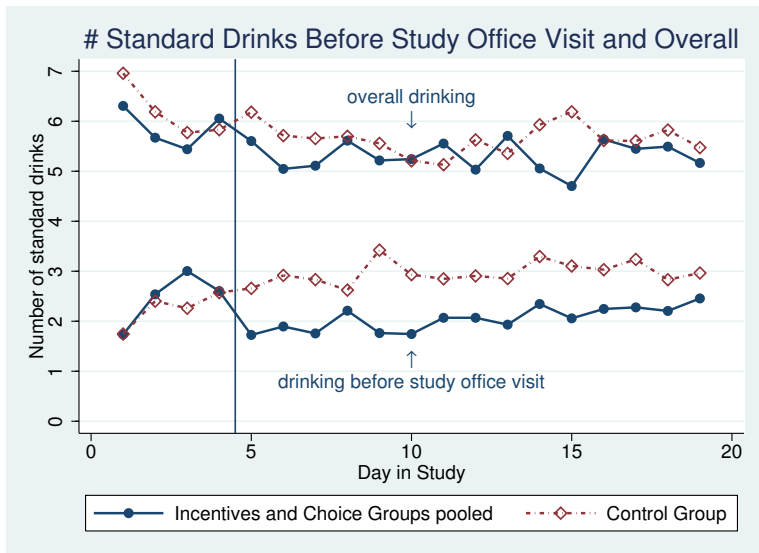
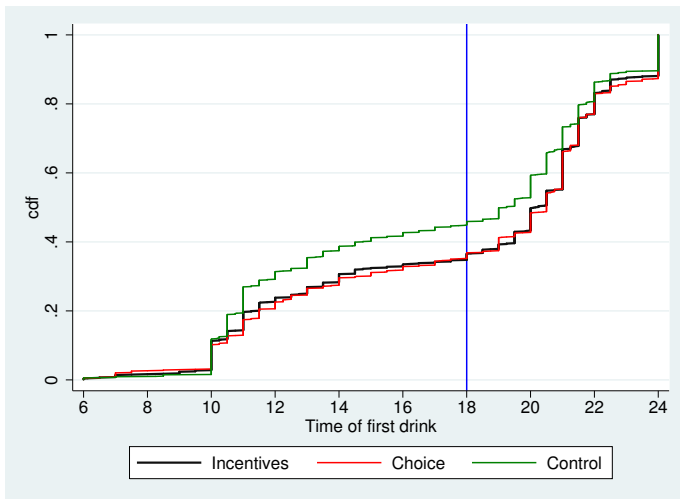# Financial incentives significantly increased daytime sobriety.

Sobriety at the Study Office

← Alcohol treatment assigned
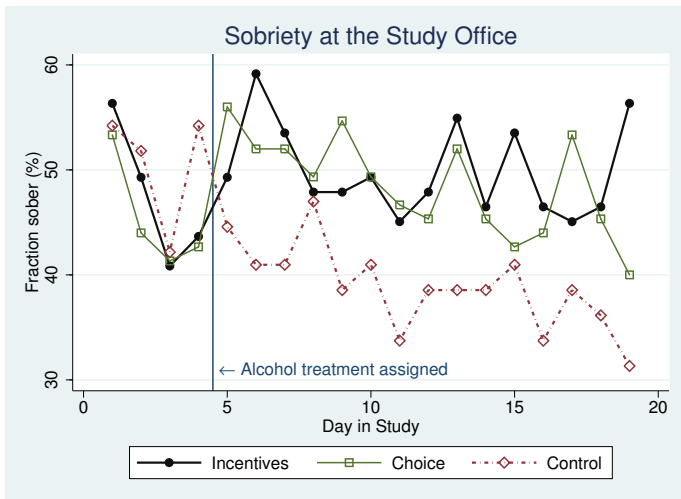
▸ ATTENDANCE IN THE INCENTIVE GROUP IS LOWER.

...but reported overall drinking did not fall by much.

Standard Drinks Before Study Office Visit and Overall

overall drinking ↓

drinking before study office visit ↑

Number of standard drinks

Day in Study

Incentives and Choice Groups pooled   ⋯◇⋯ Control Group

Intertemporal substitution: time of first drink

No significant effects on earnings

Earnings (Rs/day)

← Alcohol treatment assigned
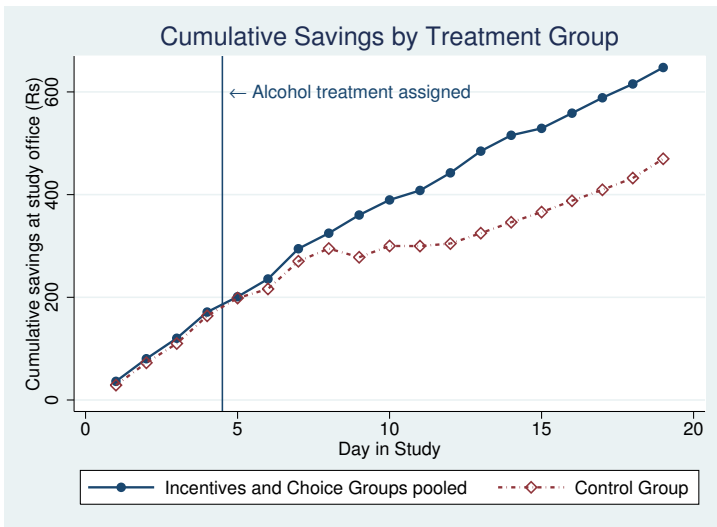
Daily earnings (Rs.)

Day in Study

Incentives and Choice Groups pooled   Control Group
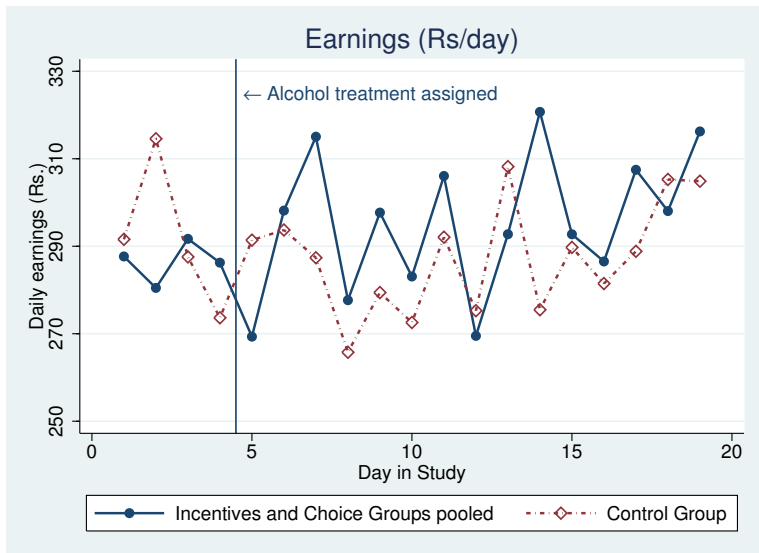
Measuring the impact of increased sobriety on savings

- All subjects got personalized savings box at study office.
  - Could save up to Rs. 200 per day.
  - Paid out entire amount plus matching contribution on day 20.

- Cross-randomized matching contribution to benchmark effects
  - 10% vs. 20% of amount saved

- Cross-randomized commitment savings feature
  - Allowed to withdraw any day between 6 pm and 10 pm
  - Not allowed to withdraw until day 20

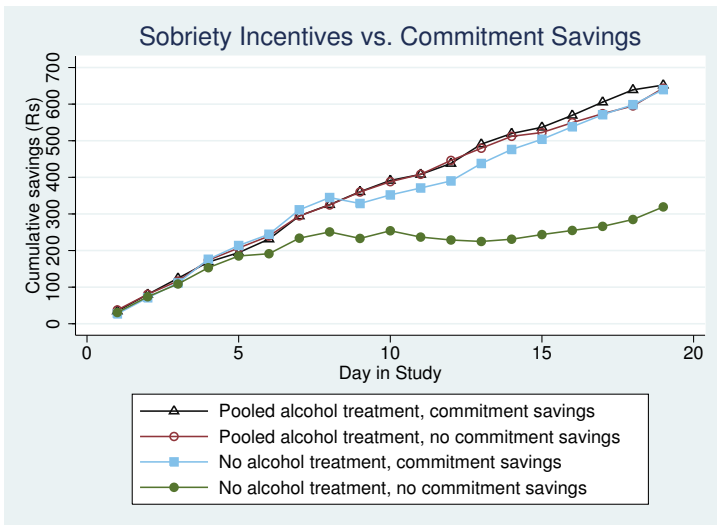# Incentives for sobriety increased savings.

Cumulative Savings by Treatment Group

← Alcohol treatment assigned

Cumulative savings at study office (Rs) / Day in Study

Incentives and Choice Groups pooled · · ◇ · · Control Group

▸ DEPOSITS ▸ WITHDRAWALS

Incentives for sobriety increased savings.

VARIABLES	(1) Rs/day	(2) Rs/day	(3) Rs/day
Pooled alcohol treatment	12.45**	13.41***	11.55**
	(6.262)	(5.018)	(4.792)
High matching contribution	9.29	10.11**	11.65**
	(6.532)	(4.873)	(4.619)
Commitment savings	7.59	2.88	2.86
	(6.539)	(5.074)	(4.820)
Daily study payment (Rs)			0.35***
			(0.050)
Observations	3,435	3,435	3,435
R-squared	0.006	0.113	0.129
Baseline survey controls	NO	YES	YES
Phase 1 controls	NO	YES	YES
Control mean	20.42	20.42	20.42

Standard errors in parentheses, clustered by individual.

Interaction between sobriety and commitment savings

Sobriety Incentives vs. Commitment Savings

— △ — Pooled alcohol treatment, commitment savings
— ○ — Pooled alcohol treatment, no commitment savings
— ■ — No alcohol treatment, commitment savings
— ● — No alcohol treatment, no commitment savings

▸ WITHDRAWALS   ▸ DEPOSITS

Sobriety incentives vs. commitment savings: deposits
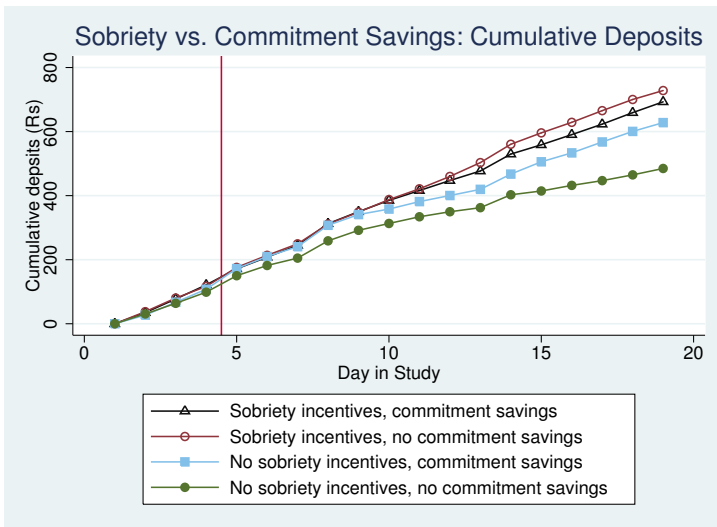
Sobriety incentives vs. commitment savings: withdrawals

Sobriety vs. Commitment Savings: Cumulative Withdrawals

Legend:
- —△— Sobriety incentives, commitment savings
- —○— Sobriety incentives, no commitment savings
- —■— No sobriety incentives, commitment savings
- —●— No sobriety incentives, no commitment savings

X-axis: Day in Study
Y-axis: Cumulative withdrawals (Rs)
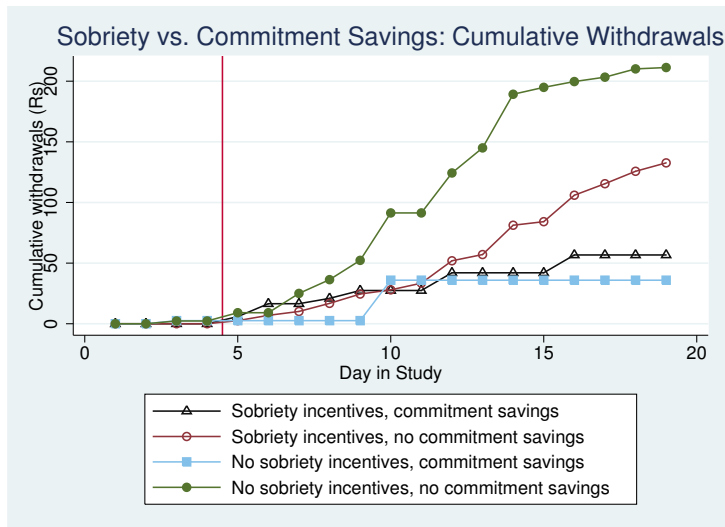
# Eliciting willingness to pay for incentives

- Choice Group chooses between:
  - Incentives for sobriety
  - Unconditional payments

- Choice sessions on days 7, 13, 20, each for subsequent week
  - Elicit preferences for set of 3 choices
  - Then randomly select one choice to be implemented (RLIS)

Demand for incentives

- **Option A:** incentives for sobriety
  - Same payment structure as Incentive Group
  - Rs. 60 if BAC > 0, Rs. 120 if BAC $= 0$

- **Option B:** payment of Rs. Y regardless of BAC

	Option A		Option B
	BAC > 0	BAC $= 0$	regardless of BAC
(1)	Rs. 60	Rs. 120	Rs. 90
(2)	Rs. 60	Rs. 120	Rs. 120
(3)	Rs. 60	Rs. 120	Rs. 150

Demand for commitment persists over time.
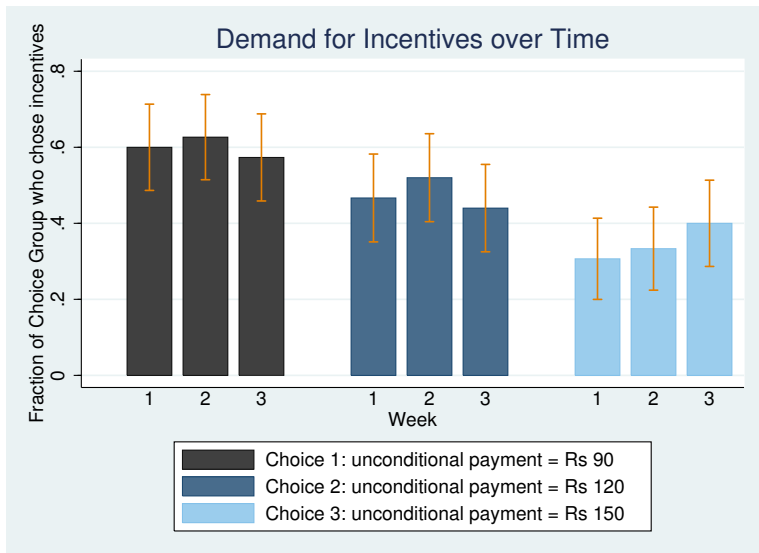
Exposure to incentives increases demand for incentives.

Demand for Incentive across Treatment Groups
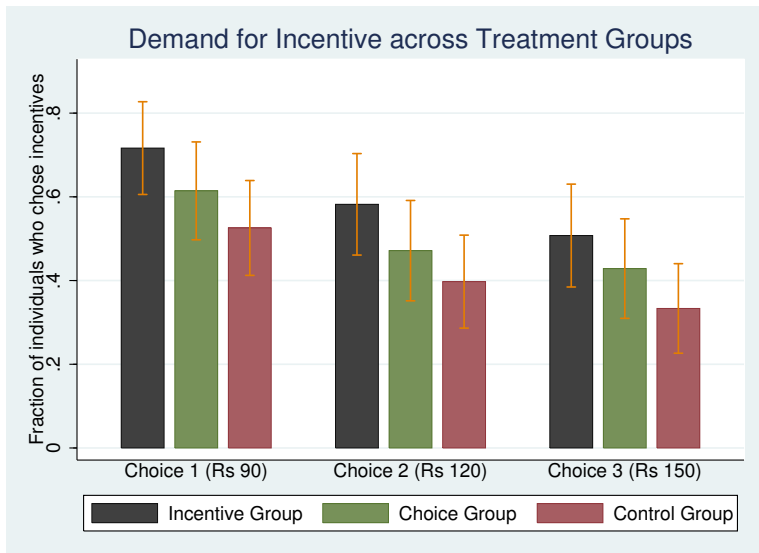
Unique Features

- Unique feature 1: Effect of commitment device on drinking on another patience-related activity: savings
    - How do we interpret the effect?
        - Effect on withdrawing – mechanical given drunkenness
        - Effect on deposits – sophistication?
    - Would be great to know if sobriety incentives increases or lowers demand for savings commitment device (not in design)
- Unique feature 2: Exceptional demand for commitment device by for drinking
    - 1/3 population even when very expensive
    - Other existing studies – Demand typically goes to near zero

Section 9

Methodology: Commitment Field Experiments

Growing literature on field experiments offering commitment devices

- Recipe for typical device:
  - Random assignment into Treatment (T) and Control (C)
  - Group T: Offered commitment option (action that imposes constraints)
  - Group C: No option
  - Observe take-up of commitment in T
  - Observe outcome (e.g., saving, smoking, eating) in C and T

Three sets of results

1. **Take-up.** What share in T uses commitment device?
   - Standard agent would not choose additional constraints $\rightarrow$ Smoking gun for time inconsistency
   - Time inconsistency can be from present bias$+$ sophistication
   - OR from hot/cold states or intra-family bargaining

Three sets of results

1. **Take-up.** What share in T uses commitment device?
   - Standard agent would not choose additional constraints $\rightarrow$ Smoking gun for time inconsistency
   - Time inconsistency can be from present bias+ sophistication
   - OR from hot/cold states or intra-family bargaining
2. **Effect on outcome.** Compare outcomes in T and C
   - Notice: Compare *everybody* in T to *everybody* in C
   - Cannot focus on those that took up the commitment in T, since do not know who they compare to in C
   - Treatment on Treated: rescale by dividing by take-up (assumption of no effect on non-takers)

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   - Treatment on Treated: rescale by dividing by take-up (assumption of no effect on non-takers)

3. **Who Takes Up?** Document who in T takes up commitment
   - Correlation with measured time preferences, previous behavior, etc.
   - This is not causal evidence, but still interesting

Representative studies: Investment Goods

- *Homework Completion* (Ariely-Wertenbroch *PS*)
  - Deadlines are penalties for delivering homework late
  - Result 1. Very large take-up rate (65 percent)
  - Result 2. Large effect on quality of homework and delay (in exp. 2)

Representative studies: Investment Goods

- *Health-club attendance* (Royer, Stehr, and Sydnor, *AEJ Applied* 2014)
    - First pay a treatment group to go to the gym
    - Then offer half of this treated group commitment device to keep going
    - Commitment device is money deposited into an account. Money forfeited if do not attend at least once every 14 days for 4 months
    - Result 1: Low demand for commitment: 13% take-up, with average sum of $63
    - Result 2: Some effect on attendance

Health-club attendance
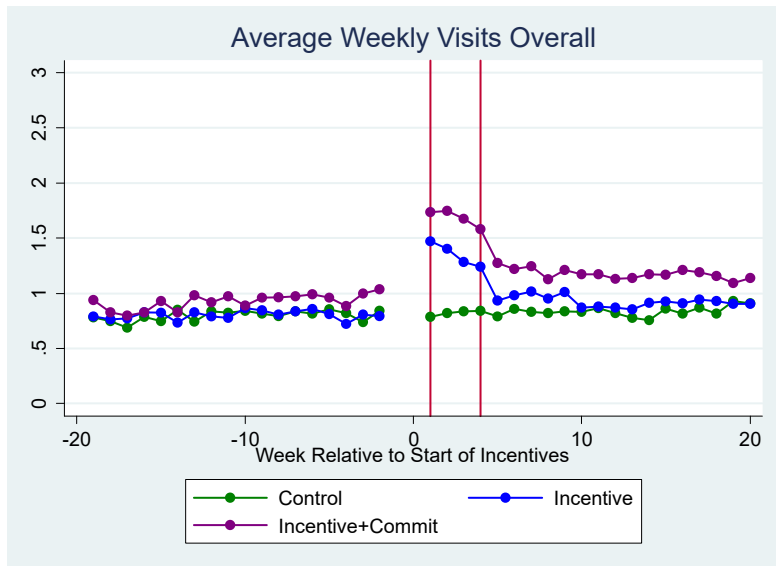
Representative studies: Leisure Goods

- *Consumption/Savings* (Ashraf-Karlan-Yin)
  - Result 1. Commitment device take-up 24%
  - Result 2. Significant effect on overall savings

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    - Result 1. Commitment device take-up 24%
    - Result 2. Significant effect on overall savings
- *Consumption/Savings* (Beshears, Choi, Laibson, Madrian, Mekong, 2011)
    - RAND panel respondents, 495 subjects, given $50, $100, or $500
    - Choice between
        - Liquid account (r=22% yearly)
        - Commitment account (set a goal) with r of 21%, 22%, or 23%
        - Penalty for early withdrawal
        - (Notice: only group with r=21% is a commitment device design)
        - Can choose share into each account

Beshears et al., 2011

- Result 1. Commitment device take-up quite high – up to 56%

	21%	22%	23%
10% penalty	0.28	0.39	0.58
20% penalty		0.45	0.61
No withdrawal		0.56	0.60

Representative studies: Leisure Goods

- *Retirement Savings* (SMRT plan, Thaler and Benartzi, 2007 – last lecture)
  - Result 1. Take-up rate 80% when offered in person
  - Result 2. Huge effects on 401(k) contribution rates

Representative studies: Leisure Goods

- *Retirement Savings* (SMRT plan, Thaler and Benartzi, 2007 – last lecture)
  - Result 1. Take-up rate 80% when offered in person
  - Result 2. Huge effects on 401(k) contribution rates

- *Online gaming* (Chow, 2010 and Acland and Chow, 2010)
  - Offer online interface that one can use to limit play of online games
  - Result 1. Take-up rate relatively high initially, but declines to 5-10%
  - Result 2. Suggestive effects on time spent playing

Representative studies: Leisure Goods

- *Smoking* (Gine, Karlan, and Zinman, 2010)
  - Offer urine test for smoking in 6 months
  - Can deposit money into account – forfeited if fail test at month 6
  - Result 1. Low take-up: 11% of 781 offered product
  - Result 1. Conditional on take-up, average deposit of 57 pesos (4 weeks worth of cigarettes)
  - Result 2: At 6 months, increase of 4-5 percentage point in chance of making urine test

Representative studies: Leisure Goods

- Smoking (Gine, Karlan, and Zinman, 2010), continued
  - Result 2: At 12 months, similar increase at surprise test

TABLE 5—IMPACT OF CARES ON PASSING URINE TEST ONE YEAR LATER
(*OLS, intent-to-treat estimates*)

Assumption:	Everyone that did not take the test continues smoking		Drop if did not take the test		Everyone that was found but refused to take the test still smokes	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. With baseline covariates						
CARES treatment	0.035**	0.035*	0.057**	0.055*	0.054**	0.054**
	(0.018)	(0.018)	(0.028)	(0.028)	(0.027)	(0.027)

Representative studies: Leisure Goods

- Why often low-take up? At least 3 possibilities:
    - Self-control not prevalent
    - Self-control prevalent, but naivete' is strong
    - Demand for commitment outweighed by costs of commitment in terms of loss of flexibility
- Important to have designs to separate explanations

Representative studies: Leisure Goods

- Alternative design of the commitment device field experiments:
  2*2 Design (Chow, 2010)
    - Offer *everyone* the commitment device
    - Then randomly assign whether commitment device is actually offered
    - Therefore groups are 2 (wanted comm./did not) * (got comm./did not)

Representative studies: Leisure Goods

- Alternative design of the commitment device field experiments: *2*2 Design* (Chow, 2010)
    - Offer *everyone* the commitment device
    - Then randomly assign whether commitment device is actually offered
    - Therefore groups are 2 (wanted comm./did not) * (got comm./did not)
- Advantage of this design
    - More power on demand for commitment since everybody (not just 1/2 of subjects) is asked
    - Can estimate effect of commitment both on the subjects that demand it, and the ones who do not (but who may end up using it)
    - See also Chassang, Padro-i-Miguel, Snowberg, (AER 2012)

Section 10

Next Lecture

Next Lecture

- Present Bias
  - Laboratory Experiments
  - Errors in Applying Present Bias
- Then Reference-Dependent Preferences
  - Housing
  - Bunching-based Evidence