Temptation Lecture 2

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The Story So Far...

- Introduced methods for spotting temptation
  - Preference for commitment
  - Time inconsistency
- Presented some experimental evidence on both
- Discussed two models that try to capture aspects of temptation
  - Gul and Pesendorfer
  - $\beta\delta$ (quasi-hyperbolic) discounting

Plan For Today

- Discuss third model of Temptation and Self Control
    - Fudenberg and Levine [2006]
- Describe some further evidence on behavior of tempted people
    - Sophistication
    - Willpower Depletion
- Discuss two applications
    - Commitment vs Flexibility
    - Sin taxes

Fudenberg and Levine [2006]

- Q-hyperbolic model still difficult to solve for many periods
- Game between two long run players
- Multiple equilibria [Laibson 1997, Harris and Laibson 2004]
- Fudenberg and Levine come up with a simpler model

Fudenberg and Levine [2006]

- Long run self plays a game against a sequence of short lived self
- Short run self gets to choose what action to take $a \in A$
- Long run self chooses 'self control' $r \in R$ which modifies utility function of short run self
- State y evolves according to some (stochastic) process depending on history of y,a and r
- $\Gamma(y)$ available options in state y

Fudenberg and Levine [2006]

- Each short run player chooses an action a to maximize

$$u(y, r, a)$$

- Long run player chooses a mapping from histories h to R to maximize

$$\sum_{i=1}^{\infty} \delta^{t-1} \int u(y(h), r(h), a(h)) d\pi(h)$$

where

  - $r(h)$ is the strategy of the long run player
  - $a(.)$ is strategy of each short run player
  - $y(.)$ is the state following history h
  - π is the probability distribution over h given strategies

Fudenberg and Levine [2006]

- Define $C(y, a)$ as the self control cost of choosing a in state y

$$C(y, a) = u(y, 0, a) - \sup_{r \text{ s.t. } u(y,r,a) \geq u(y,r,b) \ \forall \ b \in \Gamma(y)} u(y, r, a)$$

- Then we can rewrite long run's self problem as a decision problem
- choose mapping from h to A in order to maximize

$$\sum_{i=1}^{\infty} \int u(y(h), 0, a(h)) - c(y(h), a(h)) d\pi(h)$$

Fudenberg and Levine [2006]

- Further assume that self control costs are
  - Linear
  - Depend only on the chosen object and most tempting object in choice set

$$c(y, a) = \lambda\left(\max_{b \in \Gamma(y)} u(b, 0, y) - u(a, 0, y)\right)$$

- This is a Gul-Pesendorfer type model
  - Reducing choice set reduces self control costs

A Consumption/Saving Example

- State y represents wealth
- a is fraction of wealth saved
- Return on wealth is R
- Instantaneous utility is log

$$u(y, 0, a) = \log((1-a)\,y)$$

- Temptation utility in each period is $\log(y)$
- Objective function becomes

$$\begin{aligned} & \sum_{i=1}^{\infty} \delta^{t-1} \left[\log((1-a)\,y_i) - \lambda(\log(y_i) - \log((1-a_i)\,y_i) \right] \\ = & \sum_{i=1}^{\infty} \delta^{t-1} \left[(1+\lambda) \log((1-a_i)\,y_i) - \lambda(\log(y_i) \right] \\ & \text{subject to} \\ a_i & \in [0,1] \\ y_{i+1} & = R a_i y_i \end{aligned}$$

- Solution. It turns out that optimal policy is constant savings rate, so $y_i = (Ra)^{i-1} y_1$

$$\sum_{i=1}^{\infty} \delta^{t-1} \left[\begin{array}{c} (1+\lambda)\log((1-a)+(i-1)\log Ra + \log y_1) \\ -\lambda((i-1)\log Ra + \log y_1) \end{array} \right]$$

$$= \quad (1+\lambda)\frac{\log(1-a)}{(1-\delta)} + \frac{\log y_1}{(1-\delta)} + \frac{\delta \log(Ra)}{(1-\delta)^2}$$

- FOC wrt a

$$\frac{(1+\lambda)}{(1-\delta)(1-a)} = \frac{\delta}{(1-\delta)^2 a}$$

A Consumption/Saving Example

$$a = \frac{\delta}{1 + (1 - \delta)\lambda}$$

- As self control costs increase, savings go down
- As δ increases, effect of self control increases

Risk Aversion in the Large and Small

- Rabin [2000] argued that lab risk aversion cannot be due to curvature of utility function
  - Would lead to absurd levels of risk aversion in the large
- Can be explained by probability weighting
- F and L offer another explanation
  - Pocket Cash vs Bank Cash

Risk Aversion in the Large and Small

- Each period split in two
- Bank
  - No consumption, but savings
  - No temptation (nothing to consume)
  - Choose amount x to take out of bank
- Casino
  - Choose how much of x to consume
  - Return remainder to the Bank

Risk Aversion in the Large and Small

- If everything is deterministic then can implement first best outcome
    - Set $a^* = \delta$
- Now assume that with some small probability will be asked to choose between gambles at casino
- Assume probability is 'small' so still set $a^* = \delta$ in the bank
- Consider receiving prize z
- Wealth in period 2 given by

$$y_2 = R(y_1 + z_1 - c_1)$$

Risk Aversion in the Large and Small

- Utility of y_2 in period 2 is given by

$$\begin{aligned}
& \sum_{i=1}^{\infty} \delta^{t-1} \left[(1+\lambda) \log((1-a^*) + (i-1) \log Ra^* + \log y_2) \right] \\
= \quad & \frac{\log(1-a^*)}{(1-\delta)} + \frac{\log y_2}{(1-\delta)} + \frac{\delta \log(Ra^*)}{(1-\delta)^2} \\
= \quad & \frac{1}{(1-\delta)} \left[\log(1-\delta) + \log y_2 + \frac{\delta}{1+\delta} \log(R\delta) \right]
\end{aligned}$$

- Total utility from consuming c_1

$$\begin{aligned}
& (1+\lambda) \log c_1 - \lambda \log(x_1 + z_1) \\
& + \frac{1}{(1-\delta)} \left[\log(1-\delta) + \log R(y_1 + z_1 - c_1) + \frac{\delta}{1+\delta} \log(R\delta) \right]
\end{aligned}$$

Risk Aversion in the Large and Small

- Gives First Order Conditions

$$
\begin{aligned}
c^* &= \frac{(1-\delta)(1+\lambda)(y_1+z_1)}{\delta+(1+\lambda)(1-\delta)} \\
&= \left(1-\frac{\delta}{\delta+(1+\lambda)(1-\delta)}\right)(y_1+z_1)
\end{aligned}
$$

- Consumption is constrained by $x_1 + z_1 = (1-\delta)y_1 + z_1$. Define z^* as

$$
\left(1-\frac{\delta}{\delta+(1+\lambda)(1-\delta)}\right)(y_1+z^*) = (1-\delta)y_1 + z^*
$$

- For $z_1 > z^*$, consume c^*, otherwise consume $(1-\delta)y_1 + z_1$

Risk Aversion in the Large and Small

- Utility of prize less than z^*

$$\log(x_1 + z_1) + \frac{1}{(1-\delta)}\left[\log(1-\delta) + \log(y_1 - x_1) + \frac{\delta}{1+\delta}\log(R\delta)\right]$$

- Utility of prize greater than z^*

$$(1+\lambda)\log\frac{(1-\delta)(1+\lambda)}{1+\lambda(1-\delta)}(y_1+z_1) - \lambda\log(x_1+z_1) + \frac{1}{(1-\delta)}\left[\log(1-\delta) + \log R\frac{\delta(y_1+z_1)}{1+\lambda(1-\delta)} + \frac{\delta}{1+\delta}\log(R\delta)\right]$$

- For 'small' wins, constant relative risk aversion relative to pocket cash
- For ‘large’ wins (approximately) constant relative risk aversion relative to wealth

Evidence for Sophistication

DellaVigna and Malmandier [2006]

- Test whether people have sophisticated beliefs about their future behavior
- Examine the contract choices of 7978 healthcare members
- Also examine their behavior (i.e. how often they go to the gym)
- Do people overestimate how much they will go the gym, and so choose the wrong contract?

Evidence for Sophistication

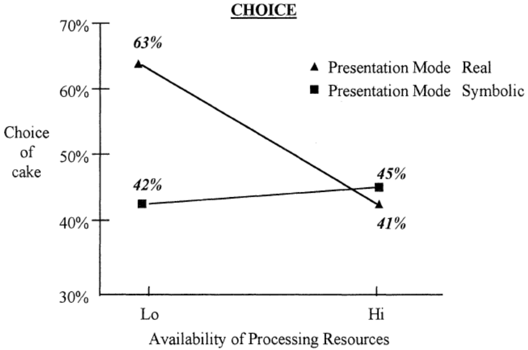
DellaVigna and Malmandier [2006]

- Three contracts
  - Monthly Contract – automatically renews from month to month
  - Annual Contract – does not automatically renew
  - Pay per usage
- Puzzles
  - 80% of customers who buy monthly contracts would be better off had they paid per visit (assuming same number of visits)
  - Customers predict 9.5 visits per month relative to 4.5 actual visits
  - Customers who choose monthly contracts are 18% more likely to stay beyond a year than those who choose annual contract

Willpower Depletion

Shiv and Fedorkhin [1999]

- Subject enters room 1
- Asked to remember a number to be repeated in room 2
- Walks to room 2 via a tray of snacks
- Containing 2 types of snack
  - Chocolate Cake
  - Fruit
- Four treatments:
- Available processing capacity
  - High (2 digit number)
  - Low (7 digit number)
- Presentation mode
  - Real
  - Symbolic


CHOICE
70%
60%
50%
40%
30%
Choice of cake
63%
42%
45%
41%
Presentation Mode Real
Presentation Mode Symbolic
Lo
Hi
Availability of Processing Resources

Willpower Depletion

Galliot et al [2007]

- Procedure
  - Measure glucose level
  - Watch video of woman talking (no sound)
  - One syllable words appear in bottom left corner of screen
  - Two treatments
  - Watch normally
  - Ignore words
  - Glucose measured again
- Result: ‘Self Control’ reduced glucose
  - Glucose levels dropped significantly for ‘Watch normally’
  - Not from ‘watch normally’ group
  - Fall in glucose level associated with worse performance in Stroop task

Willpower Depletion

DeWall et al [2012]

- Procedure
  - Subjects either consume a glucose drink or placebo
  - Watch video of woman talking (as before)
  - Four treatments
  - Glucose vs placebo
  - Watch normally vs Ignore words
- Subjects listened to an interview :
  - Young woman described how her parents were recently killed
  - Only one to care for her younger siblings.
  - Would have to drop out of college without help
- Participants were then told that the study had ended
- Before they left, asked if they would help young woman
  - Participants the opportunity to help woman by volunteering time to complete various tasks (e.g., stuffing envelopes)
- Asked to Indicate the number of hours they were willing to help, ranging from 0 to 9

- Results:
- Placebo condition
    - Those in depletion condition significantly less likely to help
- Glucose condition
    - No effect
- Looking within depletion condition, those who took glucose significantly more likely to help

Fudenberg and Levine and Cognitive Load

- Assume that cost of self control in indexed by d - cognitive load
- Assume $u^c > u^f$, but long run utility of fruit is higher than that of cake
- Assume
$$C(d, f) = g(d + u^h - u^f) + g(d)$$
- Where $g' > 0$ and $g'' > 0$

Amador Angelitos and Wernig [2005]

- So far, there has been no downside to commitment
- Tempted agents do better, non-tempted agents do the same
- This is unrealistic: what if the future is unknown?
    - e.g. preference shocks
- Then there is a trade off between commitment and flexibility

Amador Angelitos and Wernig [2005]

- One natural form of commitment is 'minimum savings rule'
  - Must save a minimum amount s
  - Free to choose any level of consumption that is consistent with this
- AAW provide conditions under which minimum savings rule is optimal
- More generally, optimal commitment always exhibits 'bunching at the top'

- Two periods with c consumed in the first period and k consumed in the second
- Total resource constraint is y, $B(y)$ is the budget set
- Utility of time 1 self is given by

$$\theta U(c) + \beta W(k)$$

- Utility of time 0 self is given by

$$E\left[\theta U(c) + W(k)\right]$$

- θ is an (uncontractible) taste shock, unknown at time 0, distributed according to F
- (Similar results hold for G and P Set up)

- Time 0 self gets to choose $C \subset B(y)$
- Does so to maximize

$$\int [\theta U(c(\theta) - W(k(\theta)] \, dF(\theta)$$

- subject to

$$c(\theta), k(\theta) \in \arg \max_{\{c.k\} \in C} \theta U(c(\theta)) - \beta W(k(\theta))$$

- Assume distribution of types is represented by continuous θ on $\Theta = [\underline{\theta}, \bar{\theta}]$
- For convenience, assume we are choosing $u(\theta) = U(c(\theta))$ and $w(\theta) = W(k(\theta))$ directly
- Value of plan for type θ is

$$V(\theta) = \max_{\theta' \in \Theta} \left[\frac{\theta}{\beta} u(\theta') + w(\theta') \right]$$

- Assuming truth telling, and by envelope theorem

$$V'(\theta) = \frac{u(\theta)}{\beta}$$

- Integrating $V'(\theta)$ tells us that

$$
\begin{aligned}
V(\theta) &= \frac{\theta}{\beta}u(\theta) + w(\theta) \\
&= \int_{\underline{\theta}}^{\theta} \frac{1}{\beta}u(\theta')d\theta' + \frac{\underline{\theta}}{\beta}u(\underline{\theta}) + w(\underline{\theta})
\end{aligned}
$$

- As is standard in principle agent problems, this condition plus monotonicity are necessary and sufficient for incentive compatibility

The Principle's Problem

- Choose $\{u, w\}$ to maximize

$$\int \left(\theta u(\theta) + w(\theta)\right) f(\theta) d\left(\theta\right)$$

subject to

$$\begin{aligned} & \frac{\theta}{\beta} u(\theta) + w(\theta) \\ = \;& \int_{\underline{\theta}}^{\theta} \frac{1}{\beta} u(\theta') d\theta' + \frac{\underline{\theta}}{\beta} u(\underline{\theta}) + w(\underline{\theta}) \end{aligned}$$

$$C\left(u(\theta)\right) + K\left(w(\theta)\right) \leq y$$

$$u(\theta') \geq u(\theta) \text{ for } \theta' \geq \theta$$

The Principle's Problem

- Can use the IC constraint to get rid of w
- Objective function becomes

$$\frac{\underline{\theta}}{\beta}u(\underline{\theta}) + \underline{w} + \frac{1}{\beta}\int_{\underline{\theta}}^{\bar{\theta}}(1 - G(\theta))u(\theta)d\theta \qquad (1)$$

subject to

$$W(y - Cu(\theta)) + \frac{\theta}{\beta}u(\theta) - \int_{\underline{\theta}}^{\theta}\frac{1}{\beta}u(\theta')d\theta' - \frac{\underline{\theta}}{\beta}u(\underline{\theta}) - w(\underline{\theta}) \geq 0$$

and monotonicity, where

$$G(\theta) = F(\theta) + \theta(1 - \beta)f(\theta)$$

Bunching at the Top

- It is always optimal to have some bunching at the top

Theorem

An optimal allocation (w, u^*) *satisfies* $u^*(\theta) = u^*(\theta_p)$ *for* $\theta \geq \theta_p$, *where* θ_p *is the lowest value in* Θ *such that*

$$\int_{\theta}^{\bar{\theta}} (1 - G(\theta'))d(\theta') \leq 0$$

for $\theta \geq \theta_p$

- It is always optimal to have some bunching at the top

Theorem

Proof.

The contribution of $\theta \geq \theta_p$ *to the objective function is*

$$\frac{1}{\beta}\int_{\theta_p}^{\bar{\theta}}(1 - G(\theta)u(\theta)d\theta$$

rewriting $u(\theta) = u(\theta_p) + \int_{\theta_p}^{\theta} u'(\theta)d(\theta)$ *gives*

$$\frac{1}{\beta}u(\theta_p)\int_{\theta_p}^{\bar{\theta}}(1 - G(\theta)u(\theta)d\theta + \int_{\theta_p}^{\bar{\theta}}\int_{\theta_p}^{\theta'}(1 - G(\theta''))u'(\theta'')d\theta''d\theta'$$

□

Minimal Savings Rule

- It is always optimal for all types above a certain threshold consume the same amount
- This does not imply that a minimum savings rule is necessarily optimal
- For that we need one further condition

$$G(\theta) = F(\theta) + \theta(1 - \beta)f(\theta)$$

  is increasing for all $\theta \leq \theta_p$
- If (and only if) this condition is satisfied, a simple minimal savings rule is optimal

Optimal Sin Taxes

- Intuitively, if temptation and self control lead to overconsumption, ‘sin taxes’ could improve welfare
  - Measuring welfare in a multiple selves model not easy
- If there is heterogeneity in temptation this may come at the cost of hurting rational agents
- O’Donoguhe and Rabin [2006] explore this trade off

Set Up

- Two goods
  - Sin good (potato chips) - x_t
  - Composite normal good - z_t
- Quasi-Linear per period preferences

$$u_t = v(x_t; \rho) - c(x_{t-1}; \gamma) + z_t$$

- Sin good has initial benefit (v) and long run cost (c)
- ρ and γ preference parameters
- v well behaved

- Intertemporal Preferences are quasi-hyperbolic

$$U(u_1, ...u_T) = u_1 + \sum \beta\delta^t u_t$$

- Simplifying assumptions
  - No borrowing
  - Prices equal to 1
  - $\delta = 1$
  - Income is I
- Assume that 'true' welfare should be measured net of β. FOC imply

$$\begin{aligned} v'(x^{**};\rho) - c(x^{**};\gamma) - 1 &= 0 \\ z^{**} &= I - x^{**} \end{aligned}$$

- Assume government levies a tax t on the sin good that they return as a lump sum transfer l
- FOC for the agent becomes

$$\begin{aligned} v'(x(t)^*;\rho) - \beta c(x(t)^*;\gamma) - (1+t) &= 0 \\ z(t)^{**} &= I + l - (1+t)x(t)^* \end{aligned}$$

- If consumers are homogeneous (or tax rates can be individually tailored), first best can be achieved by setting

$$t^{**} = (1-\beta)c(x^{**};\gamma)$$

- Assume that agents are distributed according to

$$F(\rho, \gamma, \beta) = G(\rho, \gamma) H(\beta)$$

- Assume a social welfare function that puts equal weight on all agents

$$\begin{aligned}\Omega(t) &= E_F[u(x^*(t), z^*(t, l(t))] \\ &= E_F[v'(x(t)^*; \rho) - c(x(t)^*; \gamma) + I + l(t) - (1+t)x(t)^*]\end{aligned}$$

- Optimal Sin tax is zero if $\beta = 1$ for all individuals
- Optimal sin tax positive if $\beta \leq 1$ for all and $\beta < 1$ for some

Pareto Efficient Taxation

- Consider Pareto efficient policies in the class of uniform tax rate and lump sum transfers
  - A tax t is pareto superior to t' if $u^*(t|\rho, \gamma, \beta) \geq u^*(t'|\rho, \gamma, \beta)$ for all feasible ρ, γ, β (strict for some)
  - A tax is quasi pareto superior to t' if $E_G(u^*(t|\rho, \gamma, \beta)) \geq E_G(u^*(t'|\rho, \gamma, \beta))$ all feasible β (strict for some)
- General problem: a tax rate that helps people with low β but hurts people with $\beta = 1$
- Is this generally true?

Pareto Efficient Taxation

- For any given tax rate, the long run utility of an agent

$$u^*(t) = v'(x(t)^*;\rho) - c(x(t)^*;\gamma) - x(t)^* + I + I(t) - tx(t)^*$$

- Two effects of a tax
  1. Distorts $x(t)^*$
  2. Redistributes income towards agents for whom

$$tx(t)^* \leq I(t) = tX^*(t)$$

Pareto Efficient Taxation

- Intuition: people with high β (low self control problems) don't consume many potato chips
- Tax redistributed money towards them
- People with low β (high self control problems) benefit from distortion of $x(t)^*$
- Potentially both groups could be winners

Theorem

Assume that $\beta \leq 1$ (strict for some), and that

$$v_{xxx} - \beta c_{xxx} \geq \frac{2c_{xx}}{c_x}(v_{xx} - \beta_{xx})$$

then

1. *If G is degenerate, there exists a $t > 0$ that is pareto superior to 0*
2. *If G is not degenerate, there exists a $t > 0$ that is quasi pareto superior to t*

- Condition guarantees that consumption responses of tempted individuals are ‘strong enough’
- Satisfied for linear and quadratic costs (assuming $v_{xxx} > 0$)