Behavioral Economics

Lecture 2: Making Choices over Time
Part (e): Applications of Present Bias

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Application 1: Present Bias & Saving

[Based on work by David Laibson and his collaborators.]

Workhorse Example

A Lengthy 3-Period Saving-Consumption Problem

- You consume in 3 different periods: you choose a bundle (c_1, c_2, c_3).
- Let (Y_1, Y_2, Y_3) denote your income flows.
- Let r be the market interest rate, no liquidity constraints.

$\Longrightarrow$ Your budget constraint is

$$c_1 + \frac{c_2}{1+r} + \frac{c_3}{(1+r)^2} \leq Y_1 + \frac{Y_2}{1+r} + \frac{Y_3}{(1+r)^2} \equiv W$$

To keep things simple, let's use specific numerical values. In particular, let's use $r = 10\%$ and $W = \$1000$, and so the budget constraint is

$$c_1 + \frac{c_2}{1.1} + \frac{c_3}{(1.1)^2} \leq \$1000$$

Preferences

You have β, δ intertemporal preferences:

$$U^t(c_t, c_{t+1}, ..., c_T) = 2(c_t)^{1/2} + \beta \sum_{x=1}^{T-t} \delta^x \, 2(c_{t+x})^{1/2}.$$

Note: Instantaneous utility is $u(c) = 2(c)^{1/2}$.

Again, to keep things simple, let's use specific numerical values. In particular, let's use $\beta = .8$ and $\delta = .9$.

Long-Run Desired Behavior

Long-run desired behavior $(c_1^{**}, c_2^{**}, c_3^{**})$ maximizes

$$
\begin{aligned}
U^0(c_1, c_2, c_3) &= 2(c_1)^{1/2} + \delta\, 2(c_2)^{1/2} + \delta^2\, 2(c_3)^{1/2} \\
&= 2(c_1)^{1/2} + (.9)\, 2(c_2)^{1/2} + (.9)^2\, 2(c_3)^{1/2}
\end{aligned}
$$

subject to

$$c_1 + \frac{c_2}{1.1} + \frac{c_3}{(1.1)^2} \leq \$1000.$$

Solution:

$$c_1^{**} = \$372.46 \qquad c_2^{**} = \$365.05 \qquad c_3^{**} = \$357.78$$

A Note on Long-Run Desires

Solution from previous page:

$$c_1^{**} = \$372.46 \qquad c_2^{**} = \$365.05 \qquad c_3^{**} = \$357.78$$

Interpretation: This represents the person's ideal behavior if she was asked from a *removed perspective* — that is, what she would follow if she were able to commit prior to period 1.

Of course: Whether this is what the person will do depends on whether $\beta = 1$ or $\beta < 1$.

Period-1 Desired Behavior

Period-1 desired behavior (c_1^*, c_2^*, c_3^*) maximizes

$$\begin{aligned} U^1(c_1, c_2, c_3) &= 2(c_1)^{1/2} + \beta\delta\, 2(c_2)^{1/2} + \beta\delta^2\, 2(c_3)^{1/2} \\ &= 2(c_1)^{1/2} + (.8)(.9)\, 2(c_2)^{1/2} + (.8)(.9)^2\, 2(c_3)^{1/2} \end{aligned}$$

subject to

$$c_1 + \frac{c_2}{1.1} + \frac{c_3}{(1.1)^2} \leq \$1000.$$

Solution:

$$c_1^* = \$481.16 \qquad c_2^* = \$301.81 \qquad c_3^* = \$295.81$$

Period 0 vs Period 1 Desires

Solution from the previous page:

$$c_1^* = \$481.16 \qquad c_2^* = \$301.81 \qquad c_3^* = \$295.81$$

Interpretation: This represents the person's ideal behavior when asked from a period-1 perspective — what she would follow if she were to commit in period 1.

Now the subtlety kicks in: The degree to which a person follows this *plan* depends on whether she is naive or sophisticated.

Propensity to Over-Consume

Recall: Long-run desired behavior is

$$c_1^{**} = \$372.46 \qquad c_2^{**} = \$365.05 \qquad c_3^{**} = \$357.78$$

Recall: Period-1 desired behavior is

$$c_1^{*} = \$481.16 \qquad c_2^{*} = \$301.81 \qquad c_3^{*} = \$295.81$$

$c_1^* > c_1^{**}$ reflects that the present bias creates a propensity to over-consume (or under-save).

Actual Behavior for Naifs

In period 1, you start following your period-1 desired behavior, and so

$$c_1^N = c_1^* = \$481.16.$$

You **plan** to consume $c_2 = c_2^* = \$301.81$ and $c_3 = c_3^* = \$295.81$.

But *in reality* when period 2 comes, you reassess:

- Given you've consumed \$481.16, period-2 wealth is

$$\begin{aligned} W_2^N &\equiv (W - c_1^N)(1+r) \\ &= (\$1000 - \$481.16)(1.10) \\ &= \$570.72. \end{aligned}$$

- Hence, in period 2, you reoptimize given this wealth...

Actual Behavior for Naifs

Conditional on having period-2 wealth $W_2^N = \$570.72$, you choose (c_2, c_3) to maximize

$$\begin{aligned} U^2(c_2, c_3) &= 2(c_2)^{1/2} + \beta\delta\, 2(c_3)^{1/2} \\ &= 2(c_2)^{1/2} + (.8)(.9)\, 2(c_3)^{1/2} \end{aligned}$$

subject to

$$c_2 + \frac{c_3}{1.1} \leq \$570.72.$$

Solution:

$$c_2^N = \$363.46 \qquad c_3^N = \$227.99$$

Hence, actual behavior for naifs is:

$$c_1^N = \$481.16 \qquad c_2^N = \$363.46 \qquad c_3^N = \$227.99$$

Actual Behavior for Sophisticates

Suppose you are sophisticated.

Use backward induction:

Consider how you would behave in period 2 as a function of your chosen period-1 consumption:

- If you consumed c_1 in period 1, your period-2 wealth would be

$$\begin{aligned} W_2 &= (W - c_1)(1+r) \\ &= (\$1000 - c_1)(1.10). \end{aligned}$$

Actual Behavior for Sophisticates

Given period-2 wealth $W_2 = (\$1000 - c_1)(1.10)$, you would choose (c_2, c_3) to maximize

$$\begin{aligned} U^2(c_2, c_3) &= 2(c_2)^{1/2} + \beta\delta\, 2(c_3)^{1/2} \\ &= 2(c_2)^{1/2} + (.8)(.9)\, 2(c_3)^{1/2} \end{aligned}$$

subject to

$$c_2 + \frac{c_3}{1.1} \leq (\$1000 - c_1)(1.10).$$

Actual Behavior for Sophisticates

Solution for period-2 behavior as a function of c_1:

$$c_2(c_1) = 0.70053 * (\$1000 - c_1)$$

$$c_3(c_1) = 0.43942 * (\$1000 - c_1)$$

Knowing this, in period 1 you choose c_1 to maximize

$$\begin{aligned} & 2(c_1)^{1/2} + \beta\delta\, 2\,(c_2(c_1))^{1/2} + \beta\delta^2\, 2\,(c_3(c_1))^{1/2} \\ = \;& 2(c_1)^{1/2} + (.8)(.9)2\,[0.70053(\$1000 - c_1)]^{1/2} \\ & +(.8)(.9)^2 2\,[0.43942(\$1000 - c_1)]^{1/2} \end{aligned}$$

Actual Behavior for Sophisticates

Solution for period-1 consumption:

$$c_1^S = \$484.17.$$

After choosing c_1^S, in period 2 you actually choose:

$$c_2^S = c_2(c_1^S) = 0.70053(\$1000 - c_1^S) = \$361.35$$

$$c_3^S = c_3(c_1^S) = 0.43942(\$1000 - c_1^S) = \$226.67$$

Hence, to summarize, actual behavior for sophisticates is:

$$c_1^S = \$484.17 \qquad c_2^S = \$361.35 \qquad c_3^S = \$226.67$$

Summary of the Basic Example

Long-run desired behavior is

$$c_1^{**} = \$372.46 \qquad c_2^{**} = \$365.05 \qquad c_3^{**} = \$357.78$$

Period-1 desired behavior is

$$c_1^{*} = \$481.16 \qquad c_2^{*} = \$301.81 \qquad c_3^{*} = \$295.81$$

Actual behavior for naifs is:

$$c_1^{N} = \$481.16 \qquad c_2^{N} = \$363.46 \qquad c_3^{N} = \$227.99$$

Actual behavior for sophisticates is:

$$c_1^{S} = \$484.17 \qquad c_2^{S} = \$361.35 \qquad c_3^{S} = \$226.67$$

Conclusions from the Basic Example

$c_1^* > c_1^{**}$ reflects that the present bias creates a propensity to over-consume (or under-save).

$c_2^N > c_2^*$ and $c_2^S > c_2^*$ reflects that the time inconsistency exacerbates the problem.

$c_1^S > c_1^N$ reflects that, in this example, sophistication exacerbates over-consumption in period 1. But unlike the above results, this result is not general — sophistication can exacerbate or mitigate period-1 over-consumption depending on the specific instantaneous utility function.

Extended Example with an Illiquid Asset

Let's introduce an illiquid asset into our example:

- "Examples": a CD account, a house, a retirement account.
- If in period 1 you invest z in this asset, then in period 3 you receive $z(1+\hat{r})^2$ (but no access in period 2).

Let's initially suppose $\hat{r} = r$, and suppose further that $Y_1 = \$1000$ and $Y_2 = Y_3 = \$0$, and that you cannot borrow.

Sophisticates and the Illiquid Asset

Result: Sophisticates can now implement their period-1 desired behavior.

Recall: Period-1 desired behavior is

$$c_1^* = \$481.16,\ c_2^* = \$301.81,\ c_3^* = \$295.81$$

Without illiquid asset, actual behavior for sophisticates is

$$c_1^S = \$484.17,\ c_2^S = \$361.35,\ c_3^S = \$226.67$$

With the illiquid asset, in period 1:

- consume \$481.16.
- save \$274.37 in the bank (which yields \$301.81 in period 2).
- invest \$244.47 in the illiquid asset (which yields \$295.81 in period 3).

Sophisticates strictly prefer to use the illiquid asset in this way — indeed, they choose to do so even for $\hat{r}$ smaller than r.

Naifs and the Illiquid Asset

Recall: Period-1 desired behavior is

$$c_1^* = \$481.16,\ c_2^* = \$301.81,\ c_3^* = \$295.81$$

Without illiquid asset, actual behavior for naifs is

$$c_1^N = \$481.16,\ c_2^N = \$363.46,\ c_3^N = \$227.99$$

With the illiquid asset, in period 1 naifs COULD:

- consume \$481.16.
- save \$274.37 in the bank (which yields \$301.81 in period 2).
- invest \$244.47 in the illiquid asset (which yields \$295.81 in period 3).

BUT note that naifs are indifferent between using vs. not using the illiquid asset, because they (incorrectly) think that, even if they put their entire savings of \$518.84 in the bank, they would still consume \$301.81 in period 2 and \$295.81 in period 3.

Illiquid Assets: Conclusions

- For people with self-control problems, tying up wealth in illiquid assets can be a useful commitment device to help counteract future over-consumption.

- Sophisticates are always on the lookout for such commitment opportunities, whereas naifs do not recognize the commitment value in illiquid assets.

Illiquid Assets: A Few Comments

- The illiquid asset is not a perfect commitment technology, because you cannot prevent yourself from consuming current income. For instance, if $Y_1 = \$500$ and $Y_2 = \$550$, the illiquid asset would not help at all.

- An illiquid asset will not work as a commitment device if you can borrow against its future payoff. Hence, liquidity-enhancing instruments such as credit cards may in fact undermine the commitment value of illiquid assets.

- In the real world, illiquid assets usually have a **larger** return than liquid assets ($\hat{r} > r$).

  Standard explanation: There can be costs associated with having your wealth tied up in illiquid assets, and so people need an extra incentive to do so.

A Related Aside: Retirement Plans

Two features of retirement plans (IRA plans, 401(k) plans, etc):

- They are tax-exempt.
- They are illiquid (big penalty for early withdrawal).

Why have retirement plans?

- Goal: induce people to save for retirement.

To the extent that retirement plans are aimed at counteracting self-control problems:

- If people are sophisticated, the illiquidity feature of retirement plans is all that's needed to induce more retirement saving.
- If, in contrast, people are naive, then both features are crucial: the tax-exempt feature induces people to use retirement plans rather than some other form of saving, and then the illiquidity feature generates unexpected commitment benefits that "multiply" the effect.

Applying These Ideas to Real Data

Angeletos *et al* (*JEP* 2001)

- They conduct a quantitative test of present bias (in the consumption-saving environment).

Basic idea:

- We observe people take on large credit-card debts at high interest rates, but also accumulate significant pre-retirement wealth.
- Under exponential discounting, it is very difficult to accommodate both.
- Under present bias, this combination can be (roughly) understood as credit-card debt being driven by short-term impatience (β) and accumulation of pre-retirement wealth being driven by long-term patience (δ).

Angeletos et al: The Model

They consider a rich, calibrated model:

- A “period” is one year.
- Households begin life at 20, retire at 63, and die at 90 (if not sooner).
- Demographics calibrated to the “U.S. population”.
- Labor income calibrated to the “U.S. population”.
- There is a liquid asset with real interest rate 3.75%.
- There is credit-card borrowing with real interest rate 11.75% (with a credit limit).
- There is an illiquid asset that generates annual consumption flow equal to 5% of its value (can be sold only with a transaction cost).
- Preferences: CRRA instantaneous utility with $\rho = 2$, and β, δ intertemporal preferences.

Angeletos et al: Simulations

Exponential simulation:

- Assume that the entire economy is populated by exponential discounters with discount factor δ_{exp}.
- Choose δ_{exp} so that the simulations generate a median wealth-to-income ratio for households aged 50-59 of 3.2.

Present bias simulation (sophisticates):

- Assume that the entire economy is populated by people with present bias with $\beta = .7$ and $\delta = \delta_{PB}$.
- Choose δ_{PB} so that the simulations generate a median wealth-to-income ratio for households aged 50-59 of 3.2.

Chosen discount factors:

- $\delta_{\text{exp}} = .944$
- $\delta_{PB} = .957$

Angeletos et al: Performance of Simulated Models

Finally, they compare their simulated data to real-world data:

- households with liquid assets $>$ one-month's income:

Exponential simulation:	73%
Present Bias simulation:	40%
Data:	43%

- households with positive credit-card borrowing:

Exponential simulation:	19%
Present Bias simulation:	51%
Data:	70%

Angeletos et al: Performance of Simulated Models

- mean credit-card borrowing (all households):

Exponential simulation:	\$900
Present Bias simulation:	\$3400
Data:	$>$ \$5000

- consumption-income comovement:

Exponential simulation:	0.032
Present Bias simulation:	0.166
Data:	≈ 0.2

Application 2: Present Bias & Procrastination

Ariely & Wertenbroch (*Psychological Science* 2002)

Experiment 1:

- Subjects were 99 professionals in an MIT executive-education course.
- Two sections, and the treatment was done by section.
- 3 short papers required for the course.
- Deadline for each paper (1% penalty per day late).
- Two treatments:
  - *No Choice*: Evenly spaced deadlines imposed.
  - *Free Choice*: Each student chose own deadlines.
- Note: A deadline had the same implications for both groups.

Application 2: Present Bias & Procrastination

Results

In the free-choice group, people imposed deadlines on themselves. On average:

- Deadline for paper 1 about 42 days before end of term.
- Deadline for paper 2 about 26 days before end of term.
- Deadline for paper 3 about 10 days before end of term.

$\Longrightarrow$ People chose to make costly commitments, which is consistent with present bias and sophistication (or at least some degree of sophistication).

Application 2: Present Bias & Procrastination

But was it optimal commitment?

To answer, compare outcomes (grades) across treatments:

- The free-choice group had lower grades than the no-choice group, in both their overall grades and especially their grades on a final project that was due on the last day of class.

$\Longrightarrow$ This evidence is perhaps more consistent with present bias and partial naivete / partial sophistication.

Application 3: Present Bias & Health Clubs

DellaVigna & Malmendier (*AER* 2006)

They analyze evidence from health clubs — in particular, a panel data set that tracks members' usage over time.

Three contracts available:

- (1) \$10 per visit.
- (2) A monthly fee $\$F_M$.
- (3) A yearly fee $\$F_Y$.

During the first 6 months of membership:

- Group 2 ended up paying \$17/visit.
- Group 3 ended up paying \$15/visit.

$\Longrightarrow$ They interpret as present bias with partial naivete.

Application 3: Present Bias & Health Clubs

Further evidence of naivete:

- The monthly contract has automatic renewals, and they see what looks like procrastination in cancelling (a duration between last usage and cancellation). Moreover, this duration is positively correlated with overpayment in the initial months.

Application 4: Present Bias & Job Search

DellaVigna & Paserman (*J. of Labor Econ*, 2005)

Setting:

- Each period, an unemployed person chooses how much effort to put into searching for a job.
- Search effort requires an immediate cost, but also determines the probability of receiving job offer that period.
- If the person receives a job offer, a proposed wage is “randomly” chosen by the firm, and the person must decide whether to accept that offer — in which case the job search ends — or to decline that offer and search again next period.

Application 4: Present Bias & Job Search

Formally:

Job searcher chooses search effort e:

- incur immediate cost $c(e)$, where $\uparrow e \Longrightarrow \uparrow c(e)$.
- receive offer with probability $p(e)$, where $\uparrow e \Longrightarrow \uparrow p(e)$.

If the person receives a job offer:

- A wage w is drawn from some distribution F, where $F(\bar{w}) \equiv \Pr(w \geq \bar{w})$.
- The person must decide whether to accept the job offer.

In this environment, a "strategy" for the job searcher is an effort level e^* and a cutoff wage $\bar{w}^*$ such that put in effort e^* each period and accept the first wage offer $w \geq \bar{w}^*$.

Application 4: Present Bias & Job Search

Recall: In this environment, a "strategy" for the job searcher is an effort level e^* and a cutoff wage $\bar{w}^*$ such that put in effort e^* each period and accept the first wage offer $w \geq \bar{w}^*$.

They study the exit rate from unemployment:

- Exit Rate from Unemployment $= p(e^*)\ F(\bar{w}^*)$.

Note:

- $\uparrow e^* \implies \uparrow p(e^*) \implies \uparrow$ Exit Rate from Unemployment
- $\uparrow \bar{w}^* \implies \downarrow F(\bar{w}^*) \implies \downarrow$ Exit Rate from Unemployment

Application 4: Present Bias & Job Search

Goal: What is the effect of impatience in this environment?

$\downarrow \delta \implies \downarrow e^*$ & $\downarrow \bar{w}^* \implies$?? Exit Rate

For plausible parameters, wage-effect dominates:

$$\downarrow \delta \implies \uparrow \text{Exit Rate}$$

For naifs: $\downarrow \beta \implies \downarrow e^*$ & no change $\bar{w}^* \implies \downarrow$ Exit Rate

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For sophisticates: $\downarrow \beta \implies \downarrow e^*$ & $\downarrow \bar{w}^* \implies$?? Exit Rate

For plausible parameters, effort-effect dominates:

$$\downarrow \beta \implies \downarrow \text{Exit Rate}$$

Application 4: Present Bias & Job Search

Theoretical conclusion:

According to standard exponential discounting:

$$\uparrow \text{impatience } (\downarrow \delta) \Longrightarrow \uparrow \text{exit rate}$$

According to β, δ discounting:

$$\uparrow \text{long-run impatience } (\downarrow \delta) \Longrightarrow \uparrow \text{exit rate}$$

$$\uparrow \text{short-run impatience } (\downarrow \beta) \Longrightarrow \downarrow \text{exit rate}$$

Application 4: Present Bias & Job Search

Empirical test:

- They use data from the National Longitudinal Survey of Youth (NLSY) and from the Panel Study of Income Dynamics (PSID) on unemployment spells among male heads of households.
- They use a variety of proxies for impatience, and for most proxies, increased impatience is correlated with lower exit rates from unemployment — which is consistent with changes in short-run impatience (β)!
- Some specific proxies: Doesn't have bank account, had unprotected sex, did not have life insurance, smoked, more hangovers in past 30 days.

Application 5: Present Bias & Cigarette Taxes

Gruber & Mullainathan (*BE Policy*, 2005)

Starting point: models of present bias predict that people might smoke despite preferring not to smoke, and hence might be made better off by cigarette taxes.

Hypothesis to Test:

$$\uparrow \text{Cigarette Taxes} \Longrightarrow \uparrow \text{Happiness for Potential Smokers}$$

Application 5: Present Bias & Cigarette Taxes

Data

From the US General Social Survey (GSS), they have data on:

- Happiness: "Taken all together, how would you say things are these days — would you say that you are very happy, pretty happy, or not too happy?"
- Smoker vs. Non-Smoker
- Demographic variables: age, gender, income, education, parents' education, race, marital status, employment status, and more.

They match this data to state cigarette taxes.

Application 5: Present Bias & Cigarette Taxes

Two preliminary results:

- Smokers are less happy than non-smokers.
- Higher cigarette taxes don't seem to make smokers happier.

But we want to study impact of cigarette taxes on "potential smokers" — how to define a potential smoker:

- Step 1: Investigate how actual smoking behavior depends on demographic variables.
- Step 2: Use results from Step 1 to assign to each person a propensity to smoke — e.g., because increased education is associated with being less likely to actually be a smoker, someone with more education will be assigned a lower propensity to smoke.

Application 5: Present Bias & Cigarette Taxes

They divide people into two groups: high propensity to be smoker, and low propensity to be smoker.

- Among the low propensity group, increased cigarette taxes have no impact on happiness.
- Among the high propensity group, increased cigarette taxes are associated with increased happiness — as predicted!