Psychology and Economics[1]

14.13 Lectures 3 and 4: Time Preferences (Theory)

Frank Schilbach

MIT

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[1] These lecture slides are partially based on notes by Botond Kőszegi and David Laibson. I would like to thank them, without implicating them in any way, for sharing their materials with me.

Some housekeeping

- Please be on time, do the readings. There will be (random) pop quizzes.
- Laptop section, using phones in class
- Problem set will be posted shortly.
- Ask and answer questions on Piazza forum!

Overview: time preferences

(1) Exponential discounting

(2) Evidence against exponential discounting

(3) Quasi-hyperbolic discounting

(4) Sophistication vs. naïveté

Choices over time

- Most non-trivial economic choices involve tradeoffs between costs and benefits that occur at different points in time.
- Examples?

Example 1: Purchasing an expensive software

- Costs and benefits
  - Costly money outlay at the beginning (negative utility)
  - Pain and frustration of learning it (negative utility)
  - Mastery (positive utility, until it becomes obsolete)
- How do you decide whether to purchase the software?
  - Determine value (utility) of costs and benefits
  - Weigh these costs and benefits against each other somehow

Example 2: Going to school

- Costs and benefits
  - Direct cost of education: tuition (negative utility)
  - Opportunity costs: foregone wages (negative utility)
  - Joy or pain of going to school (positive or negative utility)
  - Future wages (positive utility, unless you decide to do a PhD)
  - ...
- How do you decide whether to go to school?
  - Determine value (utility) of costs and benefits
  - Weigh these costs and benefits against each other somehow

Example 3: De-activating a social media account

- Costs and benefits
  - Direct cost of de-activating the account (negative utility)
  - Short-run adjustment costs (likely negative utility)
  - Long-run impacts on social life, mental health, etc. (positive or negative utility)
  - ...
- How do you decide whether to de-activate the account?
  - Determine value (utility) of costs and benefits
  - Weigh these costs and benefits against each other somehow

Some important choices over time

- Investment/saving/borrowing
- Education
- Health
- Sleep
- Eating patterns
- Dating
- ...

Choices over time: A quick history – see details in Frederick et al. (2002)

- Rae (1834): Amount of labor allocated to the production of capital depends on “effective desire of accumulation”.
  - Rich psychological considerations regarding the origins of this factor
  - Bequest motive, self-restraint, anticipatory utility, etc.
- Böhm-Bawerk (1889): the interest rate is just a price.
  - Intertemporal choices are just like any other economic tradeoff.
- Fisher (1930): two-good indifference diagram
  - Still many psychological factors discussed: ‘personal factors’

Fisher (1930) diagram

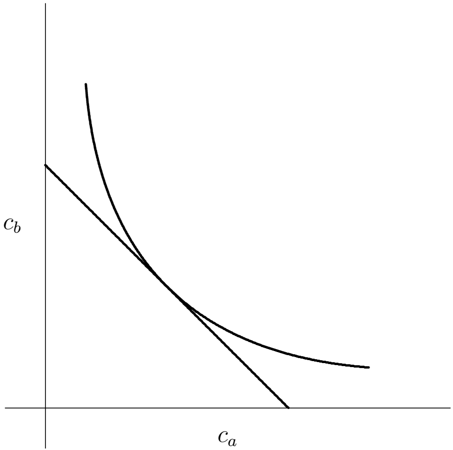


Figure: Choice between goods

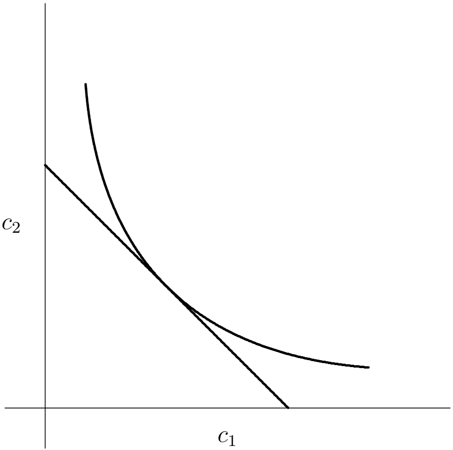


Figure: Choice over time

Samuelson (1937): discounted utility model

- Non-graphical, mathematical version of Fisher's view of intertemporal choice: just like any other tradeoff in economics. At time t, maximize **discounted utility:**

$$U_t \equiv \sum_{\tau=t}^{\infty} \delta^{\tau-t} u_\tau = u_t + \delta u_{t+1} + \delta^2 u_{t+2} + \delta^3 u_{t+3} + \ldots$$

- **Instantaneous utilities:** $u_t, u_{t+1}, u_{t+2}, \ldots$
  - capture how the person feels at a specific moment (in period τ)
  - function of consumption, leisure, etc. in period τ: $u_\tau \equiv u(c_\tau, l_\tau, \ldots)$.
- **Discount factor:** δ (usually ≤ 1)
  - measures how utility in later periods is *discounted* relative to earlier periods.
  - Instantaneous utility in period t (u_t) is always worth δ times instantaneous utility in the previous period (u_{t-1}).
  - δ replaces complex psychology of how people think about the future.
  - Samuelson chose this functional form for mathematical convenience.

Discount functions and discount rates

- $U_t = \sum_{\tau=0}^{\infty} D(\tau) u_{t+\tau}$

- Discount function $D(\tau)$
  - u utils in τ periods are psychologically worth $D(\tau) \cdot u$ utils today.
  - $D(\tau)$ specifies weights on utility derived in τ time periods.

- Discount rate $\rho(\tau)$
  - Rate of decline in the discount function: $\rho(\tau) \equiv -\frac{dD(\tau)/d\tau}{D(\tau)}$
  - $\rho(\tau)$ specifies the rate at which value of a util declines with delay.

- Exponential discounting: discount rates do not change with horizon.
  - Discount function $D(\tau) = \delta^\tau$
  - Discount factor δ
  - Discount rate $\rho(\tau) \equiv -\frac{dD(\tau)/d\tau}{D(\tau)} = -\frac{d(\delta^\tau)/d\tau}{\delta^\tau} = -\frac{\delta^\tau \log(\delta)}{\delta^\tau} = -\log(\delta) \simeq 1 - \delta$

Simple (stylized) example

- Student Amy considers writing her term paper today so as to give herself a single free evening in the future. Suppose:
  - Instantaneous cost of writing the paper is 1 util (compared to an outside option).
  - Instantaneous benefit of a free evening is 4/3 utils.
  - Daily discount factor $\delta = 0.9$
- What will she do? If the evening is ...
  - ... in the next period: $-1 + \delta \cdot 4/3 > 0$. So she's willing to do it.
  - ... in two periods: $-1 + \delta^2 \cdot 4/3 > 0$. So she's willing to do it.
  - ... in three periods: $-1 + \delta^3 \cdot 4/3 < 0$. So she isn't willing to do it.
- She will do it if the nice evening comes next period or in two periods, but not if it comes later (note we assumed that she can only do the paper today).

How can we measure or estimate δ?

- We need data.
  - Want several choices over time.
  - Need to know the costs and benefits associated with each choice.
  - Each choice gives us an inequality involving δ
- Suppose we didn't know Amy's δ but we knew u_τ for all τ.
  - How can we estimate it using the above data?
  - Suppose we know each of her choices and the costs and benefits.
  - Then, from the above choices, we have:

$$
\begin{aligned}
-1 + \delta \cdot 4/3 > 0 &\Rightarrow \delta > 3/4 \\
-1 + \delta^2 \cdot 4/3 > 0 &\Rightarrow \delta > (3/4)^{1/2} \approx 0.87 \\
-1 + \delta^3 \cdot 4/3 < 0 &\Rightarrow \delta < (3/4)^{1/3} \approx 0.91 \\
&\Rightarrow 0.87 < \delta < 0.91
\end{aligned}
$$

- In reality, we do not know u_τ. What data could we collect?

Thaler (1981): (hypothetical) monetary choices

- Choices between amounts at different points in time: What X makes you indifferent between \$15 today and \$$X$ in ...
  - ... a month?
  - ... a year?
  - ... a 10 years?

- Assume utility is linear in money: $u(X) = X$

- Back out the (yearly) discount rate $\rho(\tau) = \rho$ using exponential model:

$$u(Y) = \delta^t u(X)$$
$$Y = \delta^t X$$
$$\Rightarrow \log(Y/X) = t \log(\delta)$$
$$\Rightarrow \rho = -\log(\delta) = \frac{\log(X/Y)}{t}$$

Backing out the (yearly) discount factor δ

- What X makes you indifferent between \$15 now and \$$X$ in a month?
    - For Y=\$15 and X=\$20, we get

$$\rho = -\log(\delta) = \frac{\log(20/15)}{1/12} \approx 345\% \text{ per year}$$
$$\Rightarrow \delta = \exp(-3.45) \approx 0.03$$

    - Alternatively, we have $\delta = (15/20)^{12} \approx 0.03$.

- What X makes you indifferent between \$15 now and \$$X$ in 10 years?
    - For Y=\$15 and X=\$100, we get

$$-\log(\delta) = \frac{\log(100/15)}{10} \approx 19\% \text{ per year}$$
$$\Rightarrow \delta = \exp(-0.19) \approx 0.83$$

    - Alternatively, we have $\delta = (15/100)^{1/10} \approx 0.83$.

Progress report on estimating δ: we basically have no idea what δ is!

- Single most important variable in the exponentially discounted utility model: δ

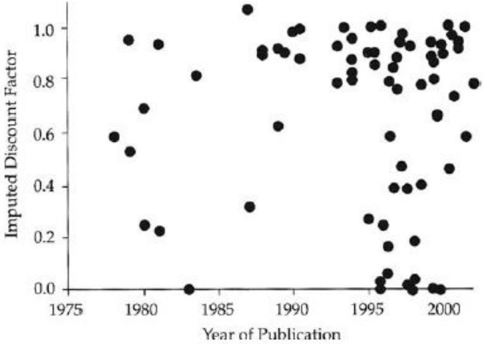


Figure 2. Discount factor by year of study publication (source: Frederick et al., 2002).

Pieces of evidence against exponential discounting

(1) Short-run impatience vs. long-run patience

(2) Preference reversals (dynamic inconsistency)

(3) Demand for commitment

Due to copyright restrictions, we aren't able to include the video "The Marshmallow Test" by Igniter Media. You can view this on YouTube at: https://bit.ly/3oQ41am

Image by Kate Ter Haar on flickr.

Thought experiment: are discount rates constant over time?

(I) Would you like to...

(A) eat one marshmallow now, or
(B) eat two marshmallows in an hour?

(II) Would you like to...

(A) eat one marshmallow in a week, or
(B) eat two marshmallows in a week and an hour?

(III) Would you like to...

(A) eat one marshmallow in a year, or
(B) eat two marshmallows in a year and an hour?

Lots of evidence of short-run impatience

(1) What makes you indifferent between \$100 now or \$$x$ in two weeks?

- Median answer in this class: $x = 110$; mean answer: $x = 120$
- Exercise: what is the implied yearly δ (assuming linear utility)?

(2) Payday loans

- As high as 5000% annualized compounded interest!
- More stores than McDonald's and Starbucks combined

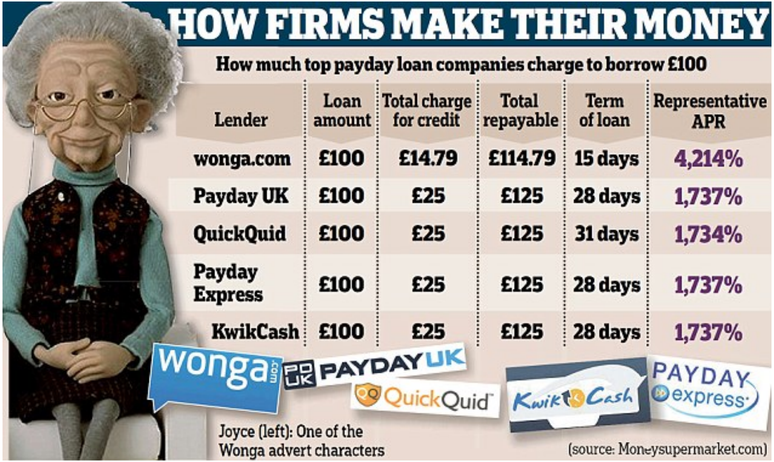
(3) Credit-card debt

- Less extreme interest rates (often 20 to 25% APR)
- Lots of credit card debt in the US!

(4) Payday effects

- Consumption of various forms follows the pay cycle.
- Caloric intake of food-stamp recipients declines by 10 to 15% over the (monthly) food-stamp cycle

Exorbitant interest rates for payday loans



HOW FIRMS MAKE THEIR MONEY

How much top payday loan companies charge to borrow £100

Lender	Loan amount	Total charge for credit	Total repayable	Term of loan	Representative APR
wonga.com	£100	£14.79	£114.79	15 days	4,214%
Payday UK	£100	£25	£125	28 days	1,737%
QuickQuid	£100	£25	£125	31 days	1,734%
Payday Express	£100	£25	£125	28 days	1,737%
KwikCash	£100	£25	£125	28 days	1,737%

High credit-card APRs

Absurd implications

- Above evidence: choices involving immediate consumption. Exponential discounting implies same level of impatience for any delay of the same length.
- Suppose the average (mean) student is an exponential discounter, and has linear utility of consumption. Then her two-week δ is $5/6$.
  - She cares about four weeks from now $(5/6)^2$ times as much as today.
- She'd be indifferent between:
  - \$100 now and $(6/5)^2 \cdot \$100 = \$144$ in four weeks.
  - \$100 today and $(6/5)^{26} \cdot \$100 > \$11,400$ in a year.
  - \$100 now and $(6/5)^{26} \cdot \$100 = \$1{,}965{,}902{,}550{,}839.90$ in five years.[2]
  - ...
- This is completely unrealistic! Her discount factor for two-week delays in the future must be higher than the discount factor for two-week delays in the present.

[2] With diminishing marginal utility of consumption, she'd strictly prefer the \$100.

Short-run impatience vs. long-run patience

- People are in fact quite patient in the long run:
    - Save for retirement
    - Invest in education
    - Exercise often
    - Do problem sets
    - ...
- Frederick et al. (2002): same exercise as Thaler (1981)
    - Economists' published estimates of δ based on real-life decisions

Frederick et al. (2002): Estimated δ increases by time horizon

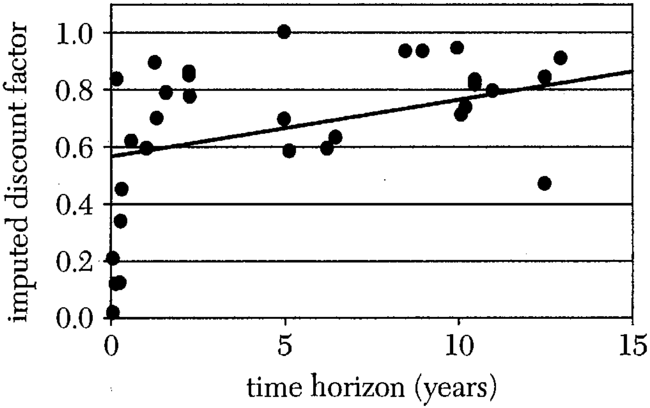


Figure: Frederick et al. (2002), Figure 1a

Pieces of evidence against exponential discounting

(1) Short-run impatience vs. long-run patience

(2) Preference reversals (dynamic inconsistency)

(3) Demand for commitment

Dynamic consistency (aka time consistency)

- Exponential discounting has another important property:

  Dynamic consistency: *The action a person thinks she should take in the future always coincides with the action that she actually prefers to take once the time comes.*

- The person's preferences at different points in time are consistent with each other—there are no "intra-personal conflicts."

- *State-contingent* plans do not change over time (though plans may changed if unforeseen information arrives or circumstances change).

- Closely related to the assumption of exponential discounting that a decision-maker counts each period δ times as much as the previous one.
  - When thinking ahead, she counts 2 years from now δ times as much as one year from now. In one year, she does the same.
  - So she does not want to do anything different when the time comes than when looking ahead.

More formal argument

- Consider the choice between two actions in period 1, A and B
- Time $t = 0$ self prefers action A over B if and only if

$$u_0 + \delta u_1(A) + \delta^2 u_2(A) + \ldots \geq u_0 + \delta u_1(B) + \delta^2 u_2(B) + \ldots$$

- But this implies:

$$\begin{aligned} \delta u_1(A) + \delta^2 u_2(A) + \ldots &\geq \delta u_1(B) + \delta^2 u_2(B) + \ldots \\ \Rightarrow u_1(A) + \delta u_2(A) + \ldots &\geq u_1(B) + \delta u_2(B) + \ldots, \end{aligned}$$

  which says exactly that time $t = 1$ self prefers action A to action B!

- Exponential discounting implies dynamic consistency.
  - However, in the real world, there are plenty of examples of intra-personal conflicts.

Time inconsistency in movie choices: Read et al. (1999)

- Choose among 24 movies
  - Some are "low brow": e.g. *Four Weddings and a Funeral; Speed*
  - Some are "high brow": e.g. *The Piano; Schindler's List*
- Choices are not consistent over time:
  - Picking for tonight: 56% choose low brow.
  - Picking for 7 days from now: 37% choose low brow.
  - Picking for 14 days from now: 29% choose low brow.

Read and van Leeuwen (1998)

Choosing Today — Eating Next Week → *Time*

If you were deciding today, would you choose fruit or chocolate for next week?

Patient choices for the future

Choosing Today — Eating Next Week → *Time*

Today, subjects typically choose fruit for next week.

74% choose fruit

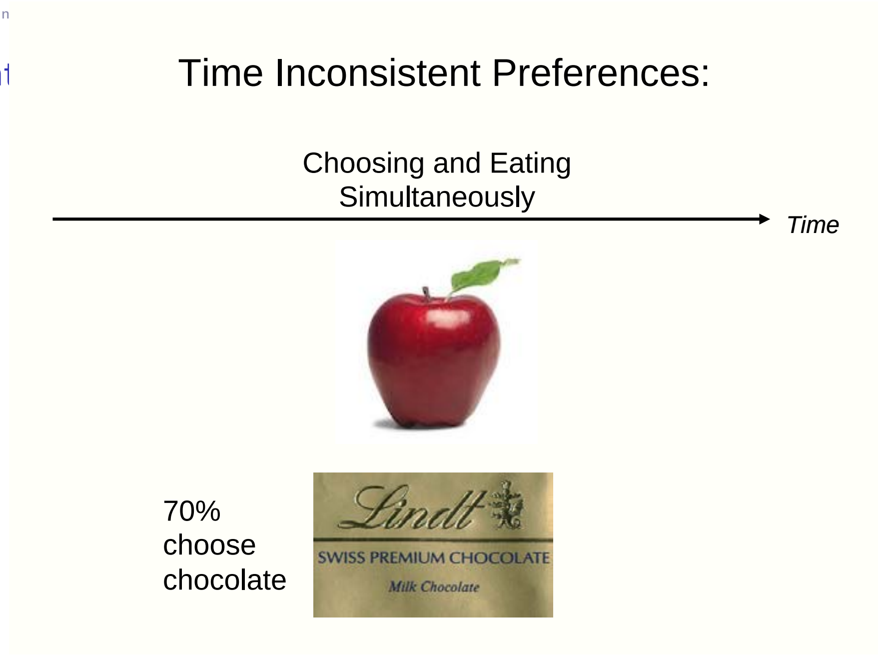
Time inconsistency?

Choosing and Eating Simultaneously

Time

If you were deciding today, would you choose fruit or chocolate for today?

Impatient


Time Inconsistent Preferences:
Choosing and Eating Simultaneously
Time
70% choose chocolate
Lindt
SWISS PREMIUM CHOCOLATE
Milk Chocolate

Pieces of evidence against exponential discounting

(1) Short-run impatience vs. long-run patience

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Intra-personal conflicts: Ulysses and the Sirens

These nymphs had the power . . . of charming by their song all who heard them, so that mariners were impelled to cast themselves into the sea to destruction. Circe directed Ulysses to stop the ears of his seamen with wax, so that they should not hear the strain; to have himself bound to the mast, and to enjoin his people, whatever he might say or do, by no means to release him till they should have passed the Sirens' island.

Intra-personal conflicts: Financial advice

Image by Paul Stocker on flickr. CC BY

- **Cut up your credit and store cards!** If possible get rid of all of your credit cards . . . **Put temptation out of reach.** If you really can't do without a credit card, limit yourself to only one . . . Put it in a tub of water and stick it in the freezer.
- Extreme? Maybe, but it will make you think hard about any impulse purchases you make in the future while you are standing there waiting for it to defrost.
- This approach may or may not help – see this movie scene from Confessions of a Shopaholic

Demand for commitment

- These examples demonstrate tendency for immediate gratification—to discount quite heavily on short-term decisions.
- Deeper point: we disapprove of this tendency beforehand.
  - Ulysses ties himself to the mast because he disapproves of his urge to join the nymphs.
  - Shoppers disapprove of impulse spending beforehand.
- Decision-makers in all these examples are time-*in*consistent.

The heart of the issue

- Conflicts rooted in difference between short-run and long-run patience
  - When thinking ahead to the future, we want to be patient.
  - When the time actually comes, we are impatient.

- Exponential discounting can't capture these because it assumes the same level of patience (δ) independently of whether consequences are immediate or delayed.

- Alternative model captures the above phenomena:
  (i) Greater patience for tradeoffs in future than for tradeoff in present
  (ii) Resulting dynamic inconsistency

Quasi-Hyperbolic Discounting (Laibson, 1997)

- **Exponential Discounting:** at time t, the person aims to maximize

$$u_t + \delta u_{t+1} + \delta^2 u_{t+2} + \delta^3 u_{t+3} + \ldots,$$

where $0 < \delta \leq 1$ is the *short-term discount factor* and $0 < \delta \leq 1$ is the *long-term discount factor*.

- **Quasi-Hyperbolic Discounting:** at time t, the person aims to maximize

$$u_t + \beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \beta\delta^3 u_{t+3} + \ldots,$$

where $0 < \beta \leq 1$ is the *short-term discount factor* and $0 < \delta \leq 1$ is the *long-term discount factor*.

Quasi-Hyperbolic Discounting (Laibson, 1997)

- **Quasi-Hyperbolic Discounting:** at time t, the person aims to maximize

$$u_t + \beta\delta u_{t+1} + \beta\delta^2 u_{t+2} + \beta\delta^3 u_{t+3} + \ldots,$$

where $0 < \beta \leq 1$ is the *short-term discount factor* and $\delta \leq 1$ is the *long-term discount factor*.

  - Typically, we assume that $\beta < 1$ and $\delta \approx 1$.
  - Example, if $\beta = 2/3$ and $\delta = 1$, discounted utility becomes

$$u_t + 2/3 \cdot u_{t+1} + 2/3 \cdot u_{t+2} + \ldots. \quad (1)$$

  - Relative to the current period, all future periods are worth much less (they get a factor of β).
  - Most (here, all) discounting is between the present and the future.
  - Little discounting between future periods.

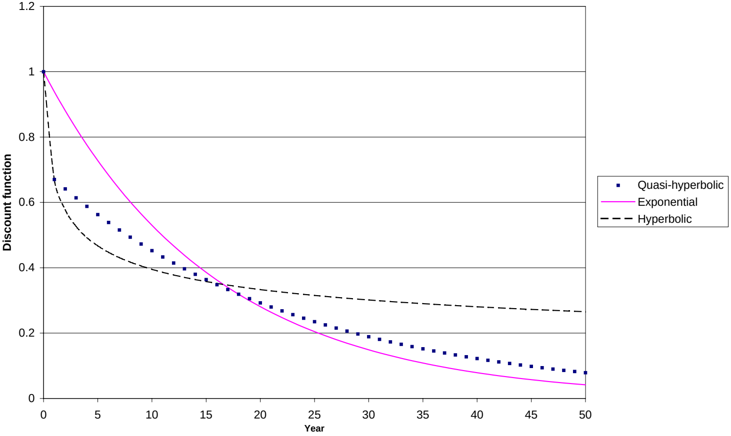
Building intuition

- Discount function for $\beta = 1/2$ and $\delta \simeq 1$:

$$D(\tau) = 1, \beta\delta, \beta\delta^2, \beta\delta^3, \ldots\}$$
$$= \left\{1, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \ldots\right\}$$

- Observations
  - Relative to present period, all future periods worth less (weight $1/2$).
  - All discounting takes place between present and immediate future.
  - In 'long-run', we are relatively patient: utils in a year are just as valuable as utils in two years.
  - Decisions are sensitive to the timing of benefits and costs.
  - Timing matters. How long is the 'present period'?

Discount functions of quasi-hyperbolic vs. hyperbolic discounting



Source: Authors' calculations. Exponential: δ^t, with $\delta=0.939$; hyperbolic: $(1+\alpha t)^{-\gamma/\alpha}$, with $\alpha=4$ and $\gamma=1$; and quasi-hyperbolic: $\{1, \beta\delta, \beta\delta^2, \beta\delta^3, \ldots\}$, with $\beta=0.7$ and $\delta=0.957$.

Figure: Exponential, hyperbolic, quasi-hyperbolic discount functions (Angeletos et al., 2001)

Leisure goods: immediate rewards, delayed costs

- Example 1: eating candy
  - Immediate utility benefits $B_{\text{PLEASURE}} = 2$
  - Delayed health costs $C_{\text{HEALTH}} = 3$
  - Let $\beta = 1/2$ and $\delta = 1$.

- Eating candy today? Yes.

$$B_{\text{PLEASURE}} - \beta \cdot C_{\text{HEALTH}} = 2 - \frac{1}{2} \cdot 3 > 0$$

- Planning to eat candy next week? No.

$$\beta \cdot (B_{\text{PLEASURE}} - C_{\text{HEALTH}}) = \frac{1}{2} \cdot (2 - 3) < 0$$

- Over-consume leisure goods relative to long-run plans

Investment goods: immediate costs, delayed benefits

- Example 2: going to the gym
  - Immediate effort costs $C_{\text{EFFORT}} = 2$
  - Delayed health benefits $B_{\text{HEALTH}} = 3$
  - Let $\beta = 1/2$ and $\delta = 1$.

- Going to the gym today? No.

$$-C_{\text{EFFORT}} + \beta \cdot B_{\text{HEALTH}} = -2 + \frac{1}{2} \cdot 3 < 0$$

- Planning to go to the gym next week? Yes.

$$\beta \cdot (-C_{\text{EFFORT}} + B_{\text{HEALTH}}) = \frac{1}{2} \cdot (-2 + 3) > 0$$

- Under-consume investment goods relative to long-run plans

Investment goods with commitment

- **Setup**
  - Consider a student with $\beta = 1/2$ and $\delta = 1$
  - Has to do problem set in exactly one of three periods, $t = 0, 1, 2$.
  - Instantaneous dis-utilities: $u_0 = -1$, $u_1 = -3/2$, and $u_2 = -5/2$.
- **Case 1: Commitment available**
  - Suppose the student can commit at $t = 0$ to doing the problem set on any date, i.e. she can decide when the pset is actually done.
  - From the perspective of period 0: If pset is done at ...
    - ... $t = 0$, the discounted disutility is -1.
    - ... $t = 1$, the discounted disutility is $1/2 \cdot (-3/2) = -3/4$.
    - ... $t = 2$, the discounted disutility is $1/2 \cdot (-5/2) = -5/4$.
  - Hence, at $t = 0$ she commits to doing the problem set at $t = 1$.

Investment goods without commitment

- **Setup**
  - Consider the same student with $\beta = 1/2$ and $\delta = 1$
  - Has to do problem set in exactly one of three periods, $t = 0, 1, 2$.
  - Instantaneous dis-utilities: $u_0 = -1$, $u_1 = -3/2$, and $u_2 = -5/2$.
- **Case 2: No commitment available**
  - Now suppose the student has no access to a commitment technology.
  - Would she actually do it in period 1?
  - From the perspective of period 1: If pset is done at ...
    - ... $t = 1$, the discounted cost is $-3/2$.
    - ... $t = 2$, the discounted cost is $(1/2) \cdot (-5/2) = -5/4$.
    - She now prefers to do the problem set at $t = 2$.
  - The student's preferences are dynamically inconsistent!

Naïveté versus sophistication (O'Donoghue and Rabin, 1999)

- Given this conflict, when does she actually do the problem set?
  - Key question: is the student *aware* of her time inconsistency?
  - Additional parameter: $\hat{\beta}$ measures beliefs about future β.

- Two extreme assumptions:

(1) **Full Naïveté:** $\hat{\beta} = 1$

- She does not realize she will change her mind.
- She assumes future selves will follow through on her favorite plan.
- Surprises about future present bias
- False optimism about future patience: "This time is different."

(2) **Sophistication:** $\hat{\beta} = \beta$

- She understands perfectly that she will change her mind.
- She does the best given future selves' correctly anticipated behavior.
- No surprises about future present bias

Naïve student's behavior

- What does she do at $t = 0$?
  - From above: self 0 prefers to do the problem set at $t = 1$.
  - Since she's naïve, she believes she will actually do it at $t = 1$.
  - So she doesn't do it at $t = 0$.
- What does she to at $t = 1$?
  - From above: self 1 does not want to do the problem set at $t = 1$. Surprise!!!
  - Hence, the naïve student does the problem set at $t = 2$.

Naïve student's behavior: summary

- At $t = 0$, she thinks she'll do the pset before doing it becomes very costly. Therefore, she believes she won't lose much by delaying.
- At $t = 1$, she again perceives the cost of delaying to be relatively small, so she delays again.
- This kind of behavior might persist for many periods. It is an example of *naïve* procrastination.
- Naïve procrastination can cause large welfare costs.

Sophisticated student's behavior

- If she doesn't do the pset at $t = 0$, she ends up doing it at $t = 2$.
  - She is effectively choosing between doing it at $t = 0$ or at $t = 2$.
  - A sophisticated student realizes this fact at $t = 0$.
- Recall that from the perspective of $t = 0$:
  - The discounted disutility of doing it at $t = 0$ is -1.
  - The discounted disutility of doing it at $t = 2$ is $1/2 \cdot (-5/2) = -5/4$.
  - So she does the problem set at $t = 0$.

Sophisticated student's behavior: summary

- She recognizes that if she delays, she'll delay more.
- Since she knows that delaying until $t = 2$ would be very costly, she reluctantly does the problem set at $t = 0$.
- So she does better than the naïve student.
  - This may seem unsurprising, since the sophisticated student understands herself better than the naïve student.
- Sophisticated procrastination (if it occurs) does *not* cause large welfare costs.

Does sophistication always help?

- The above examples was for an investment good.
- Let's now consider a leisure good.
    - As before, the student has $\beta = 1/2$ and $\delta = 1$.
    - She can go to a movie in exactly one of four periods, $t = 0, 1, 2, 3$.
    - Instantaneous utilities: $u_0 = 1$, $u_1 = 3/2$, $u_2 = 9/4$, and $u_3 = 27/8$.
- When does she go watch the movie?

A Useful Tool: Table of Discounted Utilities

Perspective	**t=0**	**t=1**	**t=2**	**t=3**	**Ranking**
Instantaneous utilities	1	3/2	9/4	27/8	3, 2, 1, 0
From $t = 0$	1	3/4	9/8	27/16	3, 2, 0, 1
From $t = 1$	—	3/2	9/8	27/16	3, 1, 2
From $t = 2$	—	—	9/4	27/16	2, 3

Recall: the student has $\beta = 1/2$ and $\delta = 1$.

What does the naïve student do?

Perspective	t=0	t=1	t=2	t=3	Ranking
Instantaneous utilities	1	3/2	9/4	27/8	3, 2, 1, 0
From $t = 0$	1	3/4	9/8	27/16	3, 2, 0, 1
From $t = 1$	—	3/2	9/8	27/16	3, 1, 2
From $t = 2$	—	—	9/4	27/16	2, 3

- $t = 0$: plans to go at $t = 3$, so she doesn't go.
- $t = 1$: plans to go at $t = 3$, so she doesn't go.
- $t = 2$: she goes. Surprise!!!

What does the sophisticated student do?

Perspective	t=0	t=1	t=2	t=3	Ranking
Instantaneous utilities	1	3/2	9/4	27/8	3, 2, 1, 0
From $t = 0$	1	3/4	9/8	27/16	3, 2, 0, 1
From $t = 1$	—	3/2	9/8	27/16	3, 1, 2
From $t = 2$	—	—	9/4	27/16	2, 3

- $t = 2$: goes if she hasn't.
- $t = 1$: realizing she won't wait until $t = 3$, she goes.
- $t = 0$: realizing she won't wait until $t = 2$ or $t = 3$, she goes.

Sophistication can hurt!

- What is going on here?
- The sophisticated student goes earlier – and enjoys the movie less! – than the naïve student. She wishes she were naïve!
- The sophisticated student's problem: her *realistic* pessimism about her future behavior.
  - She knows she won't have the patience to wait until the movie is really enjoyable.
  - But given her taste for immediate gratification, the only reason she'd wait is to go to a much better movie later, so she goes immediately.
  - The same pessimism that leads her to do worse with movies leads her to do better with problem sets.

More general lessons

- If future misbehavior *raises* the cost of current misbehavior, then sophistication *helps* in overcoming short-run impatience.
  - This tends to be true for investment goods (with immediate costs).
- But if future misbehavior *lowers* the costs of current misbehavior, sophistication *hurts* in overcoming short-run impatience.
  - This tends to be true for leisure goods (with immediate rewards).

All in all, is it beneficial to be sophisticated?

- Theoretically speaking, it's unclear.

- But many important decisions involve one-time effort that yields future benefits (and the earlier the effort, the greater the benefits):
  (1) Finishing reports/papers/presentations.
  (2) Finding good investments for retirement.
  (3) Quitting bad habits.
  (4) Finding a job (e.g. for unemployed).
  (5) ...

- Sophisticates take advantage of commitment devices (naïves don't).
  - But commitment devices don't always help (see next lectures)

Impatience or time inconsistency?

- Impatience is not the only driver of behavior. In fact, no amount of impatience will generate the above behavior.

- Time inconsistency is implicated in both cases.
  - The student ends up doing something that is *worse for all selves* than another available option.
  - The naïve student does the problem set in period 2, whereas all selves would be better off if she did it in period 0.
  - The sophisticated student goes to the movie in period 0, whereas all selves would be better off if she went in period 3 (or 2).

- This kind of behavior cannot happen with exponential discounting: later selves would be willing to carry out self 0's optimal plan.

Solving Problems with (Quasi-)Hyperbolic Discounting

- **Naïve** decision-makers:
  (1) Start at the beginning.
  (2) Solve for the optimal plan, assuming future selves will follow the plan.
  (3) The person takes the first step in that plan.
  (4) Go to the next period, and keep doing the same.

- **Sophisticated** decision-makers:
  (1) Start at the end.
  (2) Solve for optimal action.
  (3) Go back to the previous period.
  (4) Solve for the optimal action, taking into account what happens in the next period.
  (5) Go back to the previous period, and keep doing the same.

- What about partially sophisticated decision-makers with $\beta < \hat{\beta} < 1$? See lectures next week.

Next week: many applications

- Readings for Tuesday (!) and Wednesday
  - Ariely and Wertenbroch (2002): read entire article
- Applications
  - Smoking and drinking
  - Setting deadlines
  - Commitment savings
  - Self-control at work
  - Paying (not) to go to the gym
  - Bundling temptations
  - ...

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