Topic 2C: Choice over Time
Evidence that Contradicts the Standard Model

EC 404: Behavioral Economics

Professor: Ben Bushong

March 1, 2022

General Version of Discounted Utility

Recall the general version of the discounted-utility model:

$$U^t = \sum_{x=0}^{T-t} D(x)\ u_{t+x}.$$

- U^t is intertemporal utility from perspective of period t.
- u_τ is instantaneous utility in period τ ("well-being" in period t).
- x is the delay before receiving some utility.
- $D(x)$ is a discount function that specifies the amount of discounting associated with delay x.

Again, in principle, we could have any discount function.

Exponential discounting **assumes** $D(x) = \delta^x$.

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How to Measure Discount Functions?

Typical procedure elicits indifference points of the form:

$$(A \text{ at date } x) \;\sim\; (B \text{ at date } x + y)$$

To interpret, typically make four assumptions:

- "The Usual Assumptions"

  (1) People obey discounted utility model.

  (2) People treat these amounts as "bursts" of consumption.

  (3) "Utility" is linear in the amount.

  (4) Normalize $D(0) = 1$.

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An implication of the usual assumptions:

$$(A \text{ now}) \;\sim\; (B \text{ at date } x)$$

$$\iff \qquad D(0)u(A) = D(x)u(B)$$

$$\iff \qquad A = D(x)B$$

$$\iff \qquad D(x) = \frac{A}{B}$$

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How to Measure Discount Functions?

More generally, the usual assumptions imply:

$$(A \text{ at date } x) \;\sim\; (B \text{ at date } x+y)$$

$$\iff \qquad D(x)u(A) = D(x+y)u(B)$$

$$\iff \qquad D(x)A = D(x+y)B$$

$$\iff \qquad \frac{D(x+y)}{D(x)} = \frac{A}{B}$$

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An alternative procedure elicits WTP now for something to be received later — e.g., if WTP up to A now to obtain B at date x, this implies:

$$(-A \text{ now } \& +B \text{ at date } x) \sim (\text{no changes})$$

Applying the usual assumptions here yields:

$$D(0)u(-A) + D(x)u(B) = 0$$

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Some Evidence from Thaler (1981)

Using a (hypothetical) matching technique, Thaler found that people were indifferent between:

a. (\$15 now) $\sim$ (\$30 in 3 months)

b. (\$15 now) $\sim$ (\$60 in 1 year)

c. (\$15 now) $\sim$ (\$100 in 3 years)

Implications under the usual assumptions:

- a. $D(3 \text{ months}) = \frac{15}{30} = 0.50.$
- b. $D(1 \text{ year}) = \frac{15}{60} = 0.25.$
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We can convert each $D(x)$ into an implicit yearly discount rate:

Definition: The *average yearly discount rate applied to delay x* (where x is specified in years) is the ρ such that

$$e^{-\rho x} = D(x) \qquad \text{or} \qquad \rho = \frac{1}{x}(-\ln D(x)).$$

Applying this definition:

- a. $D(3 \text{ months}) = 0.50 \implies 277\%$ yearly discounting.
- b. $D(1 \text{ year}) = 0.25 \implies 139\%$ yearly discounting.
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More Evidence from Thaler (1981)

Thaler (1981) also found that people were indifferent between:

e. (\$250 now) $\sim$ (\$300 in 3 months)

f. (\$250 now) $\sim$ (\$350 in 1 year)

g. (\$250 now) $\sim$ (\$500 in 3 years)

Implications under the usual assumptions:

- e. $D(3 \text{ months}) = \frac{250}{300} = 0.83 \Longrightarrow 73\%$ yearly discounting.
- f. $D(1 \text{ year}) = \frac{250}{350} = 0.71 \Longrightarrow 34\%$ yearly discounting.
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Conclusions from Thaler (1981)

Conclusion #1: The amount matters — there is more discounting for smaller amounts ("magnitude effect").

But the **key conclusion** is:

Conclusion #2: For either amount, discount rates are higher in the short run than in the long run (sometimes referred to as "declining discount rates").

- This finding is inconsistent with exponential discounting!

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Some "Hypothetical Evidence" on "Preference Reversals"

Consider the following hypothetical choice scenarios:

Choice 1:

[10 M&M's now] vs. [15 M&M's tomorrow]

Choice 2:

[10 M&M's in 7 days] vs. [15 M&M's in 8 days]

A plausible pattern:

$$(10 \text{ M\&M's now}) \succ (15 \text{ M\&M's tomorrow})$$

$$(10 \text{ M\&M's in 7 days}) \prec (15 \text{ M\&M's in 8 days})$$

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Some “Hypothetical Evidence” on “Preference Reversals”

Implication: Under the usual assumptions, this pattern implies

$$D(0)10 \quad > \quad D(1)15 \qquad \Longleftrightarrow \qquad \frac{D(0)}{D(1)} > 1.5$$

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In fact, Kirby & Herrnstein (1995) show that, for 23 of their 24 subjects, they can make the subject exhibit this type of "preference reversal".

For instance, for each of these 23 subjects, they find an $x > 0$ and a $y > 0$ such that the subject's preferences are

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Evidence of "Hyperbolic Discounting"

Another approach to the same type of data is to directly compare two functional forms:

- Exponential Discounting: $D(x) = e^{-kx}$
- Hyperbolic Discounting: $D(x) = \frac{1}{1+kx}$

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Conclusions from the Evidence

In the experimental data, there seems to be a key feature that virtually always holds:

- Discount rates are higher in the short run than in the long run (sometimes referred to as "declining discount rates").

In terms of our notation, the evidence seems to suggest:

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