Present Bias I

EC895; Fall 2022

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Today

Our Outline:

(1) The Standard Model

(2) A Model of Present Bias

(3) Procrastination

(4) Evidence of Present Bias

from (Samuelson, 1937)

Exponential discounting

When a person receives utility at different points in time, she seeks to maximize her *intertemporal utility*:

$$U \equiv u_1 + \delta u_2 + \delta^2 u_3 + \ldots + \delta^{T-1} u_T$$

or put another way:

$$= \sum_{t=1}^{T} \delta^{t-1} u_t.$$

- u_t is her **instantaneous utility** in period t (or her "well-being" in period t).
- δ is her **discount factor**, where $\delta \in (0, 1]$.

What are some of the implied assumptions of this model?

- Consumption independence
- Stationary instantaneous utility
- Independence of discounting from consumption
- **Constant discounting and time consistency**

Is this realistic?

Empirical question: How do people weight utility now vs slightly later vs even later?

A common technique: **Calibration exercise**. (Here, magnitudes don't fit with intuition, as we'll see)

- Evidence of systematic "preference reversals"
- (Sometimes) demand for commitment

A Calibration Argument

If we discount utils tomorrow by 1%,

- then the one-year discount factor is $.99^{365}$.
- 100 utils in 1 year are worth 2.6 utils today.
- 100 utils in 10 year are worth 1 x 10^{-14} utils today.

If we discount utils in a year by 5%,

- then the one-day discount factor is $0.95^{1/365}$.
- 100 utils tomorrow are worth 99.99 utils today.

Something here seems amiss.

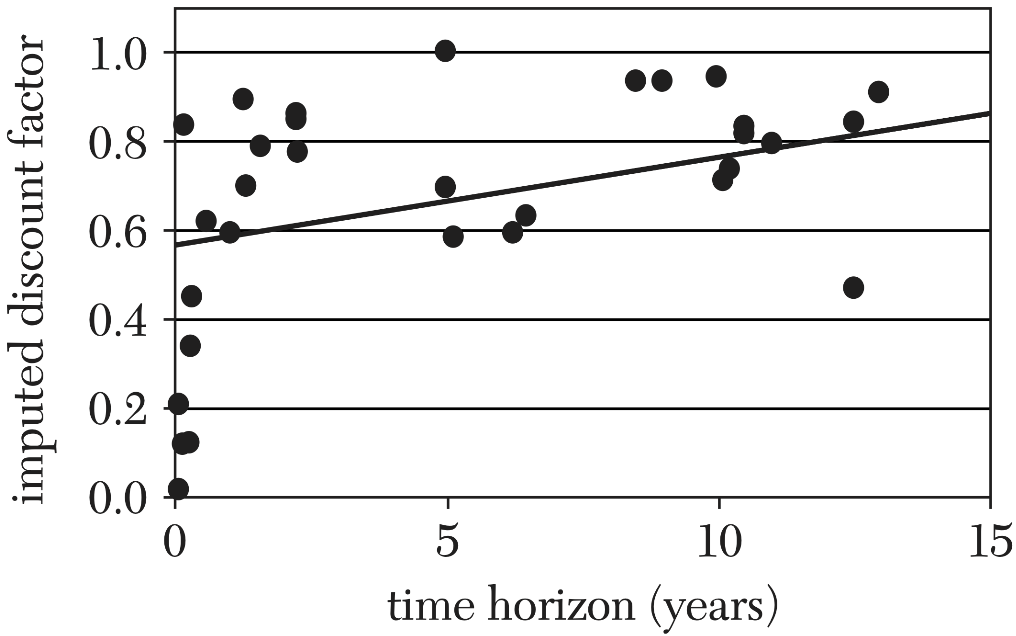
(Thaler, 1981a):

> "What amount of money in one month / one year / ten years would make you indifferent to receiving $15 now?

Finding: the implicit (annual) discount rate decreases in time horizons.

- 345 percent over one-month horizon
- 120 percent over one-year horizon
- 19 percent over ten-year horizon

General pattern of diminishing impatience well-replicated.



(Frederick, Loewenstein, and O'Donoghue, 2002) Figure 1a: Discount Factor as a Function of Time Horizon (all studies)

People's time preferences (predictably) change over time.

Asking today:

- Do you prefer $50 today or $60 tomorrow?
- Do you prefer $50 in 30 days or $60 in 31 days?

Asking in 30 days:

- Do you prefer $50 today or $60 tomorrow?
- Do you prefer $50 in 30 days or $60 in 31 days?

The **quasi-hyperbolic discount function** as in Phelps and Pollak (1968), O'Donoghue and Rabin (1999), and Laibson (1997):

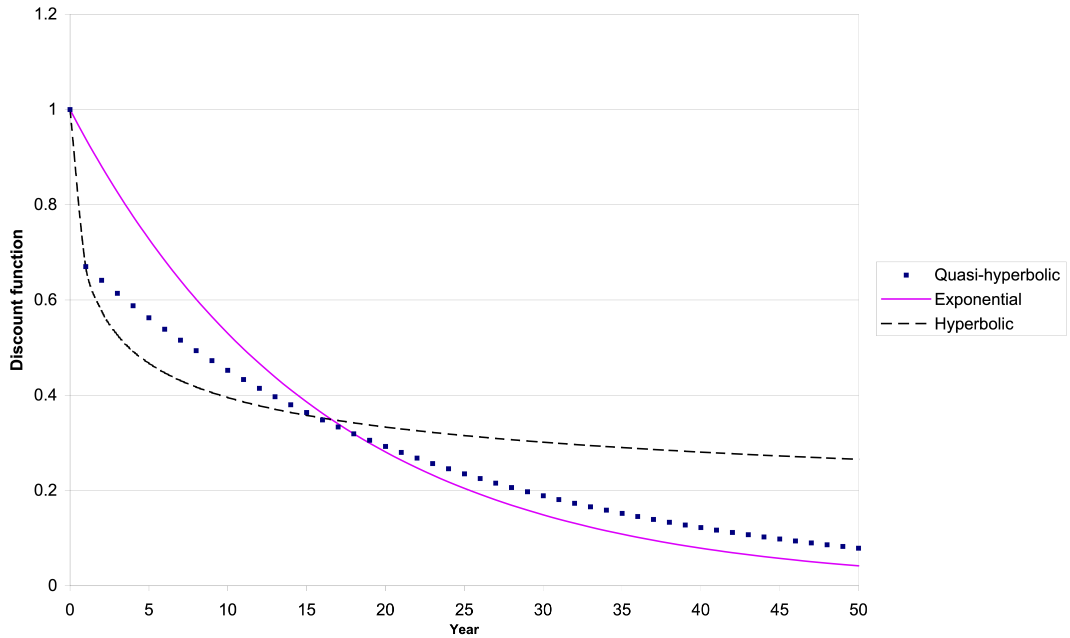
$$D(\tau) = \begin{cases} 1 & \text{if } \tau = 0 \\ \beta \cdot \delta^{\tau} & \text{if } \tau \in \{1, 2, \ldots\} \end{cases}$$

where $\beta \leq 1$

- We can then write the utility function as:

$$U^t = u_t + \beta \sum_{\tau=1}^{T-t} \delta^{\tau} u_{t+\tau}$$

Visualizing Discount Functions



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

Comparison of exponential, hyperbolic, and quasi-hyperbolic discount functions; from Angeletos, Laibson, Repetto, Tobacman, and Weinberg (2001a).

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

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

Relative to present period, all future periods worth less (weight 1/2).

- All discounting takes place between the present and the immediate future.
- In the *long-run*, we are relatively patient: utils in a year are just as valuable as utils in two years.

$\Rightarrow$ Decisions are sensitive to the timing of benefits and costs.

Leisure goods: immediate rewards with delayed costs.

Eating candy

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

Planning not to eat candy next week:

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

...but eating candy today:

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

$\Rightarrow$ Over-consume leisure goods relative to long-run plans

Investment goods: immediate costs with delayed rewards.

Going to the gym

- Immediate effort costs $C_{\text{EFFORT}} = 2$
- Delayed health benefits $B_{\text{HEALTH}} = 3$
- (Continue with $\beta = 1/2$ and $\delta = 1$).

Planning to go to the gym next week:

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

...but not going going today:

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

$\Rightarrow$ Under-consume investment goods relative to long-run plans

Might a person with present bias:

- Build up $5,000 of debt on a credit card at 20% interest? **Yes.**
- Take out a home equity loan at 5% interest requiring three hours of paperwork and a two-week processing delay? **I'll do it next week.**
- Take out a home equity loan at 10% interest, *pre-approved with no paperwork required*? **Yes.**
- Buy a new car, making $4,000 down-payment? **No thanks.**
- Buy a new car, without a down-payment? **Ooh.**

Doing it Now or Later

(*Courtesy of Matthew Rabin*) Suppose there is a task that you must complete on one of the next four days.

To complete this task, you incur costs as follows:

- If you complete the task in period 1, the cost is 3.
- If you complete the task in period 2, the cost is 5.
- If you complete the task in period 3, the cost is 8.
- If you complete the task in period 4, the cost is 13.

Suppose there is no reward, that you value costs linearly, and that you have $\beta = 1/2$ and $\delta = 1$.

The Importance of Awareness

A critical issue: Are you aware of your future self-control problems (or your future present bias)?

Note that your period-1 preferences are:

$$(\text{period } 2) \succ (\text{period } 1) \succ (\text{period } 3)$$

while your period-2 preferences are:

$$(\text{period } 3) \succ (\text{period } 2).$$

If you were asked to commit yourself in period 1, you'd commit yourself to do the task in period 2.

Suppose instead that in period 1 you only choose whether or not to do the task then. Then your choice will depend on what you expect to do in period 2 (if you were to wait).

Two extreme assumptions about people's awareness of their own future self-control problems:

Sophisticates are *fully aware* of their future self-control problems and thus correctly predict future behavior. To solve for sophisticates:

- Treat each period-self as a separate agent, and solve for the subgame-perfect Nash equilibrium to the game played between these agents (using backward induction).
- Sophisticates always stick to their plans.

Naifs are *fully unaware* of their future self-control problems and thus expect to behave in future exactly as they currently would like themselves to behave in future. To solve for naifs:

- Each period, derive the optimal lifetime path, and follow this period's component. But when next period arrives, reassess this plan.
- **Obviously:** Naifs may not stick to their plans.

(also known as Fibonacci's Fine Arts Cinema; thanks Matthew).

- Week 1: mediocre movie, 3 utils
- Week 2: good movie, 5 utils.
- Week 3: great movie, 8 utils.
- Week 4: **Moonfall** (obviously the best movie ever), 13 utils.

Assume $\delta = 1, \beta = \frac{1}{2}$.

Suppose you must miss one movie, and thus get 0 utils that day.

Your (cinematic) life choices are $(u_1, u_2, u_3, u_4) =$.

-Choose $(0, 5, 8, 13)$ or $(3, 0, 8, 13)$ or $(3, 5, 0, 13)$ or $(3, 5, 8, 0)$.

Rules: You cannot commit to which movie to miss. You must decide incrementally each week whether to see that movie or skip it. (This assumption **matters**.)

What movie should you miss?

What movie *will* you miss?

Doing it Now or Later

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Have to consider two cases: naive vs sophisticated decision-maker.

Case 1: What will a sophisticate do?

- Because $\mathbf{8 + \frac{1}{2}0 > 0 + \frac{1}{2}13,}$ the sophisticate won't skip Week 3.
- Because $\mathbf{0 + \frac{1}{2}(8 + 13) > 5 + \frac{1}{2}(8 + 0),}$ the sophisticate *will* skip Week 2 (if she has not already skipped Week 1).
- Because $\mathbf{3 + \frac{1}{2}(0 + 8 + 13) > 0 + \frac{1}{2}(5 + 8 + 13),}$ the sophisticate *won't*\ skip Week 1.

Case 2: What will a naif do?

- Because $\mathbf{3 + \frac{1}{2}(0 + 8 + 13) > 0 + \frac{1}{2}(5 + 8 + 13),}$ won't skip Week 1.
- Because $\mathbf{5 + \frac{1}{2}(0 + 13) > 0 + \frac{1}{2}(8 + 13),}$ won't skip Week 2.
- Because $\mathbf{8 + \frac{1}{2}0 > 0 + \frac{1}{2}13,}$ the naif won't skip Week 3.

Note that even given $\beta = \frac{1}{2}$, all four selves agree that missing the moon literally fall into the earth is a bad thing to happen. Yet the naif does so.

Calibrational exercise: Let us see what we would infer from the observed behavior if we were an anachronistic economist who believed in $\boldsymbol{\beta = 1}$.

An exponential discounter would have to have a **weekly** discount factor $\tilde{\delta} \leq Min[\sqrt[3]{\frac{3}{13}}, \sqrt[2]{\frac{5}{13}}, \frac{8}{13}] \approx .61$ to be willing to miss that gem of a film.

	Letting $\beta < 1$	**Insisting $\beta = 1$**
Week 1 weight on u_2 vs. u_1	$.61$	$.61$
Week 1 weight on u_4 vs. u_1	$.61$	$.23$

Procrastination: Doing It . . . Tomorrow

Procrastination involves the *immediate gratification* of not doing something optimally onerous

- Often the main "cost" of doing some beneficial task is primarily the opportunity cost of doing something gratifying.
- Procrastination is in fact a wonderful vice: You can, **and ideally should** do it concurrently with other vices!
- Note: quitting smoking, etc. qualitatively similar to procrastination.

But what *is* it?

- Not just delaying unpleasant tasks, which is often right thing to do.
- It is delaying beyond when you yourself want to complete them.

Suppose that, with 120 minutes of effort today, you could reduce the effort by 10 minutes needed to undertake a task every day for rest of your life.

E.g., learn some short cuts or tricks with your word-processing package, or "fix" some annoying problem in the current user set-up.

- So, within 2 weeks, you will on net save time. In a year, 58 hours, and in a decade, 600 hours.
- Suppose that value of time the same each day. No deadlines, no commitment devices.
- Do you do the task? If so, when?

If do the task today your intertemporal well-being is:

$$U^t = -120 + \beta\delta \cdot 10 + \beta\delta^2 \cdot 10 + \beta\delta^3 \cdot 10 + \ldots$$
$$= -120 + \beta\frac{\delta}{1-\delta}10,$$

...relative to the utility of doing nothing.

Suppose time consistent, no taste for immediate gratification.

E.g., $\beta = 1, \delta = .999$. Then:

$$U^t(\text{fix today}) = -120 + \frac{.999}{1-.999}10 = 9,870.$$

$$U^t(\text{fix tomorrow}) = .999(-120 + \frac{.999}{1-.999}10) = 9,861$$

$$U^t(\text{fix next day}) = .999^2(-120 + \frac{.999}{1-.999}10) = 9,852$$

...and so on

$$U^t(\text{never}) = 0$$

So: Person will do it right away.

The Fundamental Theorem of Time-Consistent Task-Assessment in Stationary Environments:

- $U^t(today) \succ$
- $U^t(tomorrow) \succ$
- $\ldots \succ$
- $U^t(never)$

or

- $U^t(never) \succ$
- $\ldots \succ$
- $U^t(tomorrow) \succ$
- $U^t(today)$.

This is the combination we are interested in:

- $U^t(today) \succ U^t(never)$, but $U^t(tomorrow) \succ U^t(today)$.

This would never happen for a time-consistent person, by the FT-TC-TASE.

- In a stochastic or non-stationary environment, could be that a TC person happens to not want to do it today
- But the systematic congruence of these two inequalities is the feature of interest for present bias.

If a task is worth doing, it is worth doing right away.

- Day-to-day variation in opportunity cost, etc., then there may be particular reason to do tomorrow than today
- or today rather than tomorrow.
- But no systematic tendency to put off tasks.

Suppose some taste for immediate gratification (present bias).

E.g., $\beta = .9, \delta = .999.$

$$U^t(today) = -120 + .9\frac{.999}{1-.999}10 = 8,871$$

(And of course, $U^t(never) = 0$)

So even with a taste for immediate gratification:

- Feels to you like you are saving about 150 hours in the future with the two hours today.
- Indeed, you would prefer doing the task today to never doing it even if it would take you 24 hours, not just 2 hours.

So...

- Do you do the task?
- If so, when?

If your choices were Today vs. Never, then you'd **obviously do it today**.

- But you could also plan to do the task tomorrow:

$$U^t(tomorrow) = .9 \cdot .999(-120 + \frac{.999}{1 - .999}10) = 8,874$$

You'd prefer to learn tomorrow rather than today.

What does the agent do **as a function of their beliefs about themselves?**

In a related context, O'Donoghue and Rabin (2001) introduce a formal model of *partial naivete*

- Since β captures the magnitude of the person's self-control problem, we can think of the person as having a perception $\hat{\beta}$ of future self-control problems

1. Sophisticates have $\hat{\beta} = \beta$
2. Naifs have $\hat{\beta} = 1$
3. Partial naifs have $\hat{\beta} \in (\beta, 1)$

- As before, the solution concept: subgame perfect equilibrium, assuming that all future selves behave with $\hat{\beta}$, while current self uses β.

Another "Theorem"

Severe procrastination for "one-shot" tasks requires some naivety.

Why? Intuitions?

Simple style of rationality argument in economics.

- Sophisticates predict their future behavior correctly, and always have one simple action available to them ... doing the action now.
- That means their utility from their now perspective is bounded below by the utility of doing it right away.

A Calibration Exercise

As before, let's explore a mispecification/calibration exercise:

- A **deltoid** will never do task only if $-120 + \frac{\delta}{1-\delta}10 \leq 0,$ so she would choose the action *never do the task* only if $\delta \leq \frac{12}{13} \Rightarrow \delta^{365} \leq .000000000002.$

Hence, to reconcile behavior with the exponential model if we are confident in our assessment of the disutilities of effort, we would need a yearly $\tilde{\delta} \leq (\frac{12}{13})^{365} = .000000000002.$

By contrast, we're explaining this with very modest (first-)yearly discounting.

Of course, effort costs probably increasing rather than linear.

- And we shouldn't assume we know utility function when inferring discount factors.

Principle: continue to take the exercise seriously.

Suppose we didn't know $\widetilde{\mu} = \frac{u(\textbf{120 minutes})}{u(\textbf{10 minutes})}$.

Exercise: What locus of $(\tilde{\delta}, \widetilde{\mu})$ would explain avoiding 2 hours of effort immediately to save 10 minutes every day rest of your life?

- This is (a little) challenging, but worth exploring for "fun". Impress your friends and neighbors!

"New" Example

Consider $\beta = .9, \delta = .999$ naif again. But now:

- Suppose that the only choice available is a "quick fix": 1 minute of effort today $\implies 9\frac{1}{2}$ minutes saved each day forever.
- Would she do this? If so, when?

$$U^t(today) = -1 + .9\frac{.999}{1-.999}9.5 = 8540$$

$$U^t(tomorrow) = .9 \cdot .999(-1 + \frac{.999}{1-.999}9.5) = 8532$$

Now suppose **both** the 120/10 task and 1/9.5 task are available.

Assume could do both sequentially, but don't save time on days when fixing.

The naif will compare her four choices:

- $U^t(\text{quick fix today}) = 8540$
- $U^t(\text{quick fix tomorrow}) = 8532$
- $U^t(\text{full fix today}) = 8871$
- $U^t(\text{full fix tomorrow}) = 8874$

So she'll perpetually **plan** to do the full fix tomorrow. And meanwhile she will **never do either of them**.

The unfortunate guiding credo of the naif:

If you are going to do something, do it right . . . tomorrow.

Somebody who is unwilling to take 120 minutes of effort to save 10 minutes *or* to take 1 minute of effort to save 9$\frac{1}{2}$ minutes every day for the rest of her life seems, **interpreted through the lens of exponential discounting**, as if she is discounting at rate of

$$\tilde{\delta}_{\text{yearly}} < .0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000000\ 0000000001.$$

Acknowledging the possibility that $\beta < 1, \hat{\beta} > \beta$ reconciles such behavior to reasonable long-term patience.

Cumulative Procrastination

Suppose you *must* read 30 pages in 30 days. That is, $\sum_{t=1}^{30} p_t \geq 30$. If you spend h_t hours reading on day t, then $u_t = -h_t$, and get $p_t = \sqrt{h_t}$ pages read.

Key feature: It is more efficient to spread out work regularly rather than doing it all in the space of a few days.

- (Other models with this qualitative feature would yield similar results.)

Obvious solution for deltoid If $\delta = \beta = \widehat{\beta} = 1$, $p_t = h_t = 1$ for all t.

Consider *April Mae*: $\delta = \widehat{\beta} = 1, \beta = \frac{1}{2}$.

Day 1: April Mae will $Max_{h_1} U^1 \equiv -h_1 + \frac{1}{2}\left[-29\left(\frac{30-\sqrt{h_1}}{29}\right)^2\right]$. If she reads h_1 hours on Day 1, she'll need to read $\frac{30-\sqrt{h_1}}{29}$ pages each remaining day, spending $\left(\frac{30-\sqrt{h_1}}{29}\right)^2$ hours each day.

So on Day 1, April Mae reads for 15$\frac{1}{2}$ minutes (planning to read 62 minutes each of the remaining 29 days). That is, she is planning to increase future h by 58 minutes to decrease h today by 45 minutes.

Day 2: Day 2: $Max_{h_2} U^2 \equiv -h_2 + \frac{1}{2}\left[-28\left(\frac{29.5-\sqrt{h_2}}{28}\right)^2\right]$. That is, on Day 2: April Mae reads for 16 minutes (and plans to read 64 minutes each day from now on).

April is the Cruelest Month

Day 3: ...reads 17 minutes ... (and plans for 67 minutes each remaining day).

Day 10: ... 22 minutes (and ... 90 minutes ...).

With a week left: Has read 16 pages in 11 hours.

Day 24: 72 minutes (and ... more than 4 hours ...).

Day 30: April Mae reads for 23$\frac{3}{4}$ hours.

Is the previous example misleading?

Put another way: Present bias leads us to do things last minute. In line with procrastination, people often complete tasks last minute. For example:

- Parking tickets (Heffetz et al., 2016); health care plan choice (Brown and Previtero, 2018); taxes (Martinez et al., 2017); patent officers' fillings (Frakes and Wasserman, 2016)

A natural idea: if task completion is driven by the tendency to procrastinate, use data on task completion to identify time preference.

"Common wisdom" (as n Frakes and Wasserman, 2016): observed bunching at the deadline is evidence of time-inconsistency.

Implicit argument: inconsistent with $\delta \approx 1$.

Suppose an analyst observes a sequence of actions over a month. Can the analyst conclude with any confidence that the person suffers (naive) present bias?

Think of *preparing your taxes* or *paying a parking ticket*.

-The agent needs to complete the task before the deadline T.

-If she did not complete the task by the end of period T, the agent gets a penalty of $\frac{y}{(\beta\delta)} \leq 0$ in period $T+1$

- So y is the period-T continuation value when not having done the task.

In every period $t \leq T$, the instantaneous utility of completing the task is drawn independently from a given payoff distribution F.

- Think of this as the instantaneous benefit of completing the task net of opportunity costs.
- Assume F is known to the agent.
- Instantaneous utility of not doing the task is normalized to zero.

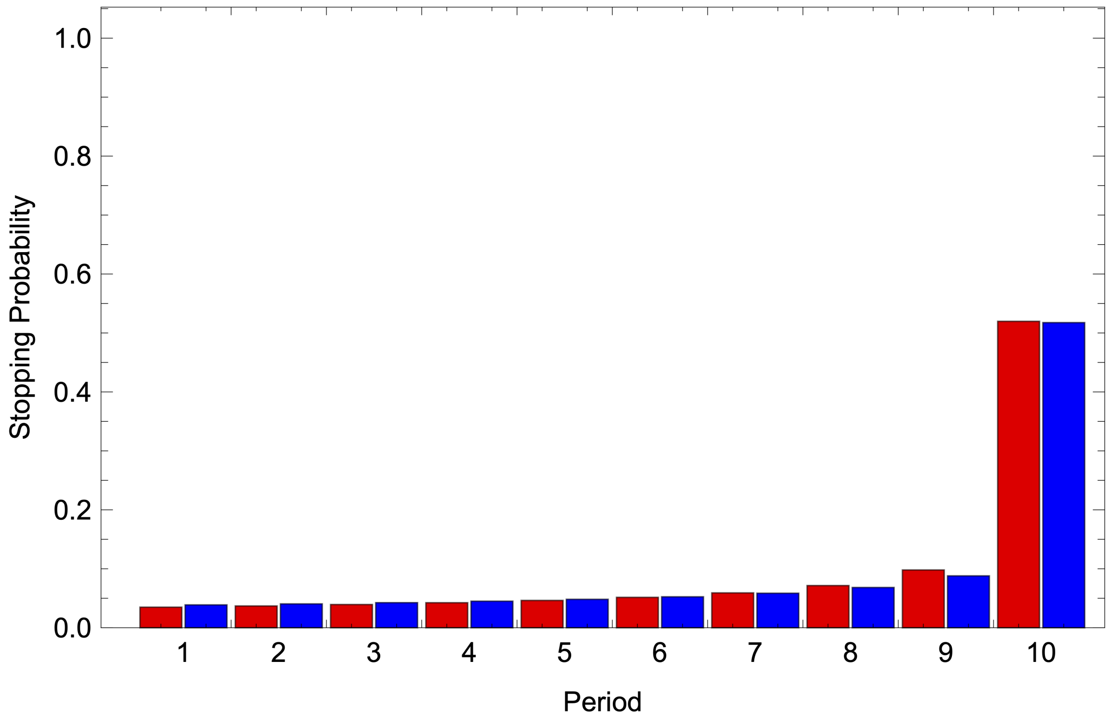
The analyst can observe agent's stopping probabilities at every point in time.

Either observes infinitely many homogeneous agents,

- or the same agent infinitely many times.
- Obviously homogeneity facilitates identifying time preferences.

It is known that opportunity costs are drawn independently from a given stationary distribution.

- (Otherwise can rationalize any data by assuming cost are either one or zero, with the probability that they are zero being equal to a period's stopping probability.)
- Stationarity is a natural starting point.



Red bar plot: time-consistent agent with log-normally distributed cost (μ=1$ and variance $\eta = 1$)

Blue bar plot: sophisticated time-inconsistent agent with $\beta = 0.7$ and parameters $\mu = 0, \eta = 2.3$.

Punchline: Caution.

from Heidhues and Strack (2021)

Despite strong stationary, homogeneity, and observability assumptions, and restriction to quasi-hyperbolic discounting:

Both, the degree of present bias as well as the discount factor are, **for any data set of stopping times** not identifiable.

- Importantly, present bias parameter is unidentified even when fixing the long-run discount factor.
- *Naivite* vs *sophistication* are also not identifiable.
- With a stationary net-benefit distribution, a hyperbolic discounter never sets an earlier deadline.

Coming Soon

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Next time: real evidence of present bias.

Please read:

1. DellaVigna and Malmendier (2006): "Paying Not To Go To the Gym" and
2. Kaur, Kremer, and Mullainathan (2015): "Self-Control at Work"