

Econ 311: Behavioral and Experimental Economics

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Putting the Theory to Work: Procrastination

Procrastination

- ▶ In many economic problems, agent must do a task
 - ▶ Task needs to be done exactly once
 - ▶ Agent Has several time periods to do task
- ▶ To analyze these types of decisions, use *backwards induction*: start analysis at the end of the process and work back to the first period
 - ▶ *Naive* agent is time inconsistent, but assumes self will be time-consistent in future
 - ▶ *Sophisticated* agent is time inconsistent, and knows self will be time-inconsistent in future

Procrastination Example: Setup

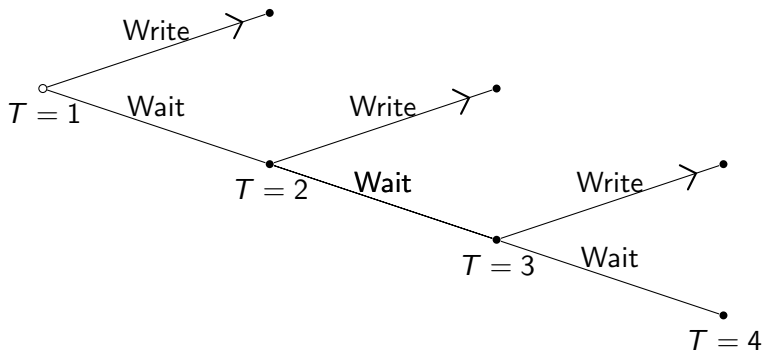
- ▶ Suppose student has a paper due in 4 weeks
- ▶ Can write the paper on weekend 1, 2, 3, or 4
- ▶ Cost of writing paper is missing going to movies with friends:
 - ▶ Weekend 1: bad movie, cost = 3
 - ▶ Weekend 2: OK movie, cost = 5
 - ▶ Weekend 3: good movie, cost = 8
 - ▶ Weekend 4: great movie, cost = 13
- ▶ Benefit of writing the paper is $\bar{v} > 0$, received in week 5 when grades are given
- ▶ For all types of agents, assume $\delta = 1$ in what follows
- ▶ For time-inconsistent types, assume $\beta = \frac{1}{2}$

When Does Time-Consistent Agent Write Paper?

- ▶ Proceed by *backwards induction*: start analysis at the end of the process and work back to the first period
- ▶ Week 4:
 - ▶ Have to do the paper at this point, so no real choice to be made
- ▶ Week 3:
 - ▶ If do paper, utility is $\bar{v} - 8$
 - ▶ If wait till next week, utility is $\bar{v} - 13$
 - ▶ So, will do paper in week 3 (if not done already)
- ▶ Week 2:
 - ▶ If do paper, utility is $\bar{v} - 5$
 - ▶ If don't write paper, know will write next week for utility $\bar{v} - 8$
 - ▶ So, will do paper in week 2 (if not done already)
- ▶ Week 1:
 - ▶ If do paper, utility is $\bar{v} - 3$
 - ▶ If don't write paper, know will write next week for utility $\bar{v} - 5$
 - ▶ So, will do paper in week 1

Decision Tree

- ▶ Can be helpful to keep track of decisions of agent with a decision tree:



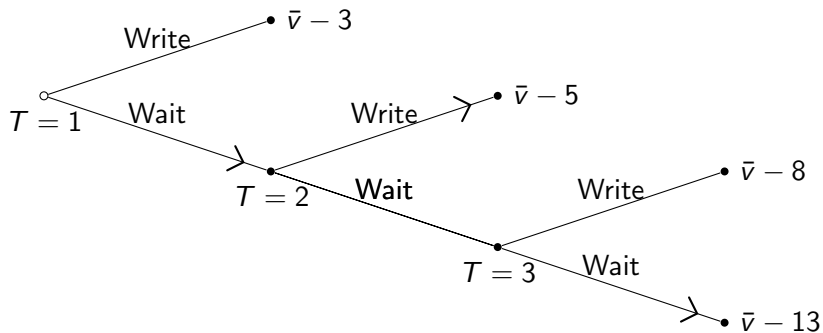
When Does Sophisticated Time-Inconsistent Agent Write Paper?

- ▶ *Sophisticated* agent is time inconsistent, and knows will be time-inconsistent in future
- ▶ Week 4:
 - ▶ Have to do the paper at this point, so no real choice to be made
- ▶ Week 3:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 8$
 - ▶ If wait till next week, utility is $\frac{1}{2}\bar{v} - \frac{1}{2}13 = \frac{1}{2}\bar{v} - 6.5$
 - ▶ So, will choose NOT to do paper in week 3
- ▶ Week 2:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 5$
 - ▶ If don't write paper:
 - ▶ Remember, knows future self is time-inconsistent
 - ▶ So, thinks (correctly) that will NOT do paper in week 3
 - ▶ From perspective of week 2, utility of waiting is $\frac{1}{2}\bar{v} - 6.5$
 - ▶ So, will choose to DO paper in week 2

Sophisticated Time-Inconsistent Agent, con't

- ▶ Week 1:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 3$
 - ▶ If don't write paper:
 - ▶ Remember, knows future self is time-inconsistent
 - ▶ So, thinks (correct) that will do paper in week 2
 - ▶ From perspective of week 1, utility of waiting is $\frac{1}{2}\bar{v} - \frac{1}{2}5 = \frac{1}{2}\bar{v} - 2.5$
 - ▶ So, will choose NOT to do paper in week 1
- ▶ Overall result: waits until week 2 to do paper, meaning agent misses OK movie

Decision Tree for Sophisticated Agent



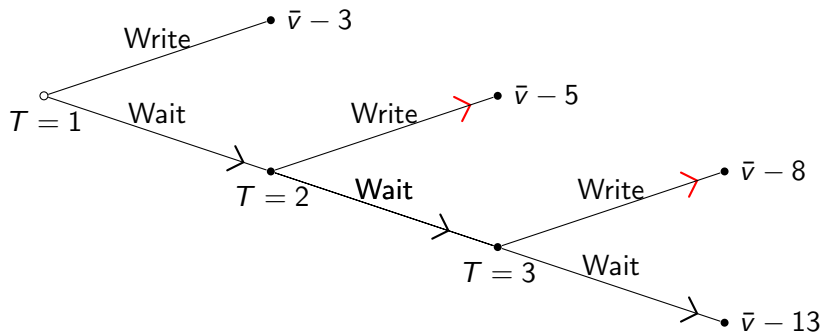
When Does Naive Time-Inconsistent Agent Write Paper?

- ▶ *Naive* agent is time inconsistent, but incorrectly assumes will they be time-consistent in future
- ▶ Week 4:
 - ▶ Have to do the paper at this point, so no real choice to be made
- ▶ Week 3:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 8$
 - ▶ If wait till next week, utility is $\frac{1}{2}\bar{v} - \frac{1}{2}13 = \frac{1}{2}\bar{v} - 6.5$
 - ▶ So, will choose NOT to do paper in week 3
- ▶ Week 2:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 5$
 - ▶ If don't write paper:
 - ▶ Remember, thinks future self is time-consistent
 - ▶ So, thinks (incorrectly!) that will do paper in week 3
 - ▶ From perspective of week 2, utility of waiting is $\frac{1}{2}\bar{v} - \frac{1}{2}8 = \frac{1}{2}\bar{v} - 4$
 - ▶ So, will choose NOT to do paper in week 2

Naive Time-Inconsistent Agent, con't

- ▶ Week 1:
 - ▶ If do paper, utility is $\frac{1}{2}\bar{v} - 3$
 - ▶ If don't write paper:
 - ▶ Remember, thinks future self is time-consistent
 - ▶ So, thinks (incorrectly!) that will do paper in week 2
 - ▶ From perspective of week 1, utility of waiting is $\frac{1}{2}\bar{v} - \frac{1}{2}5 = \frac{1}{2}\bar{v} - 2.5$
 - ▶ So, will choose NOT to do paper in week 1
- ▶ Overall result: waits until week 4 to do paper, meaning agent misses best movies

Decision Tree for Naive Agent



Measuring Time Preferences

The Marshmallow Test: Mischel et al (1989)

- ▶ 35 preschoolers in lab, each given one marshmallow
- ▶ Told that if they can wait 15 minutes without eating marshmallow, they can get another one
- ▶ Measure how long they wait before eating marshmallow
- ▶ 12 years later, those students take the SAT
- ▶ Results:
 - ▶ Waiting time strongly positively correlated with SAT math and verbal scores
 - ▶ Waiting for 5 more minutes predict 40 points higher SAT math score

Measuring Time Preferences

- ▶ So far, evidence we have seen has not attempted to estimate either aggregate or individual time preference parameters (eg β or δ)
- ▶ General strategy in economics experiments
 - ▶ Focus on tradeoffs two time periods, say t and $t + k$
 - ▶ Try to find point where $u(c_t) = \beta^{\mathbb{I}_{t>0}} \delta^k u(c_{t+k})$
 - ▶ By varying t , allows us to estimate β and δ separately
- ▶ Several experimental methods to go about doing this
 - ▶ Willingness to pay: *State the lowest amount you'd be willing to accept today instead of \$X in one month*
 - ▶ Matching: *I am indifferent between \$__ today and \$X in one month*
 - ▶ Multiple Price Lists: *Indicate which one you prefer: \$X today or \$Y in one month*

Details on Multiple Price List Methodology

- ▶ Most commonly used experimental method
- ▶ Choices between a smaller, sooner reward and a later, larger reward
- ▶ Typically one option stays fixed while the other varies
- ▶ Point at which subject switches from smaller/sooner reward to larger/later reward helps estimate their time preference parameters

Example Multiple Price List (MPL)

List 1		
Choice	Option A	Option B
1	\$100 today	\$99 in one month
2	\$100 today	\$101 in one month
3	\$100 today	\$103 in one month

List 2		
Choice	Option A	Option B
1	\$100 in one month	\$99 in two months
2	\$100 in one month	\$101 in two months
3	\$100 in one month	\$103 in two months

Measuring $\beta - \delta$ Preferences with MPL

- ▶ Assume for simplicity that $u(x) = x$
- ▶ Suppose you say that you are indifferent between \$100 in one month and \$Y in two months
- ▶ Then we must have $\beta\delta 100 = \beta\delta^2 Y$, which implies:

$$\delta = \frac{100}{Y}$$

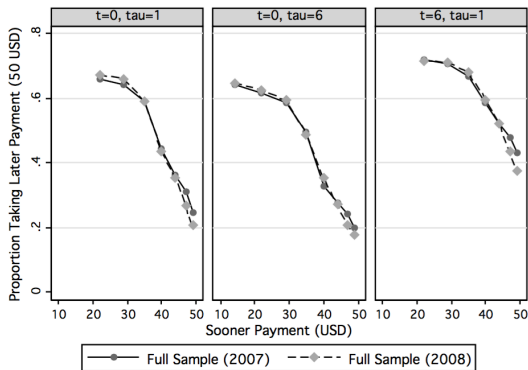
- ▶ Suppose additionally you are indifferent between \$100 today and \$X in one month
- ▶ Then we must have $100 = \beta\delta X$
- ▶ Together with the equation for δ above, this implies:

$$\beta = \frac{Y}{X}$$

Field Evidence: Meier and Sprenger (2010)

- ▶ Give MPLs to people coming in for tax advice in Boston
- ▶ Did same procedure on same population in two different years: 2007 and 2008
- ▶ 1500 observations, including 200 people who showed up both years
- ▶ Because of setting, had access to income data
- ▶ Results:
 - ▶ Estimates of β between 0.672 and 0.792
 - ▶ Estimates of monthly δ between 0.953 and 0.981
 - ▶ Estimates remarkably stable between years

Meier and Sprenger (2010): Graphical Results



- ▶ t is early period, τ is delay length
- ▶ Note that when early reward is immediate, more likely to take early payment

Inconsistent Estimates in the Whole

- ▶ Frederick et al. (2002): Review of time preference literature
- ▶ Large variation in estimates of β from the literature as a whole

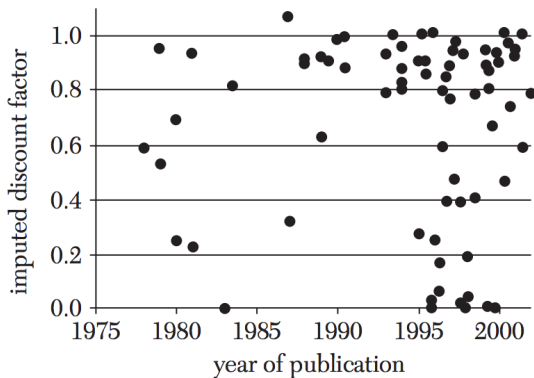


Figure 2. Discount Factor by Year of Study Publication

Potential Problems with the Standard MPL Approach

- ▶ Linearity assumption allows us to get simple formulas for parameters
 - ▶ If $u(x)$ concave, then estimates are biased
- ▶ Have assumed that transaction costs are same in all time periods
- ▶ Note we are trading off money, so subjects with access to bank accounts should be able to arbitrage if implicit interest rate in experiment is different than actual interest rate