ECOS3016 Sample Notes

Intertemporal Choice

Hyperbolic Discounting

- People violate time consistency with regularity
- Beta-delta function
    - Utility $U^0(u)$ of a utility stream $u = (u_0, u_1, u_2, \dots)$ from the point of view of $t = 0$ is
        - $U^0(u) = u_0 + \Sigma_{i=1}^{\infty} \beta \delta^i u_i$
    - When $\beta = 1$, an agent who discounts the future hyperbolically will behave exactly like an agent who discounts the future exponentially
    - Outcomes beyond the present time get discounted more than under exponential discounting
        - Exhibiting impulsivity

Choosing Not to Choose

- Fear that buying in bulk may lead to overindulgence
- Issue is approached by drawing a distinction between naïve and sophisticated hyperbolic discounters
    - Self-control problems
        - A DM prefers x to y ahead of time, but y to x when the time arrives
    - Naïve time-inconsistent individuals are unaware of their self-control problems
    - Sophisticates are aware of their self-control problems
        - Make choices based on accurate predictions of future behaviour
- Layaway plans
    - Stores offering to hold onto savings for customers to ensure they don't spend, and can afford more expensive purchases
- Sophisticated consumers may exacerbate their own self-control problems
    - Tend to preproperate
        - Doing something now when it would be better to wait
        - Paradoxically results in situations when naïve individuals are better off than sophisticates

Preferences over Profiles

- Preference for increasing utility profiles
    - When choosing between sequences of events, people will make a point of scheduling the unpleasant experience first and the pleasant one later
    - Could be captured by relaxing the assumption that δ is less than one
        - If $\delta > 1$, a rational discounter will post-pone pleasant events as much as possible
            - Follows that $\rho < 0$, which is a negative time preference
        - Awkward solution, as it means that people will exhibit the same preferences in other contexts
- Preference for spread
    - People like to distribute multiple desirable events over time
- Preference for variation
    - Avoid choosing to consume the same good over and over again
- Preference over profiles
    - Individuals care about the shape of the utility stream as well as about individual utilities

- Peak-end rule
  - Used to asses the desirability of utility streams or ‘episodes’
  - People consciously or unconsciously rank utility streams based on the average of the peak (the maximum utility) and the end (the utility near the end) and choose accordingly
  - Shape of the utility profile will be critically important
  - Entails duration neglect
    - Meaning that the length of an episode will be relatively unimportant
      - Contrary to exponential and hyperbolic discounting models

Misprediction and Miswanting
- Underprediciton of adaptation
  - People fail to appreciate the extent to which they will adapt to new conditions, such as a new endowment
  - People are unable to predict, ahead of time, just how attached they will be to an object after it has been incorporated in their endowment and loss aversion kicks in
  - Explains a no-questions-asked return policy
- Diversification bias
  - People overestimate the degree to which their future selves will enjoy variety over time
- Projection bias
  - People project their current preferences onto their future selves
- Hot-cold empathy gaps
  - Inability when in a ‘hot’ emotional state to empathise with people when in a ‘cold’ state and vice versa
  - When we are in a ‘hot’ state (experiencing hunger, thirst, anger, embarrassment or sexual arousal) we tend to underestimate how different our preferences are when we are in a cold state, and the other way around
- Miswanting
  - A mismatch between what we want because we think that we will like it when we get it and what we in fact like when we get it
  - Impact bias
    - Tendency to overestimate the enduring impact of future events on our emotional lives
    - Driven in part by underprediction of adaptation
      - Adapt to changing conditions to a much greater degree, and sooner, than they anticipate
    - Focussing illusion
      - Tendency for whatever you are attending to seem more important than it is

Applications
- Implications of $\beta - \delta$ preferences
  - O’Donoghue and Rabin (1999)
    - An agent will decide at $t = 1$ whether or not to undertake an activity that has a once-off benefit (v) and a one-off cost (c)
    - Immediate costs/investment good
      - Cost is incurred immediately at time of decision ($t = 1$)
      - Benefit v is enjoyed after a delay of one period ($t = 2$)
    - Immediate rewards/leisure good
      - Benefit is enjoyed immediately at time of decision

            - Cost is incurred after a delay of one period
        - If she does not do it, her outside option is 0 in both periods
        - Ex-ante optimality (desired behaviour)
            - From the perspective of $t = 0$ it would be desirable to undertake the activity at $t = 1$ if
                - Immediate costs
                    - $\beta[-\delta c + \delta^2 v] \geq 0$
                    - Then $\delta v \geq c$
                - Immediate rewards
                    - $\beta[\delta v = \delta^2 c] \geq 0$
                    - Then $v \geq \delta c$
            - At $t = 0$, benefits and costs are both in the future, so both are affected equally by β which cancels out of the comparison
            - At $t = 1$, a time-consistent decision-maker ($\beta = 1$) would behave according to these rules
        - Actual behaviour
            - If she has a self-control problem ($\beta < 1$), then at $t = 1$ she chooses to actually undertake the activity if
                - Immediate costs
                    - $-c + \beta\delta v \geq 0$
                    - Then $\beta\delta v \geq c$
                    - Thus she undertakes too little of investment activities, because she discounts delayed reward more heavily than a time-consistent decision-maker does
                - Immediate rewards
                    - $v - \beta\delta c \geq 0$
                    - Then $v \geq \beta\delta c$
                    - Thus she undertakes too much of leisure activities, because she discounts delayed cost more heavily than a time-consistent decision-maker does
            - Consider the agent's expectations of her future behaviour, by letting b be her belief regarding the severity of her present bias
                - If $\beta = b < 1$, she is fully aware of her self-control problem
                    - Fully sophisticated
                - If $\beta < b = 1$ she is unaware she has a self-control problem
                    - Believes she will make future decision in a time-consistent manner
                    - Fully naïve
                - If $\beta < b < 1$ she is aware she has a self-control problem, but underestimates how bad it is
                    - Partially naïve
    - Example
        - Cinema offers a mediocre movie ($v = 3$) in week 1, a good movie ($v = 5$) in week 2, a great movie ($v = 8$) in week 3 and a Jonny Depp movie ($v = 13$) in week 4

- Have an essay due in four weeks, and need to miss one of the movies
- Assume that $\delta = 1$ and $\beta = \frac{1}{2}$ and the benefit is the same regardless of which movie you miss

▪ For a time-consistent DM with $\beta = 1$, it is clearly least costly to miss the mediocre movie
  - She will write the essay in week 1

▪ For a present-biased DM with $\beta = 1/2$, the perceived cost of doing is later is discounted by $\frac{1}{2}$, making it tempting to delay
  - Costs of delaying writing essay when viewed from today (measured at different points)

		Skip movie in week			
		1	2	3	4
	1	-3	$-\frac{1}{2}5$	$-\frac{1}{2}8$	$-\frac{1}{2}13$
Discounted cost	2		-5	$-\frac{1}{2}8$	$-\frac{1}{2}13$
viewed from week	3			-8	$-\frac{1}{2}13$
	4				-13

▪ If fully naïve, she behaves myopically in each period, assuming that her future self has the same preferences as her present self
  - If she does not do it today, she believes she will do it at the time that is best, viewed through her current preferences
  - In week 1, she prefers to write the essay at 2 because $3 > \frac{1}{2}5$
    - However in week 2, she prefers to do it in week 3 because $5 > \frac{1}{2}8$
    - At week 4 she has no choice but to write the essay, tragically missing the Depp movie
  - This is naïve because her expectations of her own future behaviour are proven wrong

▪ If fully sophisticated, she chooses according ot her current preferences, but correctly anticipates whether she would do the task at each future period, assuming she has not already done it
  - Realises that she plays a psychological game against her future selves, and the game is solved by backward induction
    - If not already done, she will do it at 4 when she has no choice
    - Knowing this, she would not do it in week 3 because $8 > \frac{1}{2}13$
    - At 2 she correctly anticipates that if she does not do it now, it will not get done until 4
      - Knowing this she would do it at 2, given that $5 > \frac{1}{2}13$
      - Knowing this, she would not do it in week 1 because $3 > \frac{1}{2}5$
  - Sophisticate completes the task sooner than a naïf but later than a time-consistent DM

▪ Now suppose the schedule is the same as before, but instead of choosing one movie to skip, you can only see one of them
  - Seeing a movie thus has immediate benefits and delayed costs

        - A time consistent DM holds out to week 4

		See movie in week			
		1	2	3	4
	1	3	$\frac{1}{2}5$	$\frac{1}{2}8$	$\frac{1}{2}13$
Discounted benefit	2		5	$\frac{1}{2}8$	$\frac{1}{2}13$
viewed from week	3			8	$\frac{1}{2}13$
	4				13

        - Fully naïve DM
            - Viewed from week 1 it is best to wait for week 4
                - Same in week 2
                - In week 3, the immediate value of the week 3 movie outweighs the delayed value of the one in week 4
                    - Caves into temptation in week 3
            - Naïve belief
                - In weeks 1 and 2 believed that she would indeed wait until week 4 when in reality she did not
        - Fully sophisticated
            - The sophisticate knows that she will cave in in week 3
                - Then, the opportunity cost of seeing the good movie in week 2 is not the week 4 movie, but merely the great movie in week 3
                - Will then give in to temptation in week 2
                    - Same in week 1
            - Thus chooses to see the movie in week 1
    - Sophistication helps to overcome the self-control problem in the case of immediate costs, but actually makes it worse in the case of immediate rewards
        - Knowing about future self-control problems can lead you to give in to them today, because you realise you will give in to them tomorrow
    - Indefinite procrastination – O'Donoghue and Rabin (2001)
        - Extend the model to investment type situations in which
            - There are an indefinite number of periods in which the agent can undertake the task, and she can do it at most once
            - There is a one-off immediate cost c when the task is completed
            - There is an infinite stream of benefits v that are enjoyed in every period, starting one period after the task is completed
                - Present value of this stream is $\frac{\delta v}{1-\delta}$
        - Time consistent
            - Task is worth doing now if:
                - $-c + \frac{\delta v}{1-\delta} \geq 0$
            - For this agent, if it worth doing at all then it is best to do it right away, rather than at any other time in the future
        - If she is present biased

                - $\beta < 1$ distorts her preference between doing it now as opposed to at some other point in future
                - She will only do it now rather than in t periods time if
                    - $-c + \beta\left(\frac{\delta v}{1-\delta}\right) \geq \beta\delta^t\left[-c + \frac{\delta v}{1-\delta}\right]$
                    - $\beta < 1$ imposes a heavier discount on delayed rewards on the left, making it less attractive to do it today
                        - Waiting shrinks the term in square brackets on the right, which makes it desirable to do it soon
                - If she is sophisticated, there is some maximum acceptable t past which she would prefer to simply do it now rather than wait
                    - The more present biased she is, the longer the maximum delay
                - She will invest today rather than wait until t if
                    - $t\sim > \frac{1-\beta}{\beta} \cdot \frac{c}{v}$
                    - This is maximum tolerable delay
                        - It is zero for $\beta = 1$ and goes to infinity as β goes to zero
                        - It is also increasing in the up-front cost, and decreasing in the delayed benefit
            - If the DM is at least partially naïve, $\beta < b < 1$, she believes that her maximum acceptable delay is shorter than it really is
                - She thinks that if she does not do it today, she will get around to it sooner than she actually will
                - This can lead her to continually put off the task, thinking that if she does not do it now she will get around to it soon enough
                    - Could potentially procrastinate indefinitely
        - Present biased but sophisticated DM correctly anticipates how she actually behaves in the future
            - She may use a commitment device that constrains her future actions to be more in line with her ex-ante wishes
                - Idea is to make it costlier to not keep to not keep to the ex ante plan
            - A time-consistent agent would never constrain her own future behaviour in this way
                - In the standard model, it is not possible to make yourself better off by imposing more constraints upon yourself
- Self-imposed deadlines, Ariely and Wertenbroch
    - If she is present-biased and at least partly sophisticated, this could act a commitment device to overcome procrastination
        - However if she is less than fully sophisticated, she might still not set the deadlines optimally
    - Experiment 2
        - Recruited 'native English speakers to held up proofread papers by other students to evaluate writing skills'
        - Generated meaningless essays and introduced grammatical and spelling errors

        - Paid subjects for each error detected, but penalised subjects for each day late
      - Three groups
        - A: Three fixed, evenly spaced deadlines, each seven days
        - B: Self-imposed, binding deadlines, within a 3 week window
        - C: No deadlines – all three texts due after 21 days
      - For maximum flexibility, a time-consistent subject should set all three deadlines for the very last possible date
      - Model predicts performance across treatments as follows
        - Time consistent agent; $B = C > A$
        - Full sophisticate with a self-control problem: $B > A > C$
          - Will set the deadlines optimally
        - For fully naïve agent, $A > B = C$
        - For partially sophisticated agent; $A > B > C$
          - Will not set the deadlines optimally
    - Findings
      - Found that evenly spaced deadlines are better than the deadlines that people put on themselves
        - Even when consumers demand a commitment device, they do not use it optimally
      - However self-imposed deadlines still better than a single, final deadline
- Self-Control at Work, Kaur, Kremer and Mullainathan (2015)
    - Workers are paid by piece rate, in a weekly pay check
      - Work is an acitivty with immediate costs and delayed benefits
    - Commitment contract
      - If the day's output falls below a target X, then the piece rate is halved to $\frac{b}{2}$
      - For given output, this is dominated by the control contract
        - Direct effect of contract makes the worker worse off
      - Indirect effect via incentives
        - Penalty for low output makes it less attractive for the future self to slack off
        - If the effect on effort is big enough, this could make the worker better off in ex ante terms
      - However a worker would only choose this contract if she were sophisticated
    - if piece-rate workers are present-biased, they might work less hard than they themselves would consider ex ante optimal
      - Would also put in less effort when the pay day is distant, and more when it is nearer
      - Sophisticate may use a commitment device to encourage her future self to work harder
    - Design of experiment
      - Data entry firm
      - Workers are randomised to pay day
      - For each work day, each worker is randomised to one of four contract treatments, which they are told of the previous evening
        - Control
          - Fixed piece rate of b for each unit of output

- Target
  - Commitment contract is enforced, with one of three exogenously imposed targets
- Evening choice
  - Worker sets own target on previous evening
- Morning choice
  - Worker sets own target at start of next day

- Results
  - Workers choose nonzero targets on 35% of all opportunities
    - But 16% of workers always set a target of zero
  - Being in a choice treatment increases output by an average of 2% relative to control
  - Workers who show strongest payday effects are more likely targets, set higher targets and achieve larger output gains
  - Effects are persistent over time
  - Payday effects
    - Workers appear to work harder the closer to payday it is
    - Shows present biasedness independent of sophistication

DellaVigna, 'Self-control problems'

- Laboratory experiments
  - Evidence suggests that discounting is steeper in the immediate future than in the further future
    - Induce time inconsistency
- Model
  - Quasi-hyperbolic model
    - $U^0(u) = u_0 + \Sigma_{i=1}^{\infty} \beta \delta^i u_i$
  - O'Donoghue and Rabin (2001) allow the agent to be partially naïve about the future self-control problems
    - Expects in the future period $t + s$ to have the utility function
      - $\hat{U}_{t+s} = u_{t+s} + \hat{\beta}\delta u_{t+s+1} + \hat{\beta}\delta^2 u_{t+s+2} + \cdots$
      - With $\hat{\beta} > \beta$
    - Sophistication when $\hat{\beta} = \beta$
    - Fully naïve when $\hat{\beta} = 1$
  - If the agent could set consumption one period in advance, at $t = 0$, she would consumer if $\beta\delta b_1 + \beta\delta^2 b_2 \geq 0$ or
    - $b_1 + \delta b_2 \geq 0$
      - Where b_1 is a consumption good and b_2 is an investment good
    - However, the agent actually consumes at $t = 1$ if
      - $b_1 + \beta\delta b_2 \geq 0$
      - Therefore consumes too little of the investment good and too much of the leisure consumption good
    - Agent expects to consume:
      - $b_1 + \hat{\beta}\delta b_2 \geq 0$
      - Overestimates the consumption of the investment good and underestimates the consumption of the leisure good
- Exercise
  - DellaVigna and Malmendier (2006)

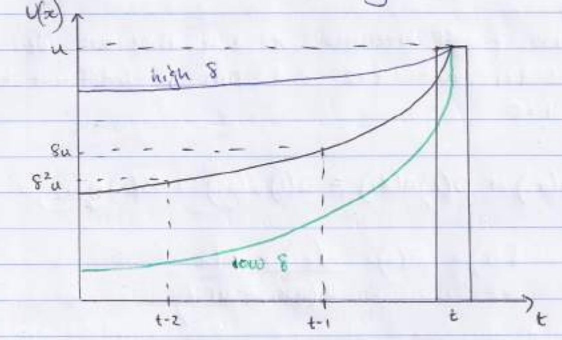
                - Observe attendance at a gym where the monthly fee is $80 per month, and an individual visit is $10
                - Find that the users with a monthly contract attend only 4.4 times per month
                - Model with partially naïve members suggest two explanations for this
                    - Users may be purchasing a commitment devise to exercise more
                    - May be overestimating their future health club attendance
- Homework and deadlines
    - Ariely and Wertenbroch (2002)
        - 51 professionals enrolled in a semester allowed to set their own binding deadlines for homework
        - According to the standard model, they should set deadlines for the last day of the semester
            - No benefit in setting early deadlines as they do not receive feedback
        - 68% of the deadlines are set for weeks prior to the last week
            - Indicates a demand for commitment
    - Ran a follow up experiment with three groups
        - Found that self-set deadlines improve performance over control group
            - Control group do not have any deadlines
        - However, deadline setting is not optimal
            - Group with equal-spaced deadlines does significantly better than the other groups

Beshears, Choi, Harris, laibson, Madrian, Sakong; 'Self Control and Commitment: Can decreasing the liquidity of a savings account increase deposits?'

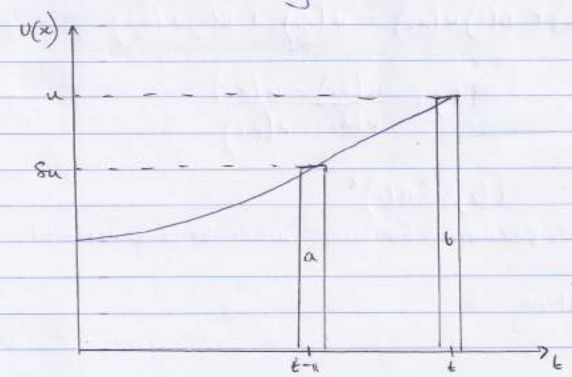
- Participant recruitment
    - Participants selected from the RAND American Life Panel, a panel of adults who are broadly representative of the US adult population
    - No overlap between participants in experiments
- Experiment 1
    - Participants randomly allocated a liquid account that they could withdraw from
        - Earned 22% annual interest rate
    - Also allocated an illiquid account with varying degrees of withdrawals allowed
        - A penalty equal to 10% of the withdrawal
        - A penalty equal to 20% of the withdrawal
        - Withdrawals disallowed altogether
    - Illiquid accounts earned a varying amount of interest
        - 21, 22, 23% interest varied randomly
    - Experiment removed the commitment accounts with 21% interest and 20% penalty and disallowed withdrawals
    - Subjects then had to allocate lots of money of $50, 100 and 500 between the two accounts
        - Randomly chosen as to what they would receive
    - Rational consumer would choose the account the highest rate of interest

            - Would choose commitment account with the earliest possible withdrawal date
- Results of experiment 1
    - Half of initial balances are allocated to the commitment account when it has the same interest rate as the liquid account
        - One quarter of initial balances are allocated to the commitment account when it has a 1% lower interest rate that the liquid account
    - When the commitment account and the liquid account have the same interest rate, stricter commitment accounts are more attractive
    - When the interest rate on the commitment account is higher than the interest rate on the liquid account, the relationship between commitment account allocations and illiquidity disappears
        - Commitment accounts with a 23% interest rate attract approximately 60% of the endowment regardless of their early withdrawal policy
    - Increasing the penalty for withdrawing causes a higher percentage of initial funds to be allocated to the commitment account
    - Failed to find any statistical evidence that suggested that withdrawals varied across each of the accounts
- Experiment two
    - Liquid account paid 22% interest and allowed withdrawals
    - Illiquid accounts also only paid 22% and varied the extend to illiquidity
        - Liquid account, and an account that imposed a 10% penalty on withdrawals
        - Liquid account, and an account that prohibited withdrawals
        - Liquid account, 10% penalty account, prohibition on withdrawals altogether
        - Liquid account, and safety valve account that prohibited withdrawals unless a financial emergency occurred
            - Not verified, so only imposed the psychological cost of lying
    - Participants told to allocate $100 into each account, with a 50% probability they would receive this, or a 50% probability all would go into the liquid account
- Results of experiment 2
    - First combination
        - 10% penalty receives 46% of endowment
    - Second combination
        - No withdrawals receives 54% of endowment
    - Third combination
        - 34% no withdrawals, 16% 10% penalty
        - Total allocations to commitment accounts are not higher when two commitment accounts are available rather than one
    - Fourth allocation
        - Presence of safety valve account not statistically significant
    - Withdrawals
        - The balance ratios (ratio between final and initial endowment) for those in the safety valve condition do not differ when participants receive all of their endowment in a liquid account
            - Substantially lower in the 10% penalty and no early withdrawal conditions

Exponential Discounting



Exponential Discounting With Indifference



Consumer ~~with~~ will be indifferent between a and b

Time Consistency

Consider two payoff streams x & y that are identical except at $t=1$ and $t=2$ and DM is indifferent between them at $t=0$

$$D(1)u(x_1) + D(2)u(x_2) = D(1)u(y_1) + D(2)\cancel{y}u(y_2)$$

$$D(2) = D(1)\,\frac{u(y_1) - u(x_1)}{u(\cancel{y}x_2) - u(y_2)}$$

Then at time 1:

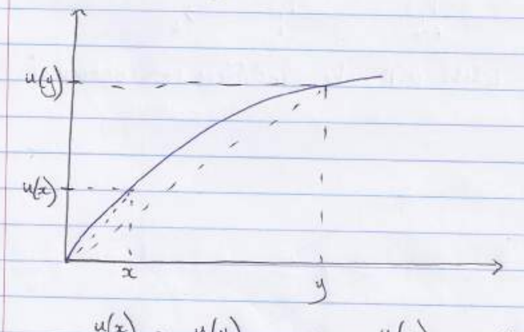
$$u(x_1) + D(1)u(x_2) = u(y_1) + D(1)u(y_2)$$

$$D(1) = \frac{u(y_1) - u(x_1)}{u(x_2) - u(y_2)}$$

$$\therefore \quad D(2) = D(1)^2$$

$\therefore$ Discount function must be exponential

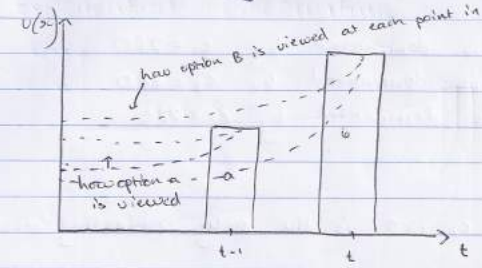
Underestimating δ



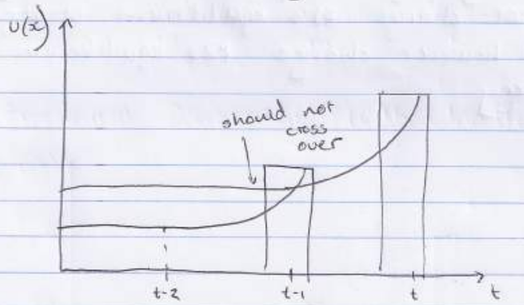
$$\frac{u(x)}{x} > \frac{u(y)}{y} \longrightarrow \frac{u(x)}{u(y)} > \frac{x}{y}$$

Hence if $\delta = \left(\frac{x}{y}\right)^{1/n}$, this will underestimate δ

Time Inconsistency and the Discount Function



Time consistency



Time inconsistency