Outline

1 Standard Model
2 Non-Fixed Discount Rate
3 Implication of Hyperbolic Discount
4 Self Awareness of Changing Time Preferences
   - Empirical Evidence
5 Influence of non-present Consumptions
6 Time Changing Utility
7 Summary
Discounted Utility

A person Intertemporal Utility Function can be described as:

\[ U^t(c_t, \ldots c_T) = \sum_{0}^{T-t} \left( \frac{1}{1 + \rho} \right)^i u(c_{t+i}) \]  

- Time is discounted at constant rate
- Consumptions Intertemporal Independence
- Stationarity of \( u \)
- Elegant, but Arbitrary (Samuelson 1937)
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Hyperbolic Discount

- Hyperbolic Discount = declining discount rate: $\rho_n$ is declining.
- The implicit discount rate over longer time horizons is generally lower than the implicit discount rate over shorter time horizons.
- Preference reversal: 110 in 31 days is preferred to 100 in 30, but 100 today is preferred to 110 tomorrow.
Hyperbolic Discount cont’d

*Figure 1a.* Discount Factor as a Function of Time Horizon (all studies)

*Figure 1b.* Discount Factor as a Function of Time Horizon (studies with avg. horizons > 1 year)
A simple Functional form of Hyperbolic Discount

\[
D(k) = \begin{cases} 
1 & \text{if } k = 0 \\ 
\frac{1}{\beta \delta^k} & \text{if } k > 0 
\end{cases} 
\] (2)

- the per period discount rate between now and the next is \( \frac{1 - \beta \delta}{\beta \delta} \)
- the one between two periods in the future is \( \frac{1 - \delta}{\delta} \)
- declining discount between now and the next, constant discount in the future
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Implication of Hyperbolic Discount

- Over Consumption (or under-saving)
  - illiquid assets as a limit to future over-consumption

- Procrastination of an onerous activity (O’Donoghue and Rabin (1999c, 2001))
  - Ex: diet
  - Ex: I plan to clean my entire house tomorrow so I do not clean the toilet today
Implication of Hyperbolic Discount (Cont’d)

- More options in terms of retirement planning may be harmful (O’Donoghue and Rabin (1999))
- Addictions (Gruber and Koszegi (2000), and Carrillo (1999))
- Strategic Ignorance (Carrillo and Mariotti (2000) and Benabou and Tirole (2000))
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A person with time-inconsistent preferences may or may not be aware that her preferences will change over time.

- “naive” believe that her future preferences will be identical to her current preferences.
- “sophisticated” correctly predict how her preferences will change over time.

A “sophisticated” has preferences for commitments (tying her own hands).

Policy might be aimed in providing commitments (impose a retirement scheme) or educating (making individuals more sophisticated).
Self Awareness, example

- A mediocre movie this week (3), a good movie next week (5), a great movie in two weeks (8), and a Johnny Depp movie in three weeks (13).

- You need to skip one to write a report ($\bar{v} > 13$), assume generally $\beta = 1/2$ and $\delta = 1$. Which movie do you see?

- Time-Consistent ($\beta = 1$) do the report in 1
- naifs do the report in 4
- sophisticates do the report in 2
Field Experiment on Savings and Commitments

- 1777 existing or former clients of a bank in the Philippines
- Three Treatments
  - SEED Treatment (N=710): Encourage to save, Offer commitment device (account with savings goal)
  - Marketing Treatment (N=466): Encourage to save, Offer no commitment
  - Control Treatment (N=469)
Out of 710 treated people, 202 take up SEED: Take up of 28%

- average savings balances increased by 81 % for those clients assigned to the treatment group
- more "hyperbolic" individuals seem more willing to take up SEED
Some Individuals have hyperbolic preferences

### TABLE III
Tabulations of Responses to Hypothetical Time Preference Questions

<table>
<thead>
<tr>
<th>Indifferent between 200 pesos in 6 months and X in 7 months</th>
<th>Patient</th>
<th>Somewhat impatient</th>
<th>Most impatient</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>X &lt; 250</td>
<td>606</td>
<td>126</td>
<td>73</td>
<td>805</td>
</tr>
<tr>
<td>34.4%</td>
<td>7.2%</td>
<td>4.1%</td>
<td>45.7%</td>
<td></td>
</tr>
<tr>
<td>Somewhat impatient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 &lt; X</td>
<td>206</td>
<td>146</td>
<td>59</td>
<td>411</td>
</tr>
<tr>
<td>11.7%</td>
<td>8.3%</td>
<td>3.3%</td>
<td>23.3%</td>
<td></td>
</tr>
<tr>
<td>Most impatient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 300</td>
<td>154</td>
<td>93</td>
<td>299</td>
<td>546</td>
</tr>
<tr>
<td>8.7%</td>
<td>5.3%</td>
<td>17%</td>
<td>31%</td>
<td></td>
</tr>
<tr>
<td>300 &lt; X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indifferent between 200 pesos now and X in one month</td>
<td>966</td>
<td>365</td>
<td>431</td>
<td>1,762</td>
</tr>
<tr>
<td>Patient X &lt; 250</td>
<td>54.8%</td>
<td>20.7%</td>
<td>24.5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- "Hyperbolic": More patient over future trade-offs than current trade-offs.
- "Patient now, Impatient later": Less patient over future trade-offs than current trade-offs.
- Time inconsistent (direction of inconsistency depends on answer to open-ended question).

The rows in the above table are determined by the response to #1, #2, and #3 below.

Question #1: "Would you prefer 200 pesos now or 250 pesos in one month?" If the respondent preferred 200 pesos now over 250 pesos in one month, Question #2 was asked. "X" (in above table) is assumed to be less than 250 if the person prefers 250 pesos in one month.

Question #2: "Would you prefer 200 pesos now or 300 pesos in one month?" If the respondent preferred 200 pesos now over 250 pesos in one month, Question #3 was asked. "X" (in above table) is assumed to be between 250 and 300 if the person prefers 300 pesos in one month.

Question #3: "How much would we have to give you in one month for you to choose to wait?" "X" (in the above table) is assumed to be more than 300 if the person is asked Question #3.
Who takes up the Commitment device?

<table>
<thead>
<tr>
<th></th>
<th>(1) All</th>
<th>(2) All</th>
<th>(3) Female</th>
<th>(4) Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time inconsistent</td>
<td>0.125*</td>
<td>0.005</td>
<td>0.158*</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>(0.067)</td>
<td>(0.080)</td>
<td>(0.085)</td>
<td>(0.098)</td>
</tr>
<tr>
<td>Impatient, now versus 1 month</td>
<td>-0.030</td>
<td>-0.039</td>
<td>-0.036</td>
<td>-0.041</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.050)</td>
<td>(0.062)</td>
<td>(0.075)</td>
</tr>
<tr>
<td>Patient, now versus 1 month</td>
<td>0.076</td>
<td>0.070</td>
<td>0.035</td>
<td>0.119</td>
</tr>
<tr>
<td></td>
<td>(0.072)</td>
<td>(0.072)</td>
<td>(0.089)</td>
<td>(0.110)</td>
</tr>
<tr>
<td>Impatient, 6 months versus 7 months</td>
<td>0.097</td>
<td>0.108*</td>
<td>0.124</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.065)</td>
<td>(0.087)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>Patien, 6 months versus 7 months</td>
<td>0.015</td>
<td>0.022</td>
<td>0.057</td>
<td>-0.021</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
<td>(0.064)</td>
<td>(0.081)</td>
<td>(0.093)</td>
</tr>
<tr>
<td>Female</td>
<td>0.099</td>
<td>0.070</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.137)</td>
<td>(0.138)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female X time inconsistent</td>
<td>0.191**</td>
<td>0.090</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married X female</td>
<td>-0.113</td>
<td>-0.117</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.091)</td>
<td>(0.090)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>0.049</td>
<td>0.050</td>
<td>-0.080</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td>(0.077)</td>
<td>(0.076)</td>
<td>(0.051)</td>
<td>(0.068)</td>
</tr>
<tr>
<td>Some college</td>
<td>0.083**</td>
<td>0.081**</td>
<td>0.081</td>
<td>0.079</td>
</tr>
</tbody>
</table>
Effects on Total Savings

<table>
<thead>
<tr>
<th>Sample</th>
<th>Intent to Treat Effect</th>
<th>OLS</th>
<th>Probit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length</td>
<td>6 months</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Dependent variable:</td>
<td>Change in total balance</td>
<td>Change in total balance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commitment &amp; marketing only</td>
<td>Commitment &amp; marketing only</td>
</tr>
<tr>
<td></td>
<td>All (1)</td>
<td>All (3)</td>
<td>All (5)</td>
</tr>
<tr>
<td></td>
<td>Commitment treatment 234.678*</td>
<td>411.466*</td>
<td>0.102***</td>
</tr>
<tr>
<td></td>
<td>(101.748)</td>
<td>(244.021)</td>
<td>(3.82)</td>
</tr>
<tr>
<td></td>
<td>Marketing treatment 184.851</td>
<td>123.891</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>(156.027)</td>
<td>(228.523)</td>
<td>(0.026)</td>
</tr>
<tr>
<td></td>
<td>Constant              40.626</td>
<td>225.476*</td>
<td>189.074**</td>
</tr>
<tr>
<td></td>
<td>(61.676)</td>
<td>(133.405)</td>
<td>(90.072)</td>
</tr>
<tr>
<td></td>
<td>Observations          1777</td>
<td>1777</td>
<td>1777</td>
</tr>
<tr>
<td></td>
<td>R²                    0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Field Experiment on Exercise and Health

- 1000 employees at a Fortune 500 company
- conducted over two years
- treatments:
  - offer of a one month financial incentive to attend their company onsite exercise facility (10 USD per visit for up to 3 visits each week)
  - half of the incentive group was randomly selected and offered participants to put money at stake for a pledge that they would continue to use the gym over the 2 months.
Results

Figure 1a. Fraction with positive gym visits by treatment status (all subjects)

- 12% take up of commitment contract
Field Experiment on Work Effort

- 11-month period in a small Indian city
- The typical worker earned Rs. 170 (3.60 USD) per day
- 124 workers participated in the experiment.
- Since effort at work is immediate and benefits delayed, effort at work is an investment good
Main Hypothesis

- workers’ effort increases as the (randomly assigned) payday gets closer
- workers choose a contract which penalizes them for not achieving a (self-chosen) threshold over the same contract without the penalty.
- demand for commitment should be associated with a payday cycle
Evidence of pay cycle in effort

Figure 2
Production over the Pay Cycle

<table>
<thead>
<tr>
<th>Days before Payday</th>
<th>6+ days</th>
<th>5 days</th>
<th>4 days</th>
<th>3 days</th>
<th>2 days</th>
<th>1 day</th>
<th>Payday</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>600</td>
<td>900</td>
<td>1200</td>
<td>1500</td>
<td>1800</td>
<td>2100</td>
</tr>
<tr>
<td>3</td>
<td>400</td>
<td>800</td>
<td>1200</td>
<td>1600</td>
<td>2000</td>
<td>2400</td>
<td>2800</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
<td>3500</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
<td>1200</td>
<td>1800</td>
<td>2400</td>
<td>3000</td>
<td>3600</td>
<td>4200</td>
</tr>
</tbody>
</table>
Quite significant take-up of commitment contract
### Table 11: Treatment Effects of Contract Assignment on Worker Production

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Production</th>
<th>Production</th>
<th>Production</th>
<th>Attendance</th>
<th>Attendance</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>All obs</td>
<td>Control &amp; Choice obs</td>
<td>Control &amp; Choice obs</td>
<td>All obs</td>
<td>Control &amp; Choice obs</td>
<td>Control &amp; Choice obs</td>
</tr>
<tr>
<td>Assignment to choice</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>Assignment to evening choice</td>
<td>147 (68)**</td>
<td>0.005</td>
<td>0.006</td>
<td>0.011 (0.010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment to morning choice</td>
<td>83 (68)</td>
<td>0.000</td>
<td>(0.010)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment to low target</td>
<td>8 (88)</td>
<td>-0.002</td>
<td>(0.013)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment to medium target</td>
<td>202 (89)**</td>
<td>-0.008</td>
<td>(0.013)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment to high target</td>
<td>305 (147)**</td>
<td>-0.014</td>
<td>(0.020)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worker fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Seat fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Date fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lag production controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Observations</td>
<td>8673</td>
<td>6489</td>
<td>6489</td>
<td>8673</td>
<td>6489</td>
<td>6489</td>
</tr>
<tr>
<td>R2</td>
<td>0.61</td>
<td>0.62</td>
<td>0.62</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
</tr>
<tr>
<td>Dependent variable mean</td>
<td>5184</td>
<td>5165</td>
<td>5165</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
</tbody>
</table>
Field Experiment on Addictions

- 2,000 smokers aged 18 or older who reside on the island of Mindanao in southern Philippines
- Offer urine test for smoking in 6 months
- offered some smokers the opportunity to voluntarily sign a commitment contract (“CARES”) to stop smoking. A smoker signing the contract pledged his own money that he would pass a urine test six months later
Results

- Low take-up: 11% of 781 offered product
- Conditional on take-up, average deposit of 57 pesos (4 weeks worth of cigarettes)
- At 6 months, increase of 4-5 percentage point in chance of making urine test
- At 12 months, similar increase at surprise test
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Habit-Formation Models

- utility from current consumption ("tastes") can be affected by the level of past consumption
  - $u(c_\tau; z_\tau)$, with $z_\tau$ depending on the past consumptions where $\Delta^2 u/\Delta c_\tau z_\tau > 0$

- habit-formation model to study addictive activities (Becker and Murphy, 1988)

- equity premium puzzle (Abel 1990)

- high growth rates can cause people to save more (Carroll, Overland, and Weil, 2000)
Reference Points Models

- According to prospect theory, outcomes are evaluated using a value function defined over departures from a reference point:
  \[ u(c_\tau; z_\tau) = u(c_\tau - z_\tau), \]
  reference point \( z_\tau \) depending on the past consumptions.

- Magnitude effect, someone who is indifferent between, say, 10 now and 20 in a year should prefer 200 in a year over 100 now because the larger rewards have a greater difference (and the same ratio) (Loewenstein and Prelec (1992)).

- Shifting consumption in any direction is made less desirable by loss aversion, since one loses consumption in one period and gains it in another (Loewenstein 1988).
Utility from Anticipation

- A person’s instantaneous utility is equal to the utility from consumption in that period plus some function of the discounted utility of consumption in future periods (Loewenstein (1987)).

- Anticipatory utility provides a reason to prefer improvement and for getting unpleasant outcomes over quickly instead of delaying.

- Emotions, such as anxiety or suspense, are driven by uncertainty about the future, incorporate in the utility such anticipatory emotions (Caplin and Leahy (2001)).

- Anxiety creates a taste for risk-free assets and an aversion to risky assets, explain equity premium puzzle.
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Visceral Influences

- incorporates “visceral” influences such as hunger, sexual desire, physical pain, cravings
  - person’s instantaneous utility: \( u(c_\tau, d_\tau) \), where \( d_\tau \) represents visceral states like hunger and dieting, sexual desire and various “heat-of-the-moment” behaviors, craving and drug addiction, and so on
- provide an alternate account of the preference reversals (Laibson 2001; Loewenstein 2000)
- The fact that visceral states are endogenous introduces issues of state-management: preference for commitment
Effect of Mood

- Saunders (1993): Days with higher cloud cover in New York are associated with lower aggregate US stock returns
  - Use weather of the city where the stock market is located
  - Negative relationship between cloud cover (de-trended from seasonal averages) and aggregate stock returns in 18 of the 26 cities
Effect of Mood

- **Magnitude:**
  - Days with completely covered skies have daily stock returns 0.11 percent lower than days with sunny skies
  - Five percent of a standard deviation
  - Small magnitude, but not negligible

- After controlling for cloud cover, other weather variables such as rain and snow are unrelated to returns
Happiness and Productivity

- Laboratory experiment involving 713 individuals
- The key difficulty is how to ‘assign’ emotions to people to produce a randomized trial.
- So we used a comedy clip, Bill Bailey, for our key treatment.
- Restricted our laboratory pool to subjects of an English background who had likely been exposed to similar humour before
Main productivity task previously used in Niederle and Vesterlund (2007), which entails asking subjects to add sequences of five 2-digit numbers under timed conditions. Example:

31 56 14 44 87

Comparatively simple but is taxing under pressure.

It might be thought of as representing in a highly stylized way an iconic white-collar job: both intellectual ability and effort are rewarded.
Effect of Happiness on Productivity

Figure A3: Those exposed to the randomized happiness treatment in the laboratory have higher happiness in Experiment II [Here the happiness treatment is a comedy movie clip in the laboratory.] [95% confidence intervals]

Figure A1: Those exposed to the randomized happiness treatment in the laboratory have higher productivity in Experiment I [Here the happiness treatment is a comedy movie clip in the laboratory.] [95% confidence intervals]
Happiness and Productivity in the Long-Run

- We used "nature" to ‘assign’ emotions to people.
- We measured the level of Happiness at the Beginning and at the end we asked about BLE
- BLE = bereavement in the close family, in the extended family, serious illness in the close family
- Same Pool of Subjects as in 1st experiment
Effect of Happiness on Productivity in the Long-Run

Figure A7: Individuals with a recent Bad Life Event (BLE) report lower happiness in Experiment IV  
[Here a bad life event is bereavement or family illness.]
[95% confidence intervals]

Figure A6: Individuals with a recent Bad Life Event (BLE) have lower productivity in Experiment IV  
[Here a bad life event is bereavement or family illness.]
[95% confidence intervals]
Time Varying Risk Aversion (Guiso et al 2013)

- In order to fit the time series of aggregate U.S. stock prices, asset pricing models require large fluctuations in the aggregate risk aversion.
- Risk aversion increases even among those who did not experience any loss. This suggests that investors were emotionally affected by a stock market crash even if they were not financially affected by it.
- Investigates whether an increase in risk aversion might be an emotional response (fear) triggered by a scary experience.
- Sample of students with a five minute clip from the movie, Hostel.
- Subjects who watched a horror movie shows an higher level of Risk Aversion (their certainty equivalent is 27% lower than the ones who did not watch the movie).
To properly make intertemporal decisions, a person must correctly predict how her tastes will change.

People may anticipate the qualitative nature of their changing preferences, they tend to underestimate the magnitude of these changes: projection bias. (Loewenstein, O’Donoghue, and Rabin (2000))

People may underappreciate the degree to which a present consumption surge will raise their reference consumption level.
Multiple-Self Models and Temptations

- Intertemporal choice as the outcome of a conflict between multiple selves.
- Two agents, one myopic and one farsighted, who alternately take control of behavior.
- Farsighted self may pour vodka down the drain to prevent tomorrow’s self from drinking it, but the myopic self rarely takes steps to ensure that tomorrow’s self will have access to the alcohol he will then crave.
- People have "temptation preferences," they experience disutility from not choosing the option that is most enjoyable now (Gul and Pesendorfer (2001)).
- Individuals may be willing to pay in advance to eliminate that option, or in other words, she may have a preference for commitment.
Summary

- Individuals experience hyperbolic and not fixed discount rates
  - Over-consumption and under-saving
  - Addictions
  - Procrastination of Onerous Activity
- Influence of non-present Consumptions
  - Habit Formation
  - Reference-Point Models
  - Future matter
- Time-Changing Utility
  - Visceral Influences
  - Multi-self Models
  - Preferences Change