Investment Behavior
Week 11 Intertemporal Choice and Time-Inconsistency

*Acknowledgement: This lecture uses slides created by Patrick McAlvanah for his course on Behavioral Economics.

Figure 1: Scan the QR code to complete a survey

1 Introduction

Intertemporal choice is the study of how people make decisions when costs and benefits occur at different points in time. Many economic decisions involve tradeoffs between the present and the future. For example, a person may decide whether to spend money today or save it for later, whether to complete unpleasant work now or postpone it, or whether to accept a smaller reward immediately instead of waiting for a larger reward in the future.

Traditional economic models usually assume that people evaluate future outcomes in a consistent and stable way. However, behavioral economics shows that people often do not behave in this way. Instead, people may change their preferences simply because time has passed. This lecture focuses on those patterns, especially time inconsistency, hyperbolic discounting, preference reversals, and related anomalies.

2 Outline of the Lecture

This lecture covers three main topics.

First, we review the standard model of intertemporal choice. This includes the interest rate, future value, present value, the discount factor, the discount rate, the classic model of intertemporal choice, and exponential discounting. We will additionally cover how time preference is measured.

Second, we examine behavioral aspects of intertemporal choice. These are often called anomalies because they are difficult to explain using the standard model. The main topics are time inconsistency, hyperbolic discounting, preference reversal, and other related anomalies.

Third, we discuss anticipation utility and memory utility. This is the idea that people may receive utility not only from consumption itself, but also from looking forward to future consumption as well as from recalling consumption in the past.

The standard model of intertemporal choice assumes exponential discounting and time-consistent preferences. However, observed behavior often violates these assumptions. Individuals frequently display present bias, preference reversals, procrastination, and self-control problems.

Behavioral intertemporal choice studies these deviations from the standard model.

3 Standard Intertemporal Choice

3.1 The Basic Idea

In standard intertemporal choice models, individuals compare outcomes that occur at different times. Because people usually prefer to receive benefits sooner and delay costs until later, future outcomes are typically discounted.

Discounting means that an outcome in the future is given less weight than the same outcome today. For example, receiving $100 today is usually preferred to receiving $100 one year from now. The reason is that the immediate money can be spent, saved, or invested right away.

3.2 Discount Factor and Discount Rate

A discount factor δ measures how much weight a person places on a future payoff relative to a current payoff. If the discount factor is close to 1, the person is relatively patient. If the discount factor is much smaller than 1, the person is relatively impatient.

The discount rate ρ is closely related to the discount factor.

$$\delta = \frac{1}{1+\rho}$$

A higher discount rate means the person places much less value on future outcomes. A lower discount rate means the person places more value on future outcomes.

3.3 Review of the Standard Model

The standard model assumes discounted utility:

$$U = \sum_{t=0}^{T} D(t)u(c_t) = \sum_{t=0}^{T} \delta^t u(c_t)$$

where $D(t)$ is called the discount function.

3.3.1 Exponential Discounting

The standard model often assumes exponential discounting, namely the discount function takes the form:

$$D(t) = \delta^t.$$

Under exponential discounting, the discount factor between any two adjacent periods is constant.

$$\frac{\delta^{t+1}}{\delta^t} = \delta$$

The important feature of exponential discounting is that the rate of discounting is constant over time. This means the relative value of two outcomes separated by one year is the same whether those outcomes occur now and one year from now, or ten years from now and eleven years from now.

This leads to time-consistent preferences.

3.3.2 What is Time Consistency?

Time consistency occurs when an individual's preferences does not change merely because time passes. A choice that is best today is still best later, unless new information has arrived.

4 Time Inconsistency

4.1 An Example Involving Work

Consider the following choice. Suppose it is January 1st. Which option would you prefer?

- A: 7 hours of boring work on April 1st.
- B: 10 hours of boring work on April 15th.

Many people may prefer option A because it involves fewer hours of work. Since both options are far in the future, the extra two-week delay may not seem very important.

Now suppose it is four months later, and April 1st has arrived. Which option would you prefer?

- A: 7 hours of boring work today.
- B: 10 hours of boring work in 2 weeks.

At this point, many people switch their preference. They now prefer to postpone the work, even if postponing means doing more total work. This is an example of how preferences can change as an outcome becomes immediate.

4.2 An Example Involving Money

Now consider a similar example involving money. Which would you prefer?

- A: $2000 right now.
- B: $2400 in one year from now.

Many people may choose the immediate $2000.

Now consider this choice:

- C: $2000 in 10 years.
- D: $2400 in 11 years.

In this case, many people may be more willing to wait for the larger amount. Notice that the time difference is one year in both cases. The difference is that, in the first case, one option is immediate, while in the second case, both options are far in the future.

4.3 Definition of Time Inconsistency

Time inconsistency, also called dynamic inconsistency, occurs when the decision that seems optimal at one point in time is no longer the decision that seems optimal at another point in time.

In other words, people experience preference reversals. When both outcomes are in the future, a person may prefer 7 hours of work on April 1st or the delayed $2400. However, when one option becomes immediate, the person may switch and prefer 10 hours of work in two weeks or the immediate $2000.

4.4 Preference Reversals Caused by Time Alone

Time inconsistency refers specifically to preference reversals caused only by the passage of time.

For example, suppose that on January 1st you prefer 7 hours of work on April 1st to 10 hours of work on April 15th. Then, on the morning of April 1st, a friend invites you to a concert that evening. Because of the concert, you now choose to work 10 hours on April 15th.

This is not a true example of dynamic inconsistency. Your preference did reverse, but the reversal was caused by a change in your opportunity set, not by the passage of time alone. Presumably, if you had known on January 1st that the concert would take place on April 1st, you would already have preferred working on April 15th.

4.5 Why Preferences Become Dynamically Inconsistent

Why do preferences become dynamically inconsistent? The answer is that people do not always discount all future periods uniformly.

In the standard exponential model, people apply a constant discount factor δ to each time period. However, actual behavior suggests that people often use different discount factors for different time periods.

In particular, people tend to overweight time periods that are close to the present relative to time periods that are farther in the future. For example, people often show a higher discount rate between now and one year from now than between seven years from now and eight years from now.

This pattern is known as hyperbolic discounting.

5 Hyperbolic Discounting

Recall that the exponential discounting function is δ^t, where δ is the per-period discount factor.

5.1 A One-Parameter Hyperbolic Function

A simple one-parameter hyperbolic function is

$$\frac{1}{1+\alpha t},$$

where $\alpha > 0$ indicates the aversiveness of delay. A larger value of α means that delay is more costly to the individual.

5.1.1 Different Levels of Inconsistency

The more inconsistent the discount function is, the more "L-shaped" or step-function-like it becomes.

For example, the following figure compares hyperbolic discount functions for different values of α:

$$\alpha = 1000, \quad \alpha = 2, \quad \alpha = .10, \quad \alpha = .0001.$$

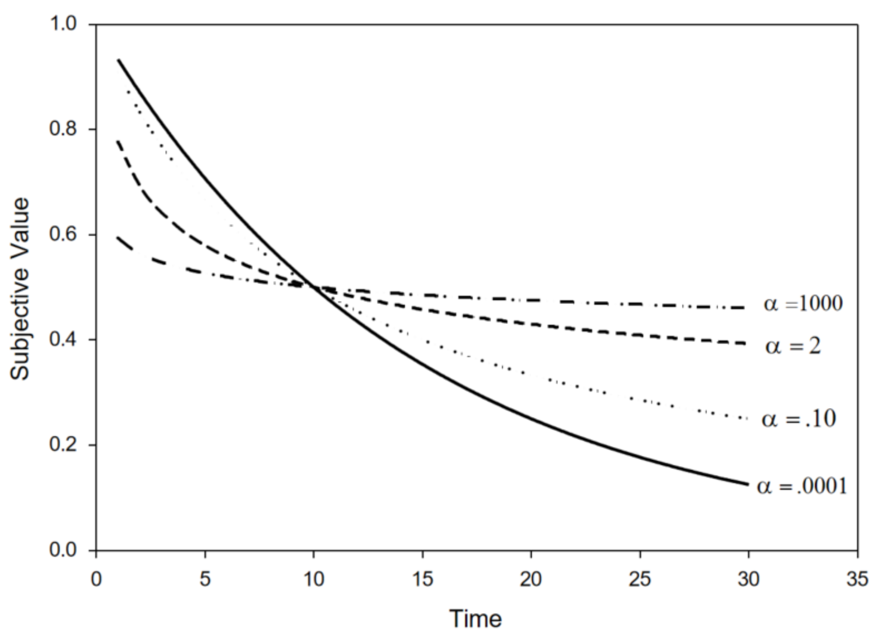

Figure 2: The value of a good as a function of its delay.

5.2 A Two-Parameter Hyperbolic Function

A two-parameter hyperbolic function is

$$\frac{1}{(1+\alpha t)^{\beta/\alpha}}.$$

This function often fits observed data better than the exponential function. It also has the advantage that α captures how inconsistent time preferences are.

As α approaches 0, the function converges to

$$e^{-\beta t},$$

which is equivalent to exponential discounting, δ^t.

Another two-parameter hyperbolic function is

$$\delta^{t^c}.$$

Here, $c < 1$ represents the non-linear perception of time. For example, the time between now and one year from now may "feel" longer than the time between five years from now and six years from now.

5.3 Declining Discount Rates

Each of the previous hyperbolic functions is characterized by declining discount rates, or equivalently, increasing discount factors with respect to time.

This means that periods closer to the present are discounted more heavily than identical intervals later in time.

For example, consider the simple hyperbolic function with $\alpha = .5$. Between time periods 0 and 1, the discount factor is

$$\frac{D(1)}{D(0)} = .6667/1 = .6667.$$

Between time periods 5 and 6, the discount factor is

$$\frac{D(6)}{D(5)} = .25/.285 = .8777.$$

This corresponds to a 50% discount rate between years 0 and 1, but only a 14% discount rate between years 5 and 6.

6 Plotting Discount Functions

6.1 Value as a Function of Delay

We can graph the value of a good as a function of its delay. These graphs help show the difference between exponential discounting and hyperbolic discounting.

For hyperbolic discounting, short delays are discounted more heavily than the exponential model predicts. However, long delays are less costly than the exponential model predicts.

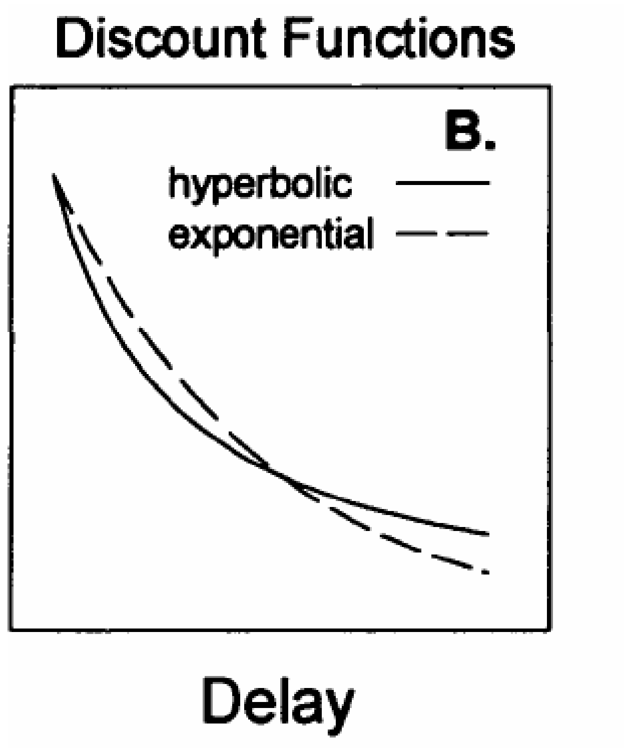

Figure 3: The value of a good as a function of its delay.

6.2 Hyperbolic and Exponential Functions Compared

When researchers fit discount functions to actual data, hyperbolic functions usually fit better than exponential functions.

The figure below compares exponential, hyperbolic, and hyperbola-like discounting for a \$10,000 reward over different delays measured in months.

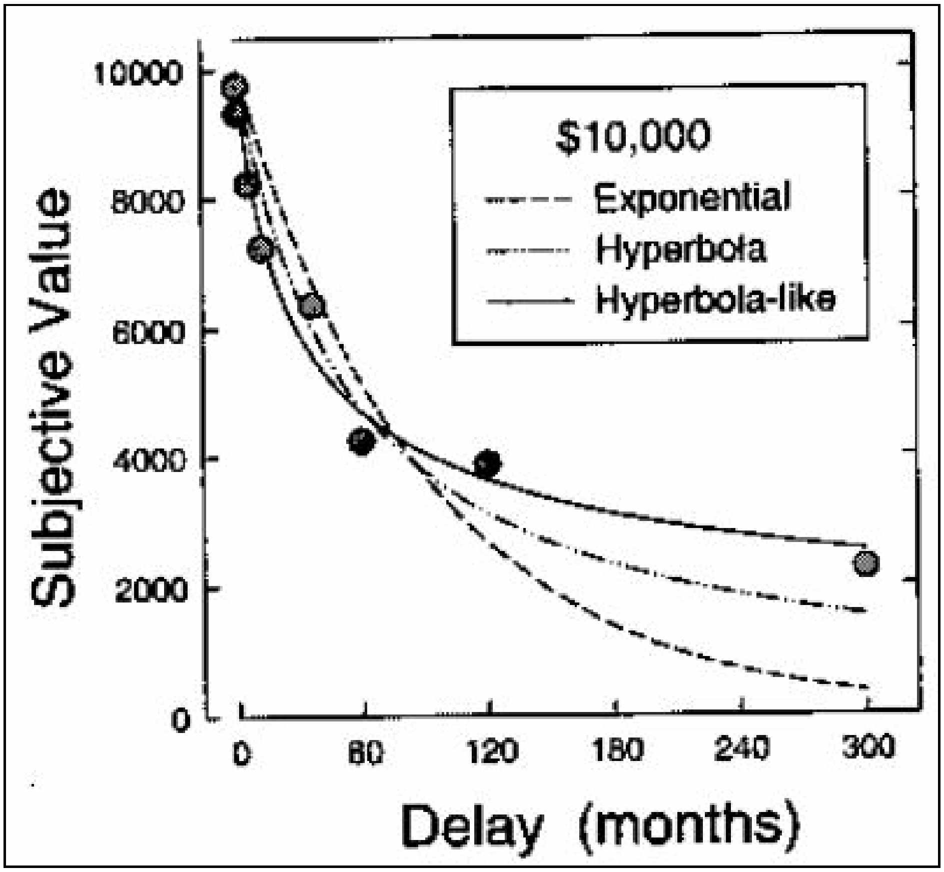

Figure 4: Exponential, hyperbolic, and quasi-hyperbolic discounting.

7 Preference Reversals

7.1 How Hyperbolic Discounting Creates Preference Reversals

Hyperbolic discounting can explain why people reverse their preferences over time.

Suppose someone is indifferent between an immediate smaller-sooner reward and a delayed larger-later reward:

$$D(0)SS = D(t)LL.$$

Now suppose we add a common delay t' to both outcomes.

Because of hyperbolic discounting, this additional delay receives relatively more weight when it is added near the present than when it is added farther in the future. As a result, the person may now prefer the larger-later reward:

$$D(t')SS < D(t + t')LL.$$

The passage of time is essentially the reverse of adding a common delay. As the smaller-sooner reward becomes more immediate, people become relatively more attracted to it. This produces preference reversals.

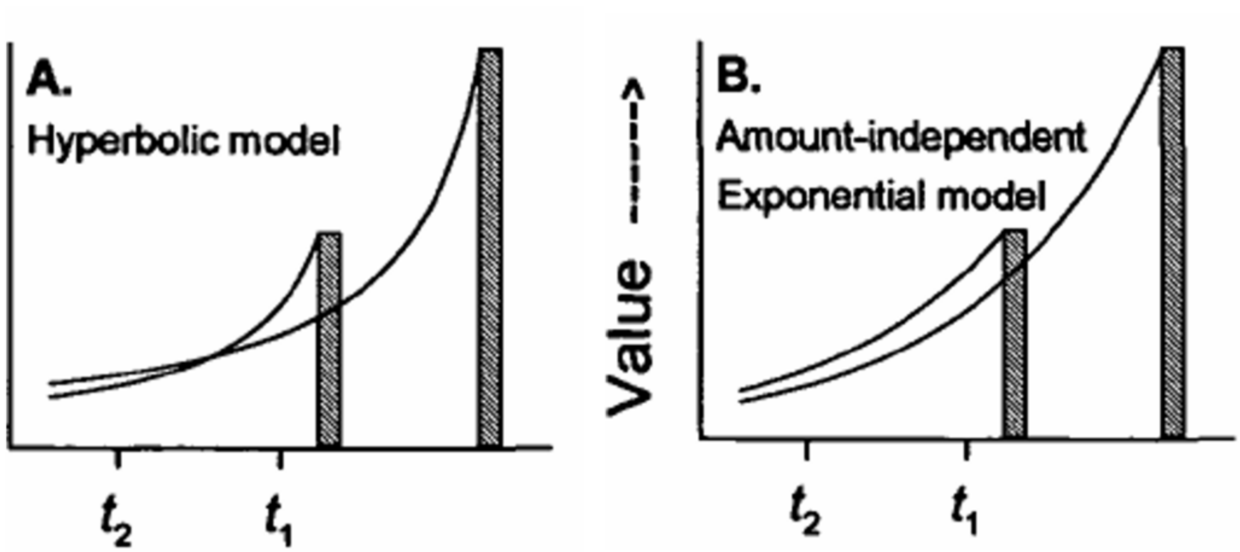

Figure 5: Preference reversals under hyperbolic discounting.

8 Other Anomalies in Intertemporal Choice

8.1 The Sign Effect

The sign effect is a classic behavioral economics anomaly in intertemporal choice—the study of how people make decisions about costs and rewards spread over time. It describes the tendency for people to discount future gains at a much higher rate than future losses.

Consider the following choice involving gains:

- A: You receive $200 right now.
- B: You receive $300 in 4 years.

- C: You pay \$200 right now.
- D: You pay \$300 in 4 years.

Most people tend to choose A over B, the immediate gain, but D over C, the postponed loss.

This implies that people often discount gains more heavily than losses. In other words, people tend to be more patient for losses than they are for gains. This can be written as

$$D(t, x) < D(t, -x).$$

Here, x represents a gain and $-x$ represents a loss. The inequality means that the discount factor for a future gain is smaller than the discount factor for a future loss. In other words, future gains are discounted more heavily than future losses.

8.2 Some Exceptions of the Sign Effect: Anticipation and Dread

In some cases, we may see the opposite of the sign effect. For example, individuals may experience positive anticipation for future gains, this may make them to want to delay rewards. Conversely, people experience dread regarding future losses, which can push them to prefer experiencing the painful event sooner.

For example, consider the following choice:

- A: A 60 volt electric shock right now.
- B: A 50 volt electric shock in 1 week.

One study found that some subjects actually preferred option A to option B.

This means that people may be willing to pay a cost to “get it over with” rather than live with the dread of a future loss.

8.3 The Magnitude Effect

The magnitude effect, also called the amount effect, refers to the fact that people tend to be more patient when the amounts at stake are larger.

Consider the following choice:

- A: \$10 right now.
- B: \$20 in 3 years.

Now compare it with this choice:

- A: \$1,000,000 right now.
- B: \$2,000,000 in 3 years.

Many people are willing to take \$10 now rather than wait for \$20 in 3 years. However, many of the same people are willing to wait for \$2,000,000 rather than take \$1,000,000 immediately.

This suggests that the discount function is not simply universal, $D(t)$. Instead, it may depend on the amount at stake:

$$D(t, A).$$

People tend to exhibit very high interest rates, greater than 100%, for very small amounts, such as amounts below \$100. However, once the amounts at stake are in the thousands, people often display more normal interest rates, such as 5–20%.

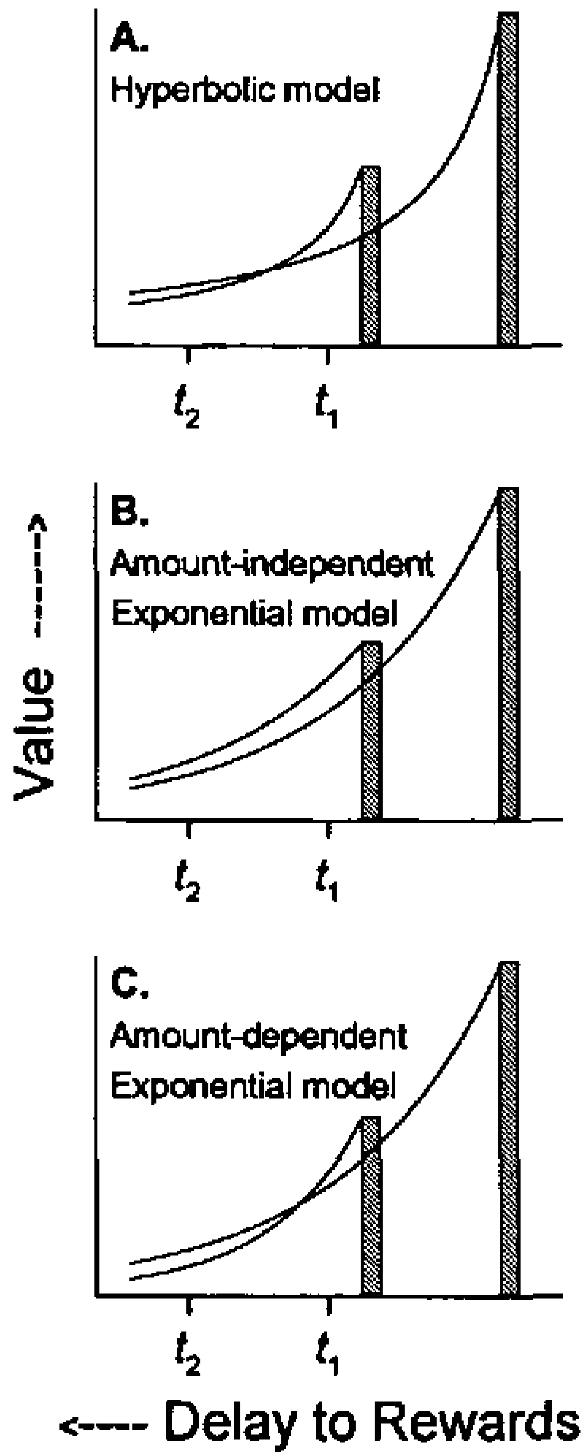

Figure 6: Amount-dependent exponential discounting (case C) can also explain preference reversal.

8.4 Delay / Speed-Up Asymmetry

Answer these two questions based on your preferences:

1. Suppose you are supposed to receive \$100 right now. How much would you require to instead receive the money in 3 years?

2. Now suppose you are supposed to receive \$120 in 3 years. How much would you be willing to give up in order to receive the money right now?

Suppose your answer is A doe question 1 and B for question 2. Raise your hand if:

$$A - 100 > 120 - B$$

That is: Compensation required to delay > Amount willing to give up to speed up.

In words: People demand a lot to wait longer, but they are not willing to sacrifice very much to receive money sooner.

In general, people display much more impatience when an outcome is delayed than when an outcome is sped up.

The first question is a delay question. You are initially supposed to receive \$100 right now, and you are asked how much extra money you would require to postpone receiving it for 3 years. Many people require a large amount of compensation to accept this delay.

The second question is a speed-up question. You are initially supposed to receive \$120 in 3 years, and you are asked how much you would be willing to give up in order to receive the money right now. Many people are willing to give up some money to receive it earlier, but the amount they are willing to give up is often smaller than the amount they would require to accept a delay.

This creates an asymmetry. If people had perfectly consistent exponential discounting preferences, then the amount required to delay a payment and the amount people would give up to speed up a payment should imply the same discount rate. However, in practice, the implied discount rate is usually much higher for delayed outcomes than for sped-up outcomes.

For example, Loewenstein found that people who expected to receive a VCR in one year would pay \$54 to receive it immediately. However, people who expected to receive the VCR immediately required \$126 to delay receiving it for one year.

Similarly, subjects in one of Patrick McAlvanah's studies displayed interest rates of 97% for small delayed gains, around \$300, but only 29% for sped-up gains.

For larger gains, around \$4000, subjects displayed interest rates of 9.1% for delayed gains, but only 4.4% for sped-up gains.

The main lesson is that people often treat delays and speed-ups differently. Delaying a reward feels like giving something up, so people demand a large premium to accept the delay. Speeding up a future reward feels like receiving an improvement, but people are often willing to pay less for that improvement than they would demand as compensation for a delay.

8.4.1 Why does delay / speed-up asymmetry occur?

One explanation is reference dependent preferences and loss aversion.

For individuals who expect to receive a reward now, delaying the reward feels like giving it up in the present. Because losses feel especially painful, loss aversion makes this unattractive and leads to higher impatience.

For individuals who expect to receive a reward later, speeding it up creates a gain now and a loss later. This feels less painful than giving up something that was expected immediately.

8.5 Subadditive Discounting

Subadditive discounting is another anomaly. It occurs when people are more impatient if a given time interval is broken into several smaller sub-periods than if it is left as one undivided interval.

For example, people may be more impatient over three consecutive 8-month intervals than over one undivided 24-month interval.

Consider this question:

> Suppose you are supposed to receive \$100 right now. How much would you require to instead receive the money in 3 years?

Now compare it with these three separate questions:

a) Suppose you are supposed to receive \$100 right now. How much would you require to instead receive the money in 1 year?

b) Suppose you are supposed to receive \$100 in 1 year. How much would you require to instead receive the money in 2 years?

c) Suppose you are supposed to receive \$100 in 2 years. How much would you require to instead receive the money in 3 years?

For example, subjects in one of Patrick McAlvanah's studies displayed interest rates of 88% for small gains, around \$300, but a 147% interest rate when the same period was subdivided over 3 intervals.

Likewise, subjects displayed a 9.8% interest rate for large gains, around $4000, but a 12.7% interest rate when the period was subdivided.

There is no strong economic reason for this pattern. It appears to come from psychophysics, or the way people perceive and mentally process time and changes.

Subadditivity also appears in other areas, such as public good valuation and probability judgement.

Subadditive discounting implies intransitive preferences, which is a serious problem for standard economic theory.

8.6 Other Anomalies

Two other anomalies are especially important.

First, people often have a preference for improving sequences. That is, they prefer outcomes that get better over time rather than worse over time.

Second, people often violate consumption independence and show a preference for spread-out outcomes.

9 Anticipation Utility and Memory Utility

9.1 The Basic Idea

Richer models of intertemporal choice include utility from anticipation. This means that a person receives utility from consumption today, but also from the anticipation of future consumption.

Anticipation utility works in the opposite direction from memory utility.

Memory utility suggests that people may want to experience good things quickly so that they can have more pleasant memories. This decreases patience.

Anticipation utility suggests that people may want to delay good things so that they have more time to look forward to them. This increases patience.

9.2 Improving Sequences and Negative Interest Rate (ρ)

Anticipation utility can help explain why people prefer improving sequences.

Future consumption provides both consumption utility and anticipation utility. Because of this, people may prefer a consumption profile that is "top heavy," meaning that better outcomes occur later.

Anticipation utility can also explain why some individuals have negative interest rates for losses. If a future loss creates dread, people may prefer to experience the loss sooner so that it does not reduce their current utility through worry or anxiety.

9.3 The Kiss and Shock Example

One famous example is the finding that the ideal time to receive a kiss from a movie star is in 3 days rather than immediately. Waiting provides time to savor and enjoy what is coming.

Similarly, subjects are willing to pay substantially to avoid a shock in 1 year or 10 years, because the dread of the future shock would otherwise hang over them.

The figure below illustrates how the proportion of current value changes with time delay for outcomes such as a kiss, a shock, losing $1000, losing $4, and gaining $4.

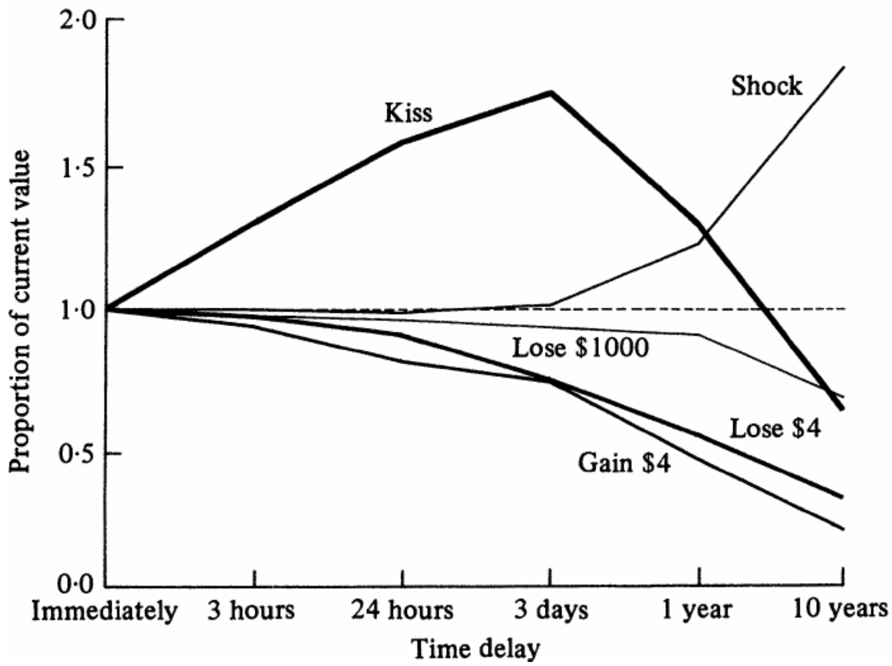

Figure 7: Anticipation utility for gains, losses, kisses, and shocks.

10 Measuring Subjective Discount Rates in Experiments

Figure 8: Scan the QR code to complete a survey

A central question in behavioral and experimental economics is how researchers can measure a person's time preferences. Time preferences describe how people trade off rewards or costs that occur at different points in time. For example, a person with strong impatience may prefer \$100 today to \$120 one month from now, while a more patient person may be willing to wait for the larger delayed reward.

The most common approach in the experimental literature is to ask subjects to make choices between a smaller-sooner reward and a larger-later reward. The smaller-sooner reward is usually denoted by SS, while the larger-later reward is usually denoted by LL. By observing when a person switches from choosing the smaller-sooner reward to choosing the larger-later reward, researchers can estimate that person's discount factor or discount rate.

10.1 Finding an Indifference Point

A common way to measure discount rates is to find the point at which a person is indifferent between a smaller-sooner reward and a larger-later reward.

This can be written as

$$(\$SS \text{ at date } x) \sim (\$LL \text{ at date } x+y),$$

where SS denotes the smaller-sooner amount and LL denotes the larger-later amount.

The subject may be asked to choose either the smaller-sooner amount or the larger-later amount that makes them indifferent for a fixed date x and interval y. Alternatively, the subject may be asked to choose the date x or the interval y for a given SS and LL.

10.2 Calculating Discount Factors

Given a person's choice, we can write the indifference condition as

$$D(x)SS = D(x+y)LL.$$

Rearranging gives

$$\frac{SS}{LL} = \frac{D(x+y)}{D(x)}.$$

For example, suppose a person is indifferent between receiving \$100 now and receiving \$120 one year from now. Then

$$\frac{100}{120} = \frac{D(1)}{D(0)}.$$

If $D(0) = 1$, then this implies that

$$D(1) = .8333.$$

Now suppose a person is indifferent between receiving \$100 in 5 years and receiving \$112 in 6 years. Then

$$\frac{100}{112} = \frac{D(6)}{D(5)}.$$

This implies that the one-year discount factor between years 5 and 6 is approximately

$$.893.$$

10.3 Multiple Price Lists

One widely used method is the Multiple Price List, often abbreviated as MPL. In an MPL, subjects are shown a list of choices. In each row, they choose between an earlier payment and a later payment. Usually, the earlier payment is held fixed, while the later payment increases across rows.

For example, a subject might be asked to choose between receiving \$100 today and receiving different amounts one month from now:

Row	Option A	Option B	Choice
1	\$100 today	\$101 in 1 month	A / B
2	\$100 today	\$103 in 1 month	A / B
3	\$100 today	\$105 in 1 month	A / B
4	\$100 today	\$107 in 1 month	A / B
5	\$100 today	\$110 in 1 month	A / B
6	\$100 today	\$115 in 1 month	A / B
7	\$100 today	\$120 in 1 month	A / B
8	\$100 today	\$125 in 1 month	A / B
9	\$100 today	\$130 in 1 month	A / B
10	\$100 today	\$140 in 1 month	A / B

There are no right or wrong answers in this task. A patient person will switch from Option A to Option B relatively early, because only a small increase in the future payment is needed to make waiting worthwhile. An impatient person will switch later, because they require a much larger future payment to give up money today.

10.4 The Switching Point

The key information in an MPL is the switching point. The switching point is the row at which the subject changes from choosing the smaller-sooner (SS) option to choosing the larger-later (LL) option.

For example, suppose a subject makes the following choices:

Row	Option A	Option B	Choice
1	\$100 today	\$101 in 1 month	A
2	\$100 today	\$103 in 1 month	A
3	\$100 today	\$105 in 1 month	A
4	\$100 today	\$107 in 1 month	A
5	\$100 today	\$110 in 1 month	B
6	\$100 today	\$115 in 1 month	B

This person switches between Row 4 and Row 5. This means that the person prefers \$100 today to \$107 in one month, but prefers \$110 in one month to \$100 today. Therefore, the amount that makes the person indifferent between receiving money today and receiving money in one month lies somewhere between \$107 and \$110.

10.5 Estimating the Discount Factor

The basic indifference condition is

$$D(x)SS = D(x+y)LL,$$

where $D(t)$ is the discount function, SS is the smaller-sooner reward, LL is the larger-later reward, x is the date of the earlier reward, and y is the delay between the two rewards.

If the earlier reward is received today, then $x = 0$ and we usually normalize $D(0) = 1$. The indifference condition becomes

$$SS = D(y)LL.$$

Solving for the discount factor gives

$$D(y) = \frac{SS}{LL}.$$

For example, suppose a student is approximately indifferent between receiving \$100 today and receiving \$110 in one month. Then the implied one-month discount factor is

$$D(1) = \frac{100}{110} = 0.90 = \delta.$$

This means that, for this student, one dollar received one month from now is valued at about 90.9 cents today.

10.6 Estimating the Discount Rate

The discount factor can also be expressed as a discount rate. If the delay is one period, then the discount factor and discount rate are related by

$$\delta = \frac{1}{1+\rho}.$$

Solving for ρ, we get

$$\rho = \frac{1}{\delta} - 1.$$

Using the previous example, where $\delta = 0.909$, the implied monthly discount rate is

$$\rho = \frac{1}{0.909} - 1 \approx 0.10.$$

Thus, the student has an implied monthly discount rate of approximately 10%. In simple terms, this means that the student requires about 10% more money in one month in order to be willing to wait.

10.7 Measuring Present Bias

A useful feature of the MPL method is that it can be used to measure present bias. Present bias occurs when people place extra weight on rewards or costs that occur immediately. A person with present bias may be very impatient when choosing between today and the near future, but much more patient when choosing between two future dates.

To measure this, researchers often compare two MPLs. The first MPL compares today with one month from now. The second MPL compares six months from now with seven months from now.

Row	Option A	Option B	Choice
1	$100 in 6 months	$101 in 7 months	A / B
2	$100 in 6 months	$103 in 7 months	A / B
3	$100 in 6 months	$105 in 7 months	A / B
4	$100 in 6 months	$107 in 7 months	A / B
5	$100 in 6 months	$110 in 7 months	A / B
6	$100 in 6 months	$115 in 7 months	A / B
7	$100 in 6 months	$120 in 7 months	A / B
8	$100 in 6 months	$125 in 7 months	A / B
9	$100 in 6 months	$130 in 7 months	A / B
10	$100 in 6 months	$140 in 7 months	A / B

Notice that both MPLs involve a one-month delay. The difference is that the first list includes an immediate reward, while the second list does not.

If a student requires much more money to wait from today to one month than to wait from six months to seven months, this is evidence of present bias. For example, suppose a student switches at $125 in the first MPL but at $105 in the second MPL. This suggests that the student is much more impatient when the earlier reward is available immediately.

10.8 Interpreting Student Responses

The interpretation of an MPL is straightforward.

A student who switches early from the smaller-sooner option to the larger-later option is relatively patient. For example, if a student chooses $100 today over $101 in one month, but chooses $103 in one month over $100 today, then only a small reward is needed to make waiting attractive.

A student who switches late is relatively impatient. For example, if a student continues to choose \$100 today until the delayed reward reaches \$130 or \$140, then the student places a much lower value on future money.

A student may also display present bias. This occurs if the student is much more impatient in the today-versus-one-month choice than in the six-months-versus-seven-months choice. Present bias is important because it helps explain behaviors such as procrastination, under-saving, unhealthy consumption, and difficulty following long-term plans.

10.9 Limitations of the MPL Method

Although MPLs are widely used, they are not perfect. First, the estimated discount factor is usually an interval rather than an exact number. If a person switches between \$107 and \$110, we know that their indifference point lies somewhere between those two values, but we do not know the exact value.

Second, subjects may make inconsistent choices. For example, a subject might choose the later reward in one row but then return to choosing the earlier reward in a later row. Researchers must decide how to handle these multiple switching points.

Third, hypothetical payments may produce different answers from real payments. In many experiments, researchers use real monetary incentives so that subjects have a stronger reason to reveal their true preferences.

Finally, choices over money may not fully capture time preferences over other outcomes, such as health, effort, studying, or unpleasant tasks. A person may be patient with money but impatient with effort, or the reverse.

10.10 Why This Measurement Matters

Measuring time preferences is important because many economic decisions involve tradeoffs between the present and the future. Saving, borrowing, investing, studying, exercising, dieting, and completing assignments all require people to compare immediate costs and benefits with future costs and benefits.

The MPL method gives researchers a simple and useful way to measure impatience, discount rates, and present bias. It also connects directly to the ideas of exponential discounting, hyperbolic discounting, and time inconsistency discussed in this lecture.