Behavioral Economics

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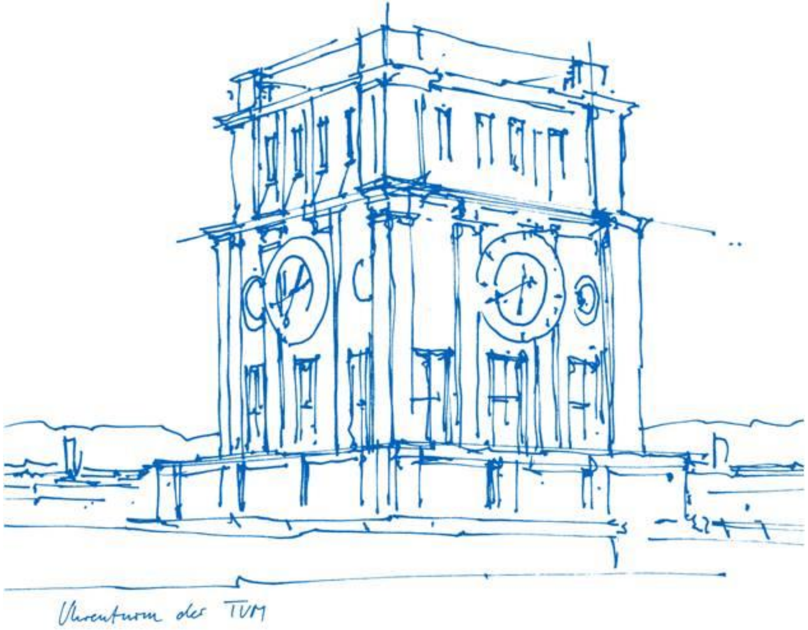
Winter 2023/24



Semester Plan

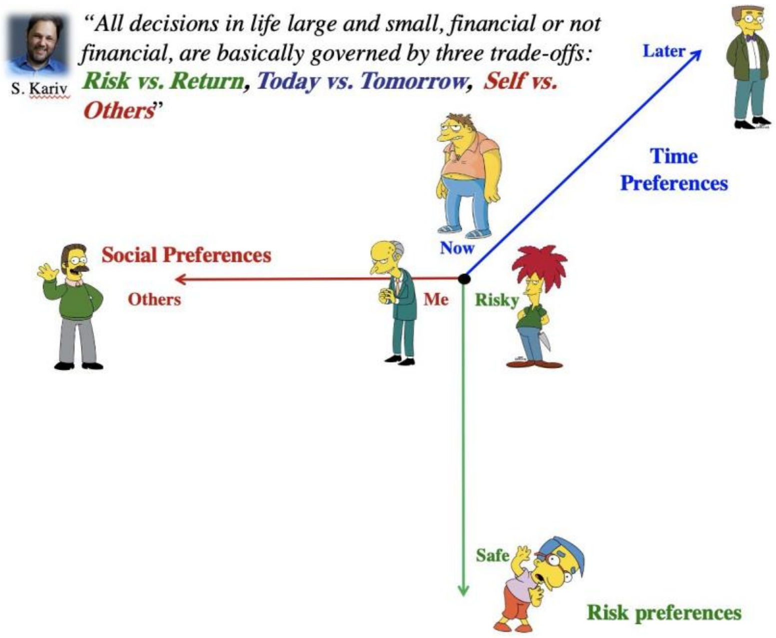
Course Overview

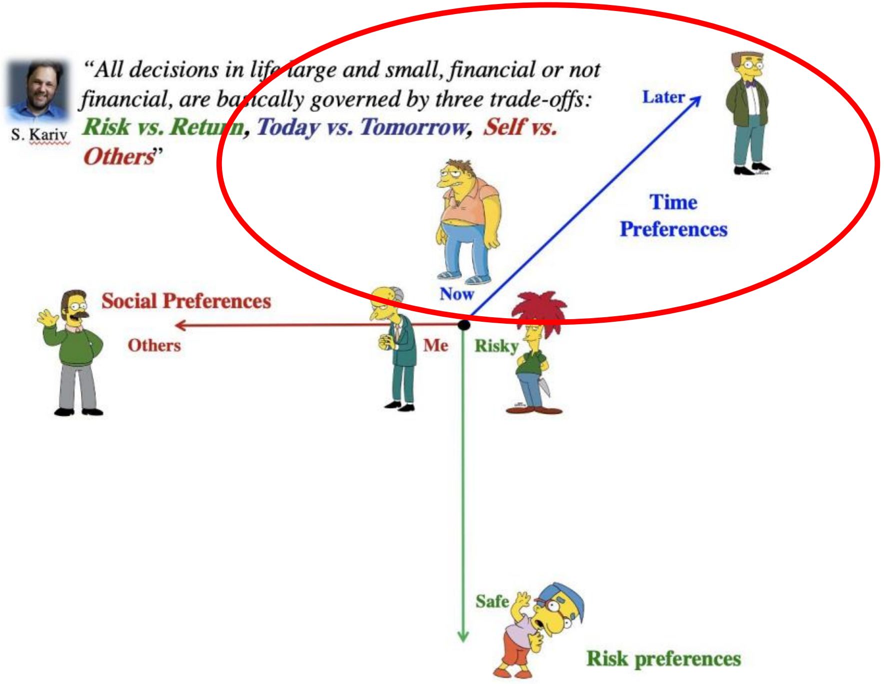
I. What is Behavioural Economics
II. Principles of Experimental Economics
III. The Standard Economic Model: Consumer Theory
IV. Reference dependence & departures from the standard model
V. Decisions Under Risk and Uncertainty
VI. Intertemporal Choice
VII. Interaction with others: Game Theory
VIII. Interaction with others: Social Preferences

Today

VI. Intertemporal Choice - Choosing when to act

- Exponential discounting
- Hyperbolic discounting
- Quasi-hyperbolic discounting
- Temptation and commitment
- Applications
  - Borrowing and saving
  - Time inconsistency and firm pricing
  - Climate change


S. Kariv
"All decisions in life large and small, financial or not financial, are basically governed by three trade-offs: Risk vs. Return, Today vs. Tomorrow, Self vs. Others"
Later
Time Preferences
Now
Social Preferences
Others
Me
Risky
Safe
Risk preferences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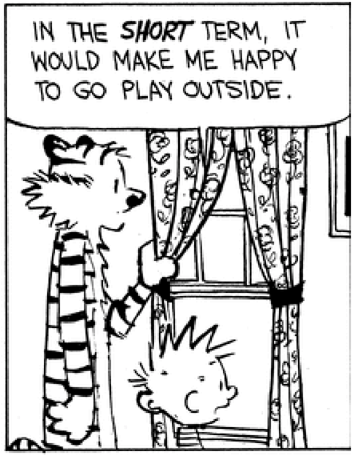
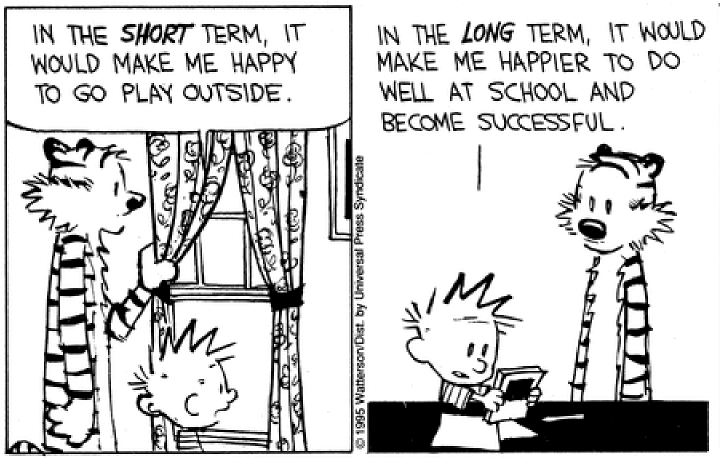
Inter-temporal decisions



Inter-temporal decisions



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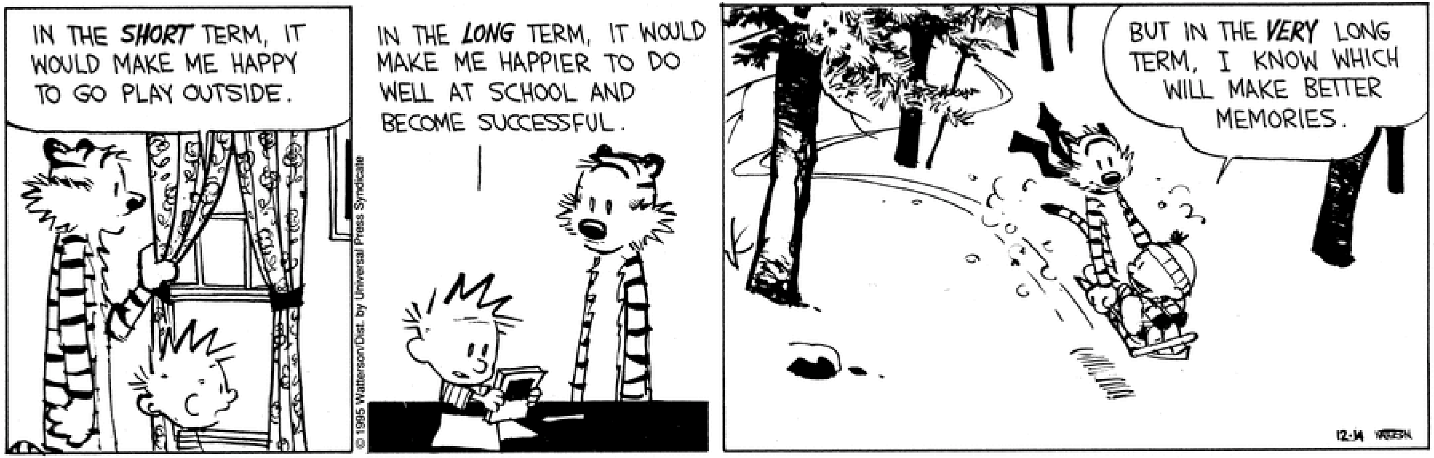
Inter-temporal decisions



Inter-temporal utility function

- A person will get a stream of utility through time. She gets utility u_t in period t.
- An inter-temporal utility function combines this stream of utility to give a measure of overall utility.
- Note: the person may also see the stream of utility as a sequence.

Today

VI. Intertemporal Choice - Choosing when to act

- **Exponential discounting**
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- Quasi-hyperbolic discounting
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- Applications
  - Borrowing and saving
  - Time inconsistency and firm pricing
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Exponential discounting

Most commonly used is a utility function with exponential discounting

$$u^T(u_1, u_2, \ldots, u_T) = u_1 + \delta u_2 + \ldots + \delta^{T-1} u_T = \sum_{t=1}^{T} \delta^{t-1} u_t .$$

Where δ is the discount factor.

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Where δ is the discount factor.

If the discount factor is $\delta = 0.8$ then \$10 next period are worth \$8 today (for $u(x)=x$).

More generally \$10 next period are worth δ\$10 today.

Thus, the smaller $\delta < 1$ the more impatient the person is.

Exponential discounting

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The discount factor is related to the discount rate

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

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Where δ is the discount factor.

The discount factor is related to the discount rate

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

If the discount factor is $\delta=0.8$, then the discount rate is $\rho = 0.25$. The person would require an interest rate of 25% to delay until next period. For example, instead of $8 today, she would accept $1.25 \times \$8 = \$10$ next period. She would refuse any amount smaller than $10 and take $8 today. She would accept any amount equal or above $10 to wait until next period. The larger the discount rate, the more impatient the person is.

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Exponential discounting

Most commonly used is a utility function with exponential discounting

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Where δ is the discount factor.

The discount factor is related to the discount rate

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

The name for exponential discounting comes from the equation for utility in continuous time:

$$u^T = \int_0^T e^{-\rho t} u_t$$

Example: When should Maria do her homework?

Maria’s homework was set on Friday and is due on Monday. Maria is planning when to do the homework.

There are a couple of things she considers:

- Doing homework is not fun
- She has no fun activities on Friday
- She has some plans for fun activities on Saturday
- She has some big-time plans for fun activities on Sunday
- Doing the homework on a weekend will result in better grades

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Example: When should Maria do her homework?

Maria’s homework was set on Friday and now she is planning when to do the homework.

There are a couple of things she considers:

- Doing homework is not fun
- She has no fun activities on Friday
- She has some plans for fun activities on Saturday
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- Doing the homework on a weekend will result in better grades

Plan	Utility on			
	Friday	Saturday	Sunday	Monday
Do it Friday	−5	5	10	4
Saturday	0	−5	10	10
Do it Sunday	0	5	−5	10
Do it Monday	0	5	10	–5

Example: When should Maria do her homework?

What are Maria's inter-temporal utilities from the different plans if her discount rate is

- $\delta=1$?
- $\delta=0.7$?

Use exponential discounting!

Plan	Utility on			
	Friday	Saturday	Sunday	Monday
Do it Friday	−5	5	10	4
Saturday	0	−5	10	10
Do it Sunday	0	5	−5	10
Do it Monday	0	5	10	–5

Inter-temporal utility in homework example

Plan	Inter-temporal utility		
	$\delta = 1$	$\delta = 0.9$	$\delta = 0.7$
Do it Friday	14	10.5	4.7
Do it Saturday	15	10.9	4.8
Do it Sunday	10	7.7	4.5
Do it Monday	10	9.0	6.7

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Inter-temporal utility in homework example

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Estimating discount factors for different choices

Benzion, Rapoprt, and Yagil (1989)

Experimental Design:

- Subject are asked four basic types of questions
  - **Postpone receipt**: You have just earned **[$200]** but have the possibility to delay receiving it by **[one year]**. How much money would you need to get after a year in order to want to delay the payment?
  - **Postpone payment**: You need to pay back a debt of **[$200]** but have the possibility to delay payment by **[one year]**. How much money would you be willing to pay back after a year if payment is delayed?
  - **Expedite receipt**: You will get **[$200]** in **[one year]** but have the possibility to receive the money immediately. How much money would you accept now rather than wait?
  - **Expedite payment**: You need to pay back a dept of **[$200]** in **[one year]** but have the possibility to pay now. How much would you be willing to pay now rather than pay off the debt later.

What does this experiment measure:

- Discount factors for different types of choices

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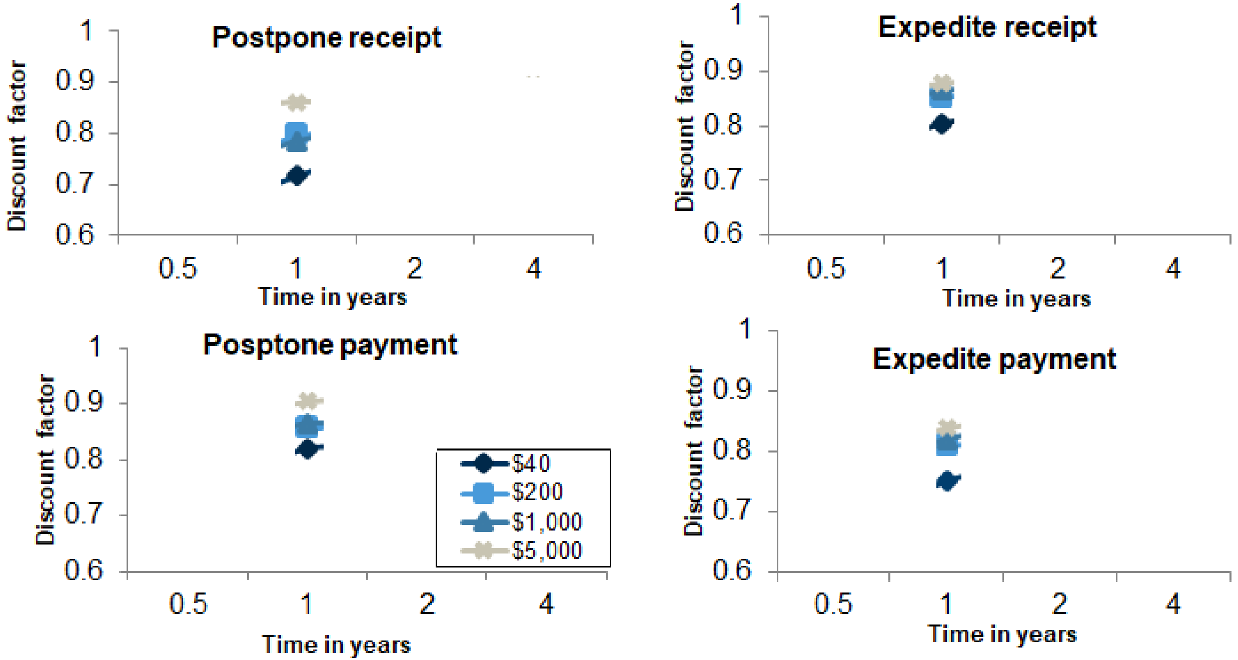
Estimated discount factors

Benzion, Rapoport, and Yagil (1989)



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Estimated discount factors

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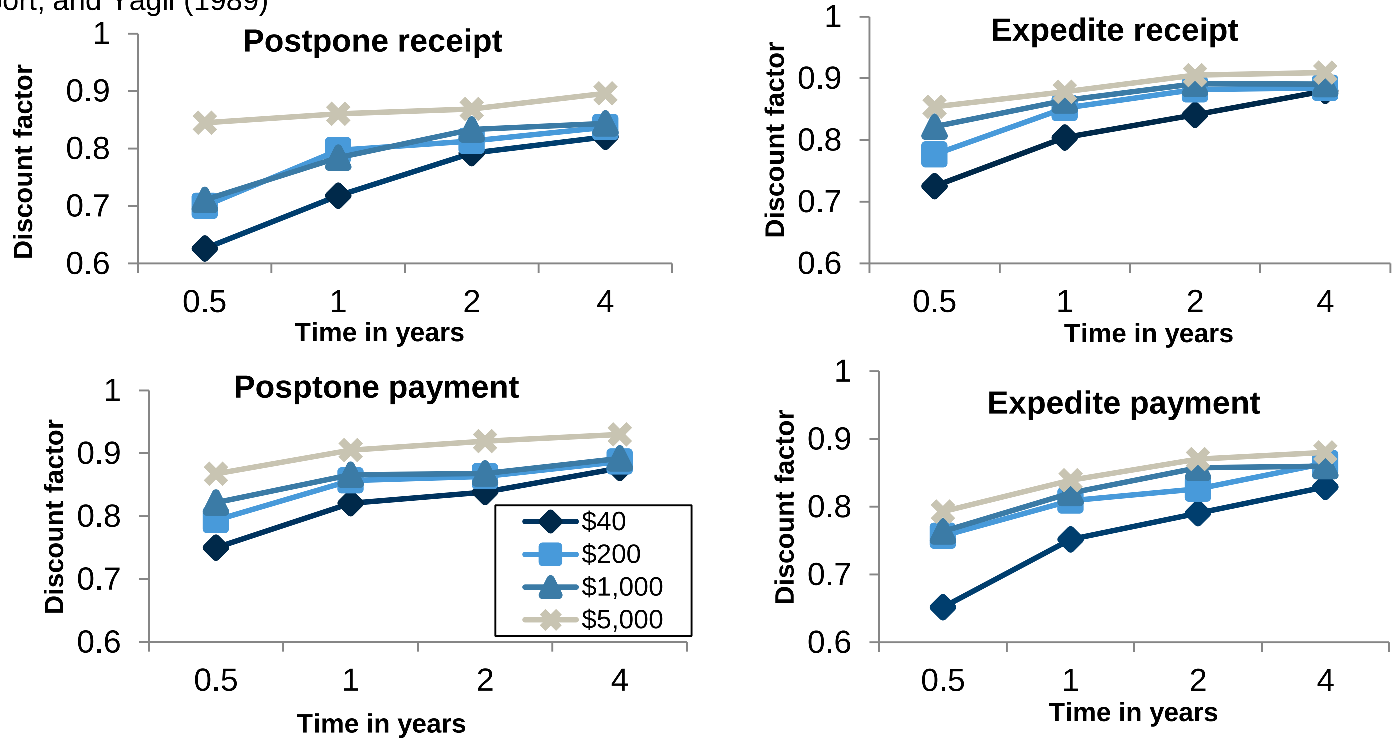

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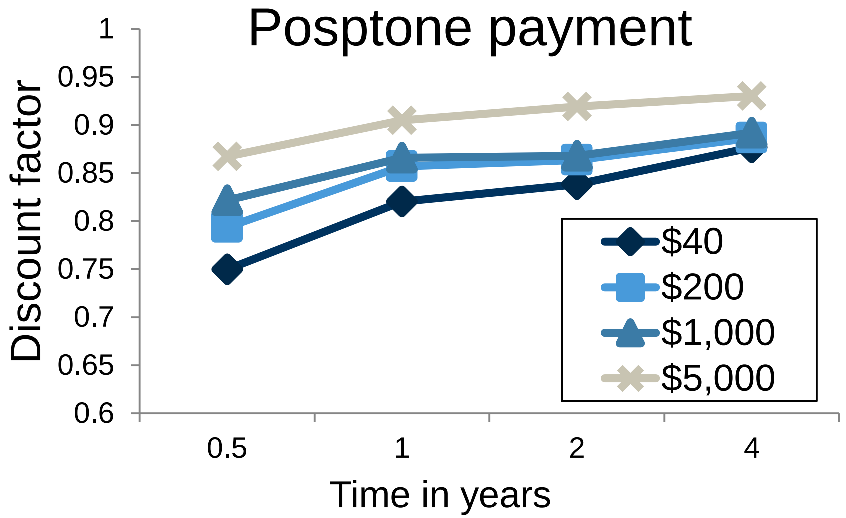
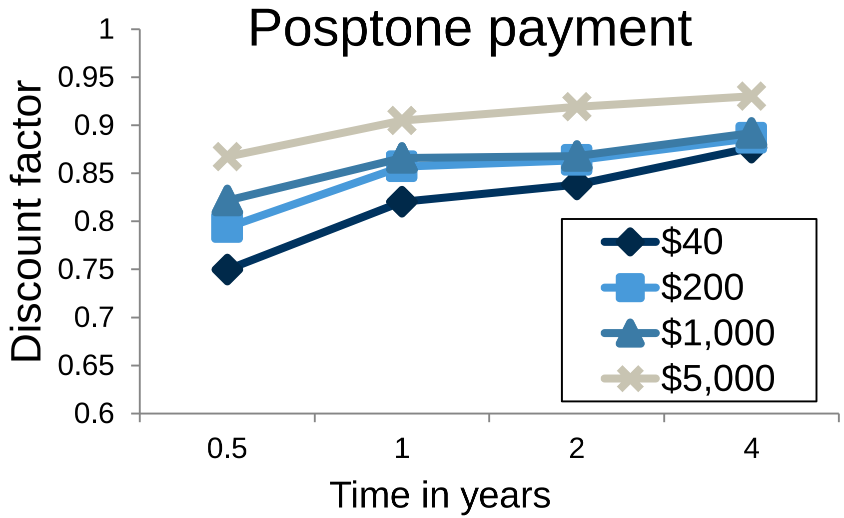


Short-term impatience: The discount factor is lower for smaller time periods

Estimated discount factors

Benzion, Rapoport, and Yagil (1989)



Short-term impatience: The discount factor is lower for smaller time periods

Absolute magnitude effect: The discount factor is larger for larger amounts of money.

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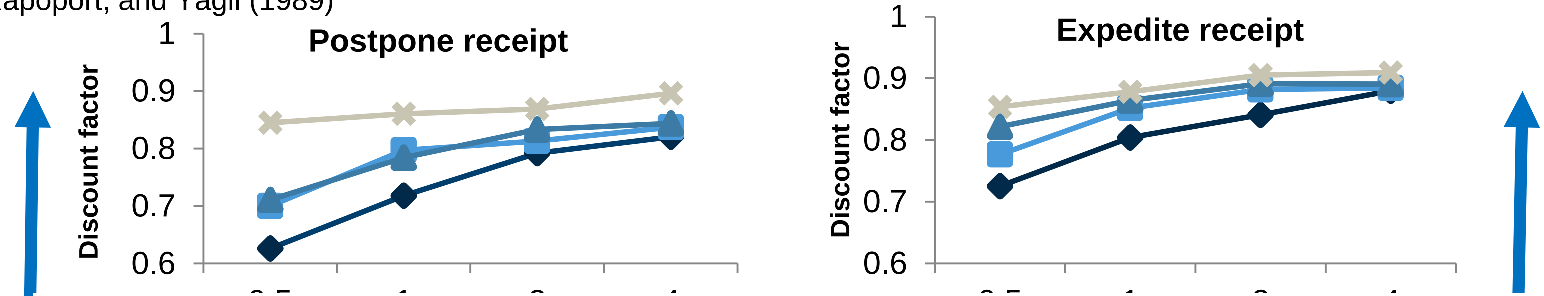
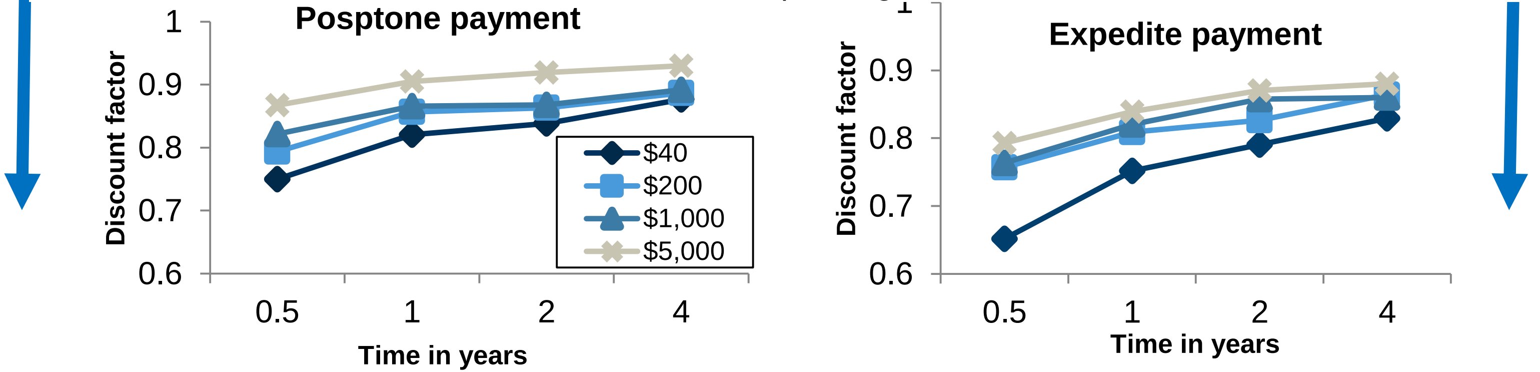
Estimated discount factors

Benzion, Rapoport, and Yagil (1989)



Gain-loss asymmetry: The discount factor is higher for postponing payments than receipts vice versa for expediting



Estimated discount factors

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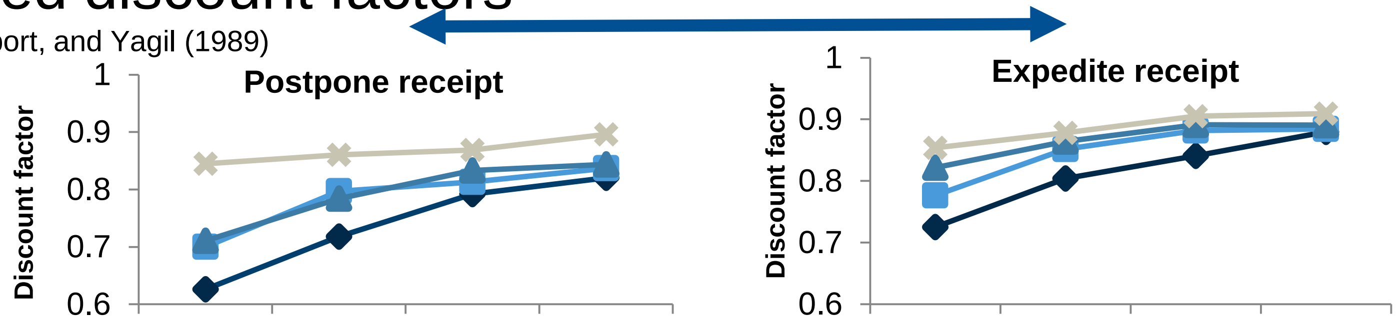
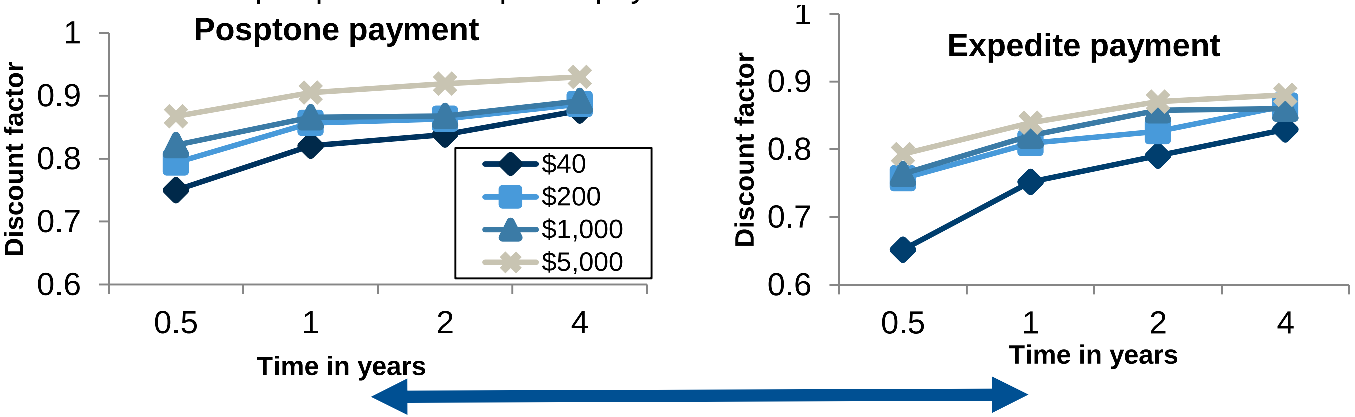


Delay-speedup asymmetry: The discount factor is higher to expedite than postpone receipt and to postpone than expedite payment



Preference for an improving sequence

Loewenstein and Prelec (1993)

Experimental Design:

- Ask subjects how they would like to time good and bad events
- Topic 1:
  - Travel on two weekends to a city where friends (very much liked) and an aunt (not very much liked) live. Per trip you can only do one visit. Who do you visit during your first trip and during your second trip?
- Topic 2:
  - For the next three weekends you have to plan if you dine out or eat at home

What does this experiment measure:

- How subject sequence good and bad events

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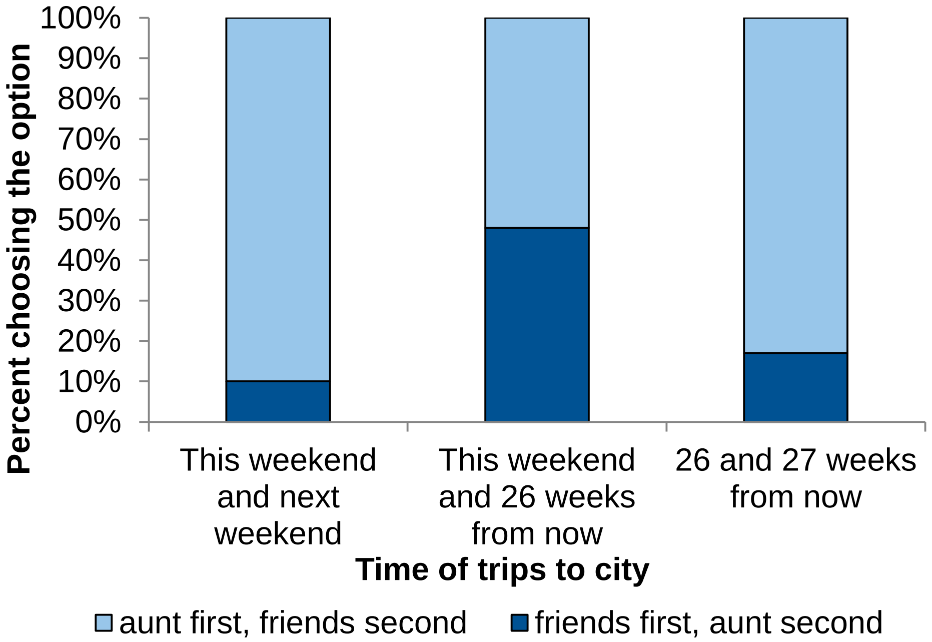
Preference for an improving sequence

Loewenstein and Prelec (1993)



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Preference for an improving sequence

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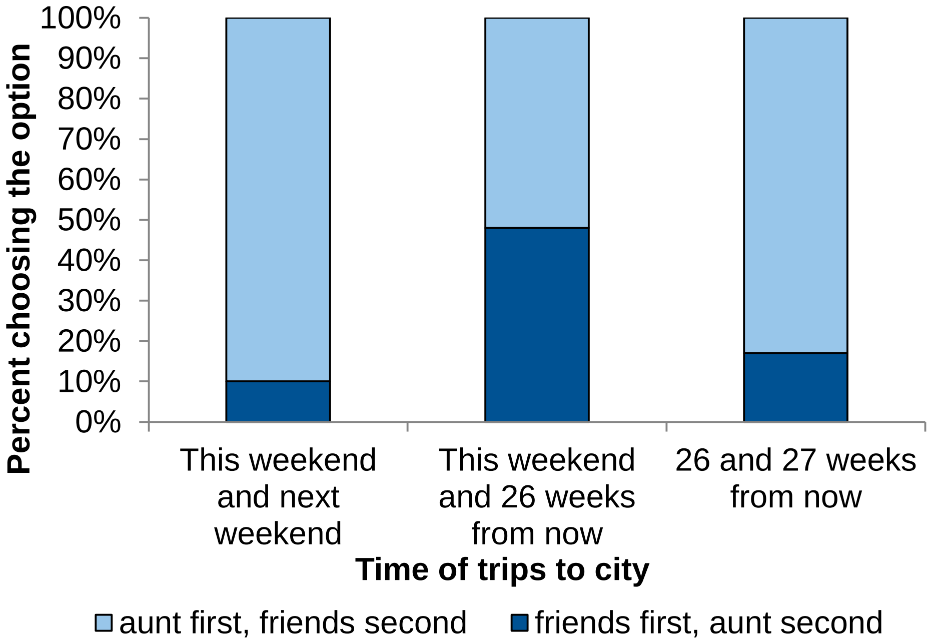

While it might seem intuitive to have preferences for an improving sequence it is the opposite of what exponential discounting would predict.

Preference for an improving sequence

Loewenstein and Prelec (1993)

Option	This weekend	Next weekend	Two weekends away	choices
A	Fancy French	eat at home	eat at home	16%
B	eat at home	Fancy French	eat at home	84%

Preference for an improving sequence

Loewenstein and Prelec (1993)

Option	This weekend	Next weekend	Two weekends away	choices
A	Fancy French	eat at home	eat at home	16%
B	eat at home	Fancy French	eat at home	84%
C	Fancy French	eat at home	Fancy Lobster	54%
D	eat at home	Fancy French	Fancy Lobster	46%

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Preference for an improving sequence

Loewenstein and Prelec (1993)

Option	This weekend	Next weekend	Two weekends away	choices
A	Fancy French	eat at home	eat at home	16%
B	eat at home	Fancy French	eat at home	84%
C	Fancy French	eat at home	Fancy Lobster	54%
D	eat at home	Fancy French	Fancy Lobster	46%

While it might seem intuitive to spread good events over time, the change in preferences is not in line with exponential discounting.

The switch in choices should not happen, because the utility in period three should not affect optimal choices in the periods one and two.

Today

VI. Intertemporal Choice - Choosing when to act

- Exponential discounting
- **Hyperbolic discounting**
- Quasi-hyperbolic discounting
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Hyperbolic discounting

The most direct way to account for short-term impatience is make the discount factor increase over time.

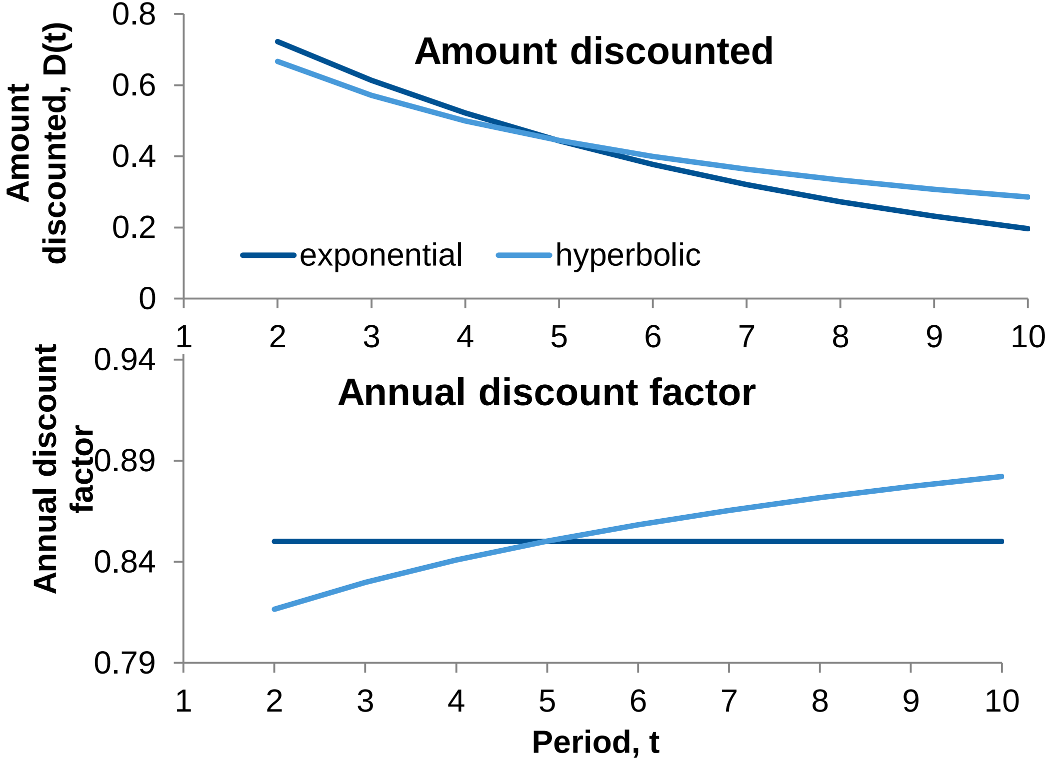
Exponential discounting uses

$$D(t) = \delta^{t-1}.$$

An alternative is

$$D(t) = \frac{1}{1 - \alpha(t-1)}$$

δ = 0.85 vs α = 0.25



Quasi-hyperbolic discounting

Do you want:

- $100 today or $110 tomorrow?

Quasi-hyperbolic discounting

Do you want:

- $100 today or $110 tomorrow?
- $100 in 30 days time or $110 in 31 days?

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Quasi-hyperbolic discounting

Do you want:

- $100 today or $110 tomorrow?
- $100 in 30 days time or $110 in 31 days?

Quasi-hyperbolic discounting

Do you want:

- $100 today or $110 tomorrow?
- $100 in 30 days time or $110 in 31 days?

If we ask you the same question after 30 days do you think the answers will have changed?

People tend to have **present-biased preferences**. Maria does not postpone her homework today, or chooses the $100 today, because it is Friday, 1st of May and on Friday, 1st of May.
Instead: she is always impatient for immediate gains

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(β, δ)-preferences - quasi-hyperbolic discounting

A simple model of quasi-hyperbolic discounting is to assume present bias. β measures the extent of present bias, the smaller it is the more weight is given to today relative to the future.

$$u^T(u_1, u_1, \ldots, u_T) = u_1 + \beta \sum_{t=2}^{T} \delta^{t-1} u_t$$

$\beta < 1$: More weight is given to today than to the future

$\beta = 1$: No bias

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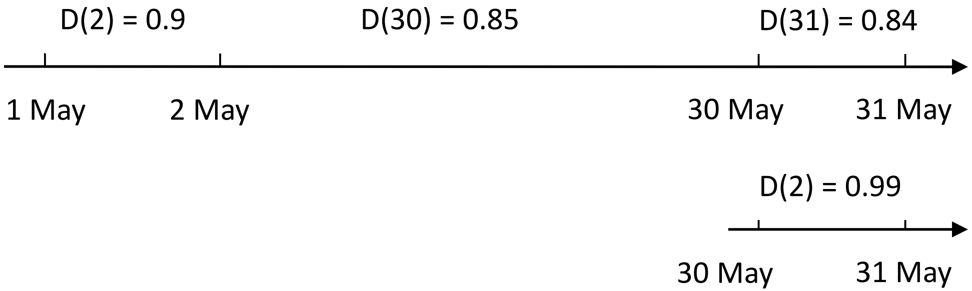
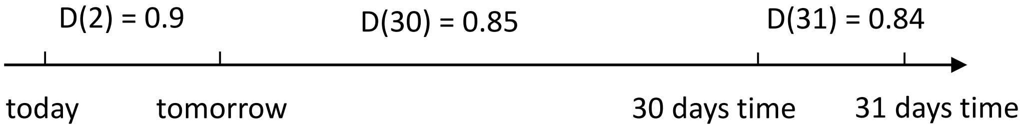
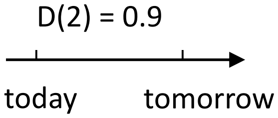
Homework example: present biased preferences

Time consistent preferences , e.g. a model of hyperbolic discounting



Present biased preferences, e.g. a model of quasi-hyperbolic discounting





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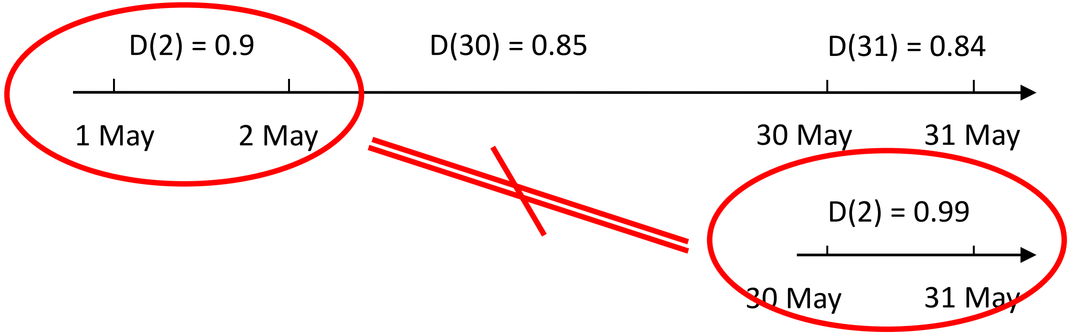
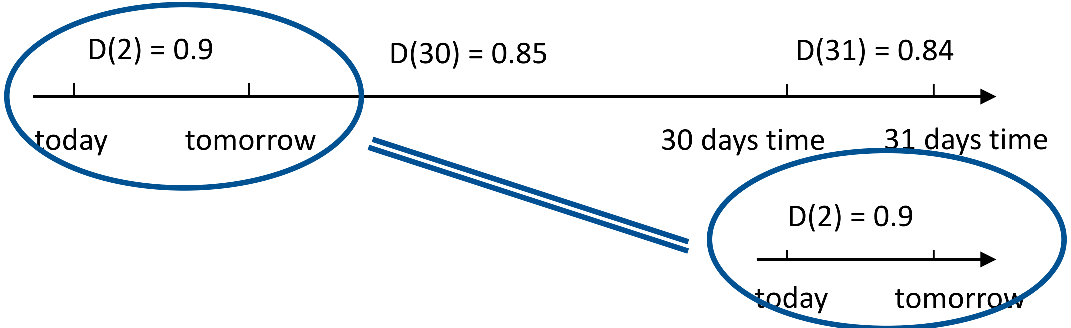


Present biased preferences, e.g. a model of quasi-hyperbolic discounting



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Quasi-hyperbolic preferences in the homework example

	$\beta = 1, \delta = 0.9$		$\beta = 0.9, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	Saturday	On Friday	Saturday	On Friday	Saturday
Do it Friday	10.5	-	9.0	-	7.4	-
Saturday	10.9	12.1	9.8	10.4	8.7	8.7
Sunday	7.7	8.6	7.0	8.2	6.2	7.9
Monday	9.0	10.0	8.1	9.5	7.2	9.0

Quasi-hyperbolic preferences in the homework example

	$\beta = 1, \delta = 0.9$		$\beta = 0.9, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	Saturday	On Friday	Saturday	On Friday	Saturday
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Sunday	7.7	8.6	7.0	8.2	6.2	7.9
Monday	9.0	10.0	8.1	9.5	7.2	9.0

Plans on Friday to do the homework on Saturday and on Saturday does the homework

Quasi-hyperbolic preferences in the homework example

	$\beta = 1, \delta = 0.9$		$\beta = 0.9, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	Saturday	On Friday	Saturday	On Friday	Saturday
Do it Friday	10.5	-	9.0	-	7.4	-
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Sunday	7.7	8.6	7.0	8.2	6.2	7.9
Monday	9.0	10.0	8.1	9.5	7.2	9.0

Plans on Friday to do the homework on Saturday but on Saturday does not do the homework

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Quasi-hyperbolic preferences in the homework example

	$\beta = 1, \delta = 0.9$		$\beta = 0.9, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	Saturday	On Friday	Saturday	On Friday	Saturday
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Sunday	7.7	8.6	7.0	8.2	6.2	7.9
Monday	9.0	10.0	8.1	9.5	7.2	9.0

Plans on Friday to do the homework on Saturday but on Saturday does not do the homework

Quasi-hyperbolic preferences can account for time inconsistencies!

Naïve vs sophisticated

A person with time inconsistent preferences may be naïve and not know about the inconsistency.

Or she may be sophisticated and know about the inconsistency.

Sophistication helps avoid procrastination but can lead to preproperation.

Time inconsistency in the homework example

	$\beta = 1, \delta = 0.9$		$\beta = 0.9, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	Saturday	On Friday	Saturday	On Friday	Saturday
Do it Friday	10.5	-	9.0	-	7.4	-
Saturday	10.9	12.1	9.8	10.4	8.7	8.7
Sunday	7.7	8.6	7.0	8.2	6.2	7.9
Monday	9.0	10.0	8.1	9.5	7.2	9.0

If she is sophisticated she will do it on Friday!

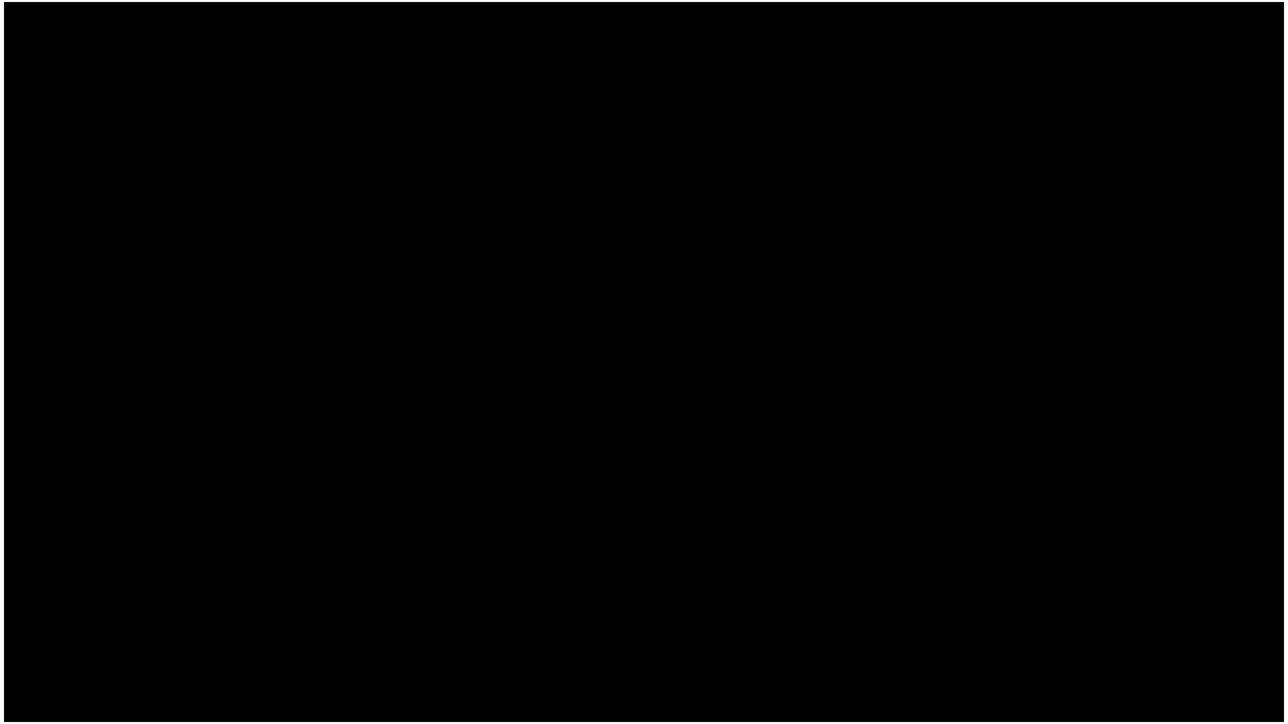
Movie example: when should Maria watch a movie?

Plan	Payoff on		
	Friday	Saturday	Sunday
Go on Friday	5	0	0
Go on Saturday	0	6	0
Go on Sunday	0	0	8

	$\beta = 1, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
Plan	On Friday	On Saturday	On Friday	On Saturday
Go on Friday	5.0	-	5.0	-
Saturday	5.4	6.0	4.3	6.0
Sunday	6.5	7.2	5.2	5.8

Preproperation!
She does things early!

Self-Control - The Marshmallow Test



https://www.youtube.com/watch?v=Wz1pnFBLZM4

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Self-Control - The Marshmallow Test

Decades of research can be summarized as follows:

- Patience increases with age of the child
- Patient children do better in later life than less patient children (higher education/income)
- Children from addicted parents are usually less patient
- Patience is positively correlated with intelligence and SAT scores

Self-Control - The Marshmallow Test

Decades of research can be summarized as follows:

- Patience increases with age of the child
- Patient children do better in later life than less patient children (higher education/income)
- Children from addicted parents are usually less patient
- Patience is positively correlated with intelligence and SAT scores

However, patience as measured with this test is correlated with the children's socio-economic background (Watts, Duncan and Quan, 2018).

See also https://www.theatlantic.com/family/archive/2018/06/marshmallow-test/561779/

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Delayed benefits versus delayed costs

	Delayed cost Homework example		Delayed benefit Movie example	
	Choice	Payoff	Choice	Payoff
Time-consistent	Saturday	10.9	Sunday	6.5
Naive	Monday	9	Saturday	5.4

So what if I am aware of my impatience? What if I am sophisticated and know what I will do?

Delayed benefits versus delayed costs

	Delayed cost Homework example		Delayed benefit Movie example	
	Choice	Payoff	Choice	Payoff
Time-consistent	Saturday	10.9	Sunday	6.5
Sophisticated	Friday	7.4	Friday	5.0
Naive	Monday	9	Saturday	5.4

So what if I am aware of my impatience?

If Maria knows, that she will delay her homework on Saturday,
then on Friday she knows that her real choice is between doing it on Friday and Monday

If Maria knows, that she will go to the movies on Saturday,
then on Friday she knows that her real choice is between doing it on Friday and Saturday

Today

VI. Intertemporal Choice - Choosing when to act

- Exponential discounting
- Hyperbolic discounting
- Quasi-hyperbolic discounting
- **Temptation and commitment**
- Applications
  - Borrowing and saving
  - Time inconsistency and firm pricing
  - Climate change

Commitment and temptation

Pre-commitment can serve two distinct purposes for someone with time-inconsistent preferences:

- In situations where he would have behaved in a time-inconsistent way the pre-commitment avoids him doing so.

Commitment and temptation

Pre-commitment can serve two distinct purposes for someone with time-inconsistent preferences:

- In situations where he would have behaved in a time-inconsistent way the pre-commitment avoids him doing so.
- In situations where he would have behaved in a time-consistent way the pre-commitment avoids him having to overcome temptation.

Commitment and temptation

Odysseus and the Sirens, Roman mosaic, ca. 200 AD

Odysseus and the Sirens,
1891, John William Waterhouse

The Siren of Canosa,
ca. 400-300 BC

Odysseus and the Sirens, ca 475 BC

Commitment and temptation

Ulysses/Odysseus has two options:

- A = Continue the journey home
- B = Approach the Sirens island

Odysseus' preferences are time-inconsistent:

- his self 0 prefers A
- his self 1 prefers B
- Thus, his self 0 and self 1 have different preferences over {A, B}.

Commitment and temptation

A commitment device is a strategy that allows us to bind our future selves when we expect that our future choices would deviate be bad for our long-term interests. Odysseus uses such a commitment device:

- He asks his sailors to tie him to the mast and to put wax in their ear to keep rowing

It allowed him to implement option A instead of option B. Without this commitment he might have impulsively selected option B, which would have harmed his long-term interest.

- his self 0 benefits from the commitment device
- his self 1 is harmed; his freedom of choice has been restricted

Are individuals naive or sophisticated?

Ariely and Wertenbroch (2002)

Experimental Design:

- Executive-education students at MIT could self-impose deadlines for their term paper.
- The students have to write three short papers within a 14 week-period.
- In the “NoChoice” condition, the deadlines for the three papers are evenly spaced. In the “FreeChoice” condition, students can choose the deadline for each of the three papers.
- Each day of delay results in a penalty equivalent to 1% of the final grade. No advantages (e.g., feedback, early grade) were provided for early submission.
- The standard model thus predicts that setting the three deadlines as late as possible

What does this experiment measure:

- Can subjects work with commitment devices and are they naïve or sophisticated?

Are individuals naive or sophisticated?

Ariely and Wertenbroch (2002)

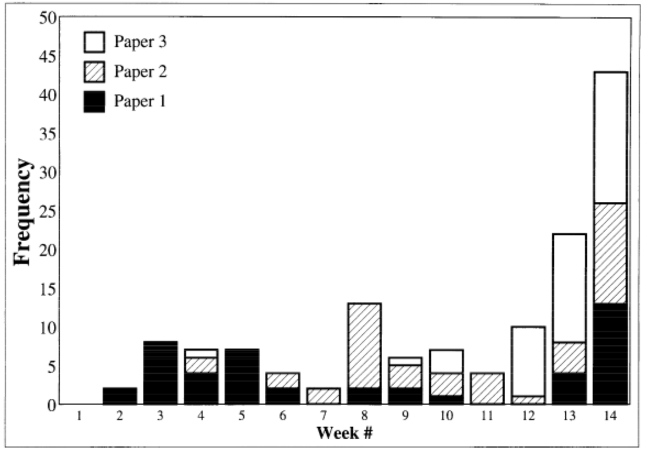

Fig. 1. Frequency distribution of the declared deadlines in Study 1 as a function of the week of class (Week 1 is the first week, and Week 14 the last week), plotted separately for the three papers.

Individuals are willing to bind themselves by setting early deadlines. Two possibilities:

a) Fully sophisticated students with procrastination problems would improve their grades.
b) Students have procrastination problems and are naive about it, deadlines lower their grades since they do not choose optimal deadlines.

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Are individuals naive or sophisticated?

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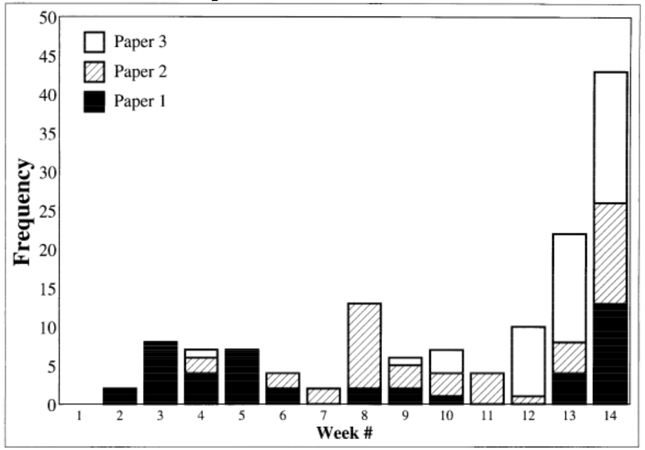

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Supported by the data!

Theory summary

- Exponential discounting is a simple way to model inter-temporal choice.
- But, we observe short-term impatience, gain-loss asymmetry, delay-speed up asymmetry, absolute magnitude effect, preference for improving sequences, ...
- Models of hyperbolic discounting and quasi-hyperbolic discounting are alternatives.
- Quasi-hyperbolic discounting can lead to time-inconsistent choices. Can contrast sophisticated an naïve time-inconsistency.

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Application 1: Borrowing and saving

Key issues:

- Saving and borrowing involve trade-offs over time.

Why save when you have debts?

Many people simultaneously

- borrow at high interests on credit cards.
- save at low interest rates.

This can be explained by naïve present biased preferences. For example $\beta = 0.9$ and $\delta = 0.96$ gives a short term discount rate of 14.6% and long term rate of 4.1%.

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Application: Firm pricing

Key issues:

- Can firms exploit consumers with present-biased preferences?
- Does it matter if the consumer is naïve or sophisticated?
- How can firms best exploit present-bias?
- Do consumers have a preference for fixed or variable tariffs?

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Effective cost per visit to the gym

Della Vigna and Malmendier (2006)

Attendance data from over 7,000 health club members

People going to the gym had 4 basic options:

- Pay $12 per visit
- Pay $100 every ten visits
- Pay $85 per month for a monthly contract (opt-out)
- Pay $850 for an annual contract (opt-in)

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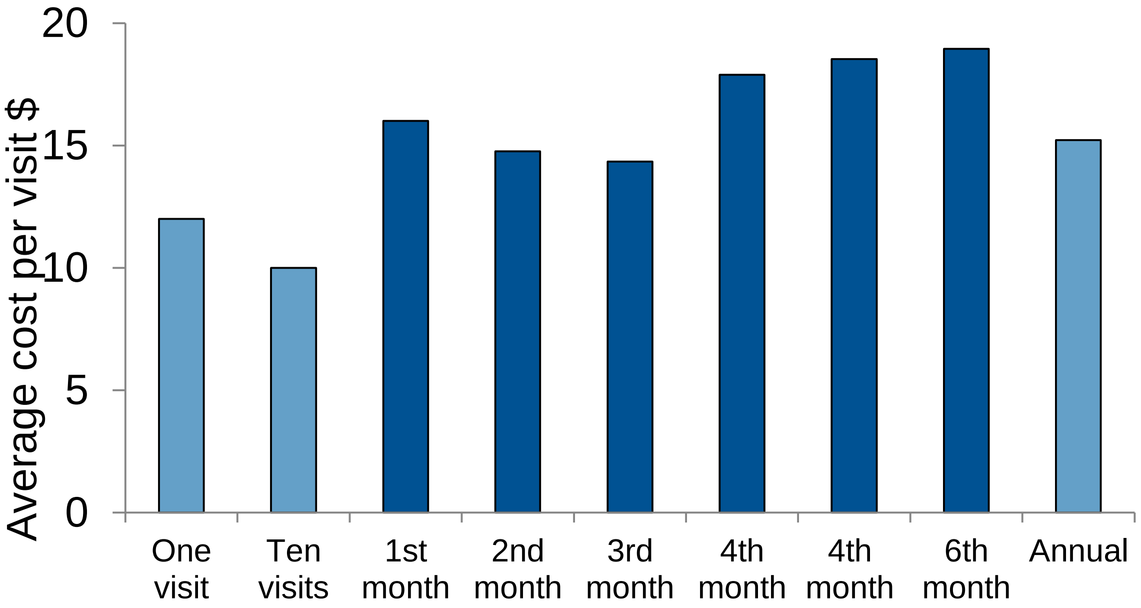

Two-part tariff timeline

Period 1
Maria finds out the **membership fee is L** and the **user fee is p**.
She decides to join or not.

Two-part tariff timeline

Period 1
Maria finds out the **membership fee is L** and the **user fee is p**.
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Period 2
If she joins she pays fee L.
She learns her personal cost c of going to the gym.
She decides whether or not to go to the gym.

Two-part tariff timeline

Period 1
Maria finds out the **membership fee is L** and the **user fee is p**.
She decides to join or not.

Period 2
If she joins she pays fee L.
She learns her personal cost c of going to the gym.
She decides whether or not to go to the gym.

Period 3
If she went to the gym she gets benefit B.

Effective cost per visit to the gym

Della Vigna and Malmendier (2006)

- Lots of people are worse off with the monthly payment scheme than with the pay-as-you-go scheme.
- Consumers with the monthly payment scheme are more likely to stay enrolled beyond one year than users choosing the annual contract.
- Most promising explanations:
  - Overconfidence (over-estimation of future self-control),
  - Persuasion by health club employees.
  - Time inconsistency and naivety ($\beta = 0.7$ $\delta = 0.9995$) can explain behavior
- The “mistakes” entail a huge loss on the consumer side.

Choice of calling plan

Miravete (2003)

Telephone calling plans from the 80s

Customers could choose a flat rate plan for $18.70 or a measured tariff of $14.02 + call charges

Survey with customers

Choice in October	flat	flat	measured	measured
Choice in December	flat	measured	flat	measured
Number of customers	953	43	41	375
Under-estimated calls by 20% or more	26%	28%	32%	33%
Over-estimated calls by 20% or more	59%	49%	61%	49%
Made wrong choice in October	11%	44%	100%	57%
Made wrong choice in December	6%	7%	0%	67%

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Application: Environmental economics

Key issues:

- Environmental economics is primarily about trade-offs over time.
- Should we protect the environment for future generations?
- How much should we sacrifice for future generations?
- How can we reduce environmental damage most efficiently?

Inter-generational discount factor

How much weight to give to future generations? Three possible approaches:

- **Stern Review**
  - Give future generations full weight.
  - Get discount factor near 1.
- **Climate-policy ramp**
  - Use current interest rates.
  - Get discount factor around 0.95.
- **Recognize uncertainty**
  - The appropriate discount factor may be 0.999 or 0.95.

Inter-temporal utility from three different policies

Policy	Utility				
	Now	50 years	100 years	150 years	200 years
Do nothing	100	100	0	0	0
Climate-policy ramp	100	95	80	90	100
Immediate action	90	90	100	100	100

Examples for three policies compared

	δ when optimal	Inter-temporal utility			
		δ = 0.999	δ = 0.95	δ = 0.9745	Uncertain (0.5 δ =0.999; 0.5, δ =0.95)
Do nothing	0.945 or less	195.1	107.7	127.5	151.4
Climate-policy ramp	0.945 to 0.996	422.1	107.8	134.6	264.9
Immediate action	0.996 to 1	434.0	97.6	124.9	265.8

Key points

- The discount factor is context dependent.
- People may have time-inconsistent and reference dependent preferences.
- Future events can be seen as distinct events or part of a sequence.
- Present-biased preferences have important implications for consumer debt, firm pricing and protecting the environment.