Intertemporal Choices

Chapter 4

Why time is relevant

Time is important in most economic decisions because **the choices** we make will have **future consequences.**

- Should she go to university and get a qualification?
- Should she eat healthily and join a gym?
- **Do you preferer $100 today or $150 in one month**?

The answer to all these questions involves **weighing future benefits and costs with present benefits and costs** that each choice implies, i.e. we need to measure future consequences.

Homework example: when should Maria do her homework?

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

Intertemporal Utility Function

In order to weigh future benefits and costs against present benefits and costs we can use an inter-temporal utility function that **combines utility from each period with one measure of overall utility**.

The simplest way to do this would be to just add together the utility from each time period. Generally, however, she might want to **discount**, that is **give less weight to future utility**.

$$U(u_1, u_2, \dots, u_T) = u_1 + \delta u_2 + \delta^2 u_3 + \cdots + \delta^{T-1} u_T = \sum_{t=1}^{T} \delta^{t-1} u_t$$

Where:

- time runs from period 1 to period T
- u_t denotes utility of period t
- **δ is the discount factor**. **If $\delta < 1$ then less weight is given to the utility in a period the further away that period is**. The discount factor δ accounts for the **weighing of future consequences**: so, **the smaller the δ the more future utility is discounted**, i.e. the **more one is impatient**

Inter-temporal utility in homework example

Plan	Intertemporal utility		
	δ = 1	δ = 0.9	δ = 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

If δ = 0.7, she is more impatient to enjoy herself and does not do the homework until Monday.

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.
- The discount factor is related to the discount rate

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

Where δ ($0 < \delta \leq 1$) is the discount factor which captures time preference

- **patience = values close to 1:** *If your discount factor is high— close to one— you exhibit patience and do not discount the future much*
- **impatience = values close to 0:** *If your discount factor is low— close to zero—you exhibit impatience and discount the future heavily*

Evidence on Discounting

Benzion, Rapoport, and Yagil (1989) estimated the discount factor in the experimental lab by posing subjects questions along the lines of “Would you prefer $100 today or $150 in a year’s time?”

- **Postpone receipt** : You have just earned $200 but have the possibility to delay receiving it one year. How much money would you need to get after a year in order to want to delay payment?
- **Postpone payment** : You need to pay back a debt of $200 but have the possibility to delay payment 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 chance to receive the money immediately. How much money would you accept now rather than have to wait a year?
- **Expedite payment** : You need to pay back a debt of $200 in one year but can pay it now. How much would you be willing to pay now rather than pay off the debt after one year?

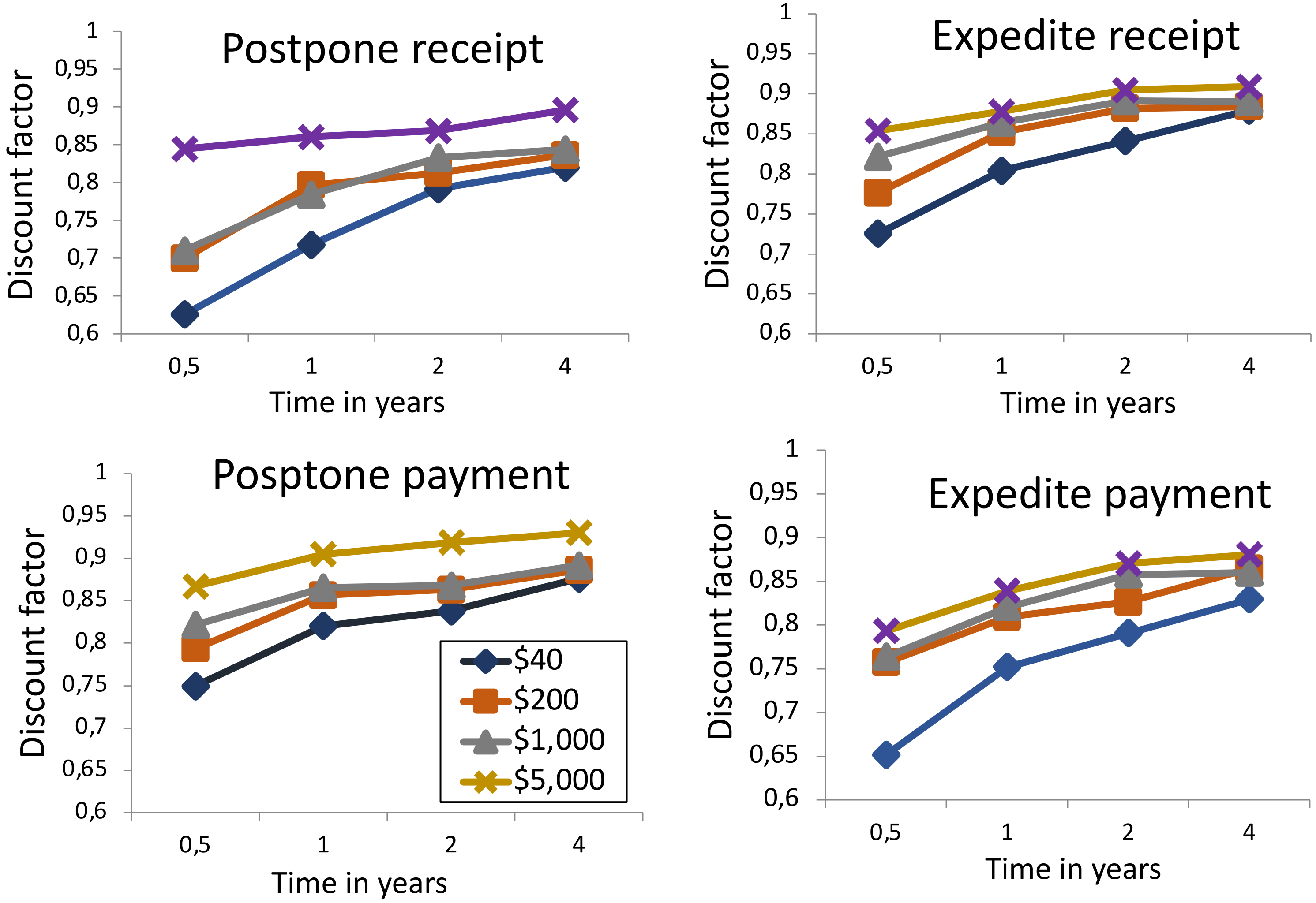
The time period was changed from six months to four years and the amount of money from $40 to $5,000.

The discount factor appears to depend a lot on <u>context</u>: this varies a lot depending on the length of time, amount of money, payment versus receipt, and expedite versus postpone.

Estimated discount factors

average impatience

The discount factor is lower than 1

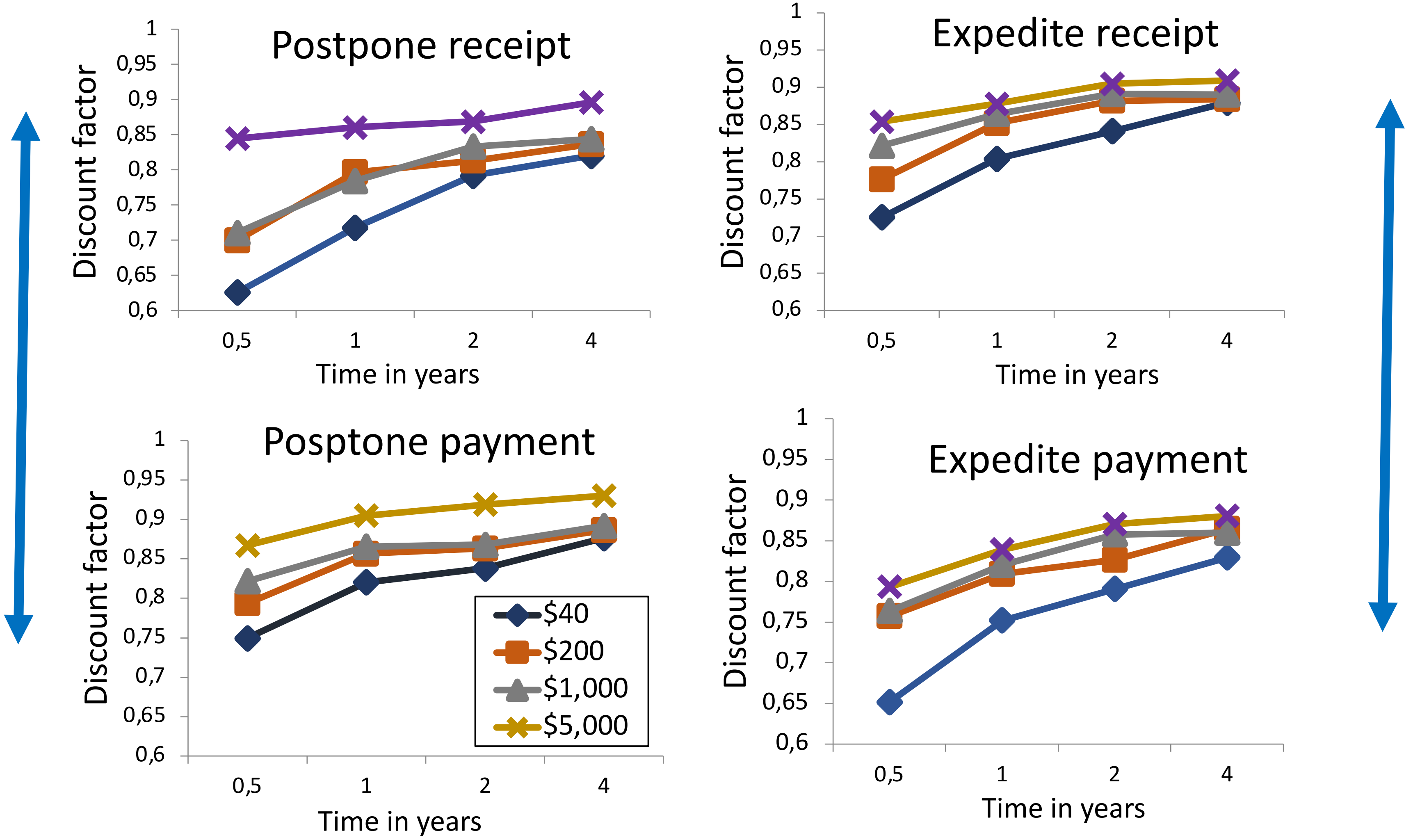


Source: Benzion, Rapoprt, and Yagil (1989)

Gain- Loss Asymmetry

<u>Gain-loss asymmetry</u>

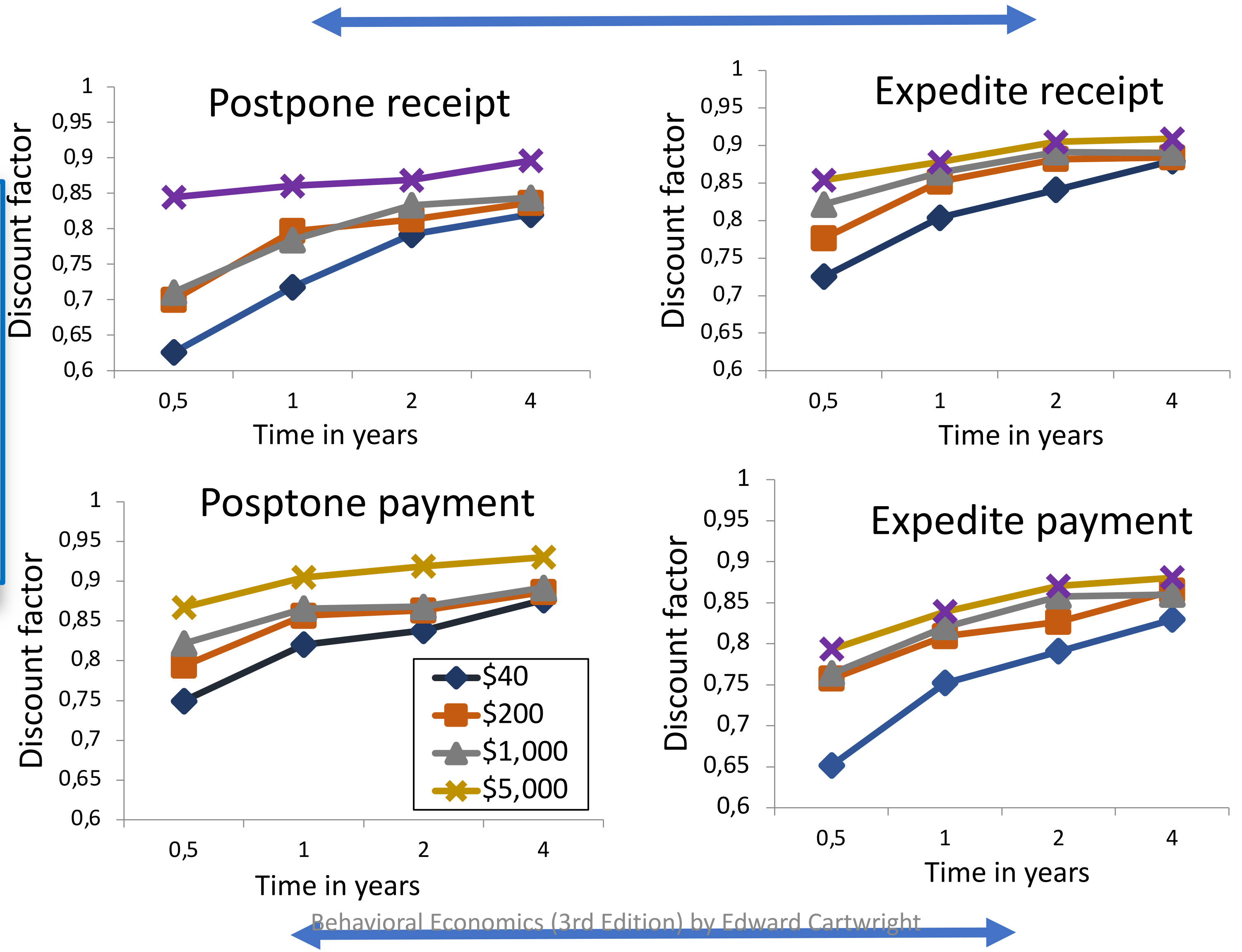
The discount factor is smaller (greater impatience) for gains than losses



Delay-speedup asymmetry

Delay-speedup asymmetry

The discount factor is higher to expedite than postponing receipt and postponing is higher than expediting payment



Limits of Exponential Discounting

Exponential discounting cannot explain the context effects we have seen: this varies a lot depending on the length of time, amount of money, payment versus receipt, and expedite versus postpone.

An alternative model that accounts for short-term impatience is hyperbolic discounting.

Hyperbolic discounting

The most direct way to account for **short-term impatience** is to make the **discount factor increase over time (decrease impatience)**

Exponential discounting uses

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

An alternative is

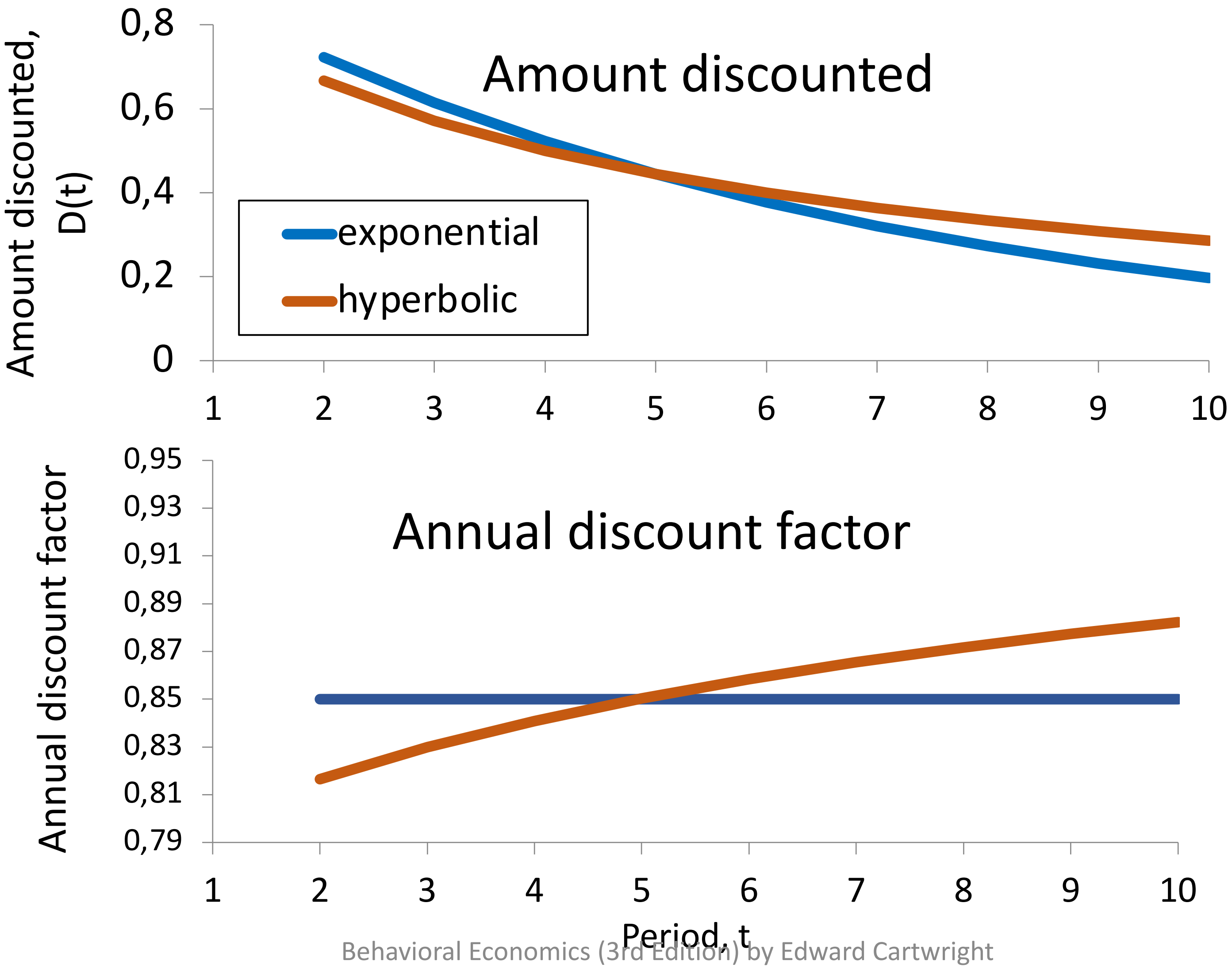
$$D(t) = \frac{1}{1+\alpha t}.$$

α is a parameter that capture changes in the discount factor over time

$$U^T(x_1, x_2, \ldots, x_T) = \sum_{t=1}^{T} D(t)\, x_t.$$

Hyperbolic discounting compared to exponential discounting.

$\delta = 0.85$ vs $\alpha = 0.25$



Hyperbolic Discounting can therefore explain this kind of evidence

- Do you want:
  - \$100 today or \$110 tomorrow?
  - \$100 in 30 days time or \$110 in 31 days?

D (2) = 0.9, D (30) =0.85 and D (31) = 0.84. Then:

- \$110 tomorrow is worth \$99=D(2)*110=0.9*110 today,
- \$100 in 30 days is worth \$85= D(30)*100=0.85*100 today
- and \$110 in 31 days is worth \$92.4= D(31)*110=0.84*110 today,

so it makes sense to choose \$100 today and \$110 in 31 days' time.

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 your answers will have changed?

Hyperbolic discounting cannot explain inconsistent choices, so would not allow for choosing $100 on day 30.

($\boldsymbol{\beta}$, $\boldsymbol{\delta}$)-preferences

A simple model of **quasi-hyperbolic discounting** is to assume **present bias**

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

- β measures the extent of present bias → The smaller it is the more weight it is given today relative to the future.

In hyperbolic discounting, decreasing impatience means that a person gets less impatient as they get older, even if only by a few days.

In Quasi-Hyperbolic discounting **one is always impatient for immediate gains**: now we interpret *t* as how many time periods from today rather than a specific point in time.

Present Bias leads to **time inconsistency, i.e.,** someone plans to do something in the future but subsequently changes her mind.

Quasi-hyperbolic preferences in the homework example

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

The consequences of time inconsistency

The consequences of time inconsistency will depend on whether people know they are time inconsistent or not.

- We say that someone is **naïve** if they are unaware that they have present-biased preferences.

In the homework example, Maria would plan on Friday to do the homework Saturday and not expect to think differently on Saturday.

- We say that someone is **sophisticated** if they know that they have present-biased preferences.

In the homework example, Maria will realize on Friday that if she leaves the homework until Saturday she will probably end up doing it Monday.

Procastination

A naive subject with present bias preferences ends up delaying activities where the costs of the activity precede the benefits.

In the homework example, Maria procrastinates because she puts off doing the costly thing. She does the homework **later than she expected** and later than she would have done without a present bias.

Will someone who is sophisticated and knows they are time inconsistent avoid such problems?

Preproperation

Consider the case where benefits come before the costs:
Imagine, it costs $10 to go to the movies and Maria only has $11 spending money. There are movies on Friday, Saturday and Sunday.

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

This table shows that she will prefer the movie on Sunday to that on Saturday, and that on Saturday to that on Friday.

	$\beta = 1, \delta = 0.9$		$\beta = 0.8, \delta = 0.9$	
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

If Maria has time consistent preferences then she would plan go to the movie on Sunday.
If she has present-biased preferences then she is impatient for benefits: on Friday she would to plan to go on Sunday but on Saturday would change her mind and go that day. Again we see a time inconsistency.
The difference is that this time Maria does something earlier than she expected and earlier that she would have done with no present bias: we can call to **preproperate**

Commitment

Someone who is **sophisticated** may use **commitment** to constrain his/her future choice.

For instance, Maria could pre-order her movie ticket on Friday for Sunday. She would be willing to pay to do such a thing because it means she is committed to making the best choice.

If she was naïve, she would see no need to do so.

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.

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?

"Paying Not to Go to the Gym" by Della Vigna and Malmendier (2004,2006) study choices to the type of subscription and then attendance to the gym.

DellaVigna and Malmendier look at attendance data for over 7,000 health club members at three health clubs in New England between April 1997 and July 2000.

People going to the gym had four basic options:

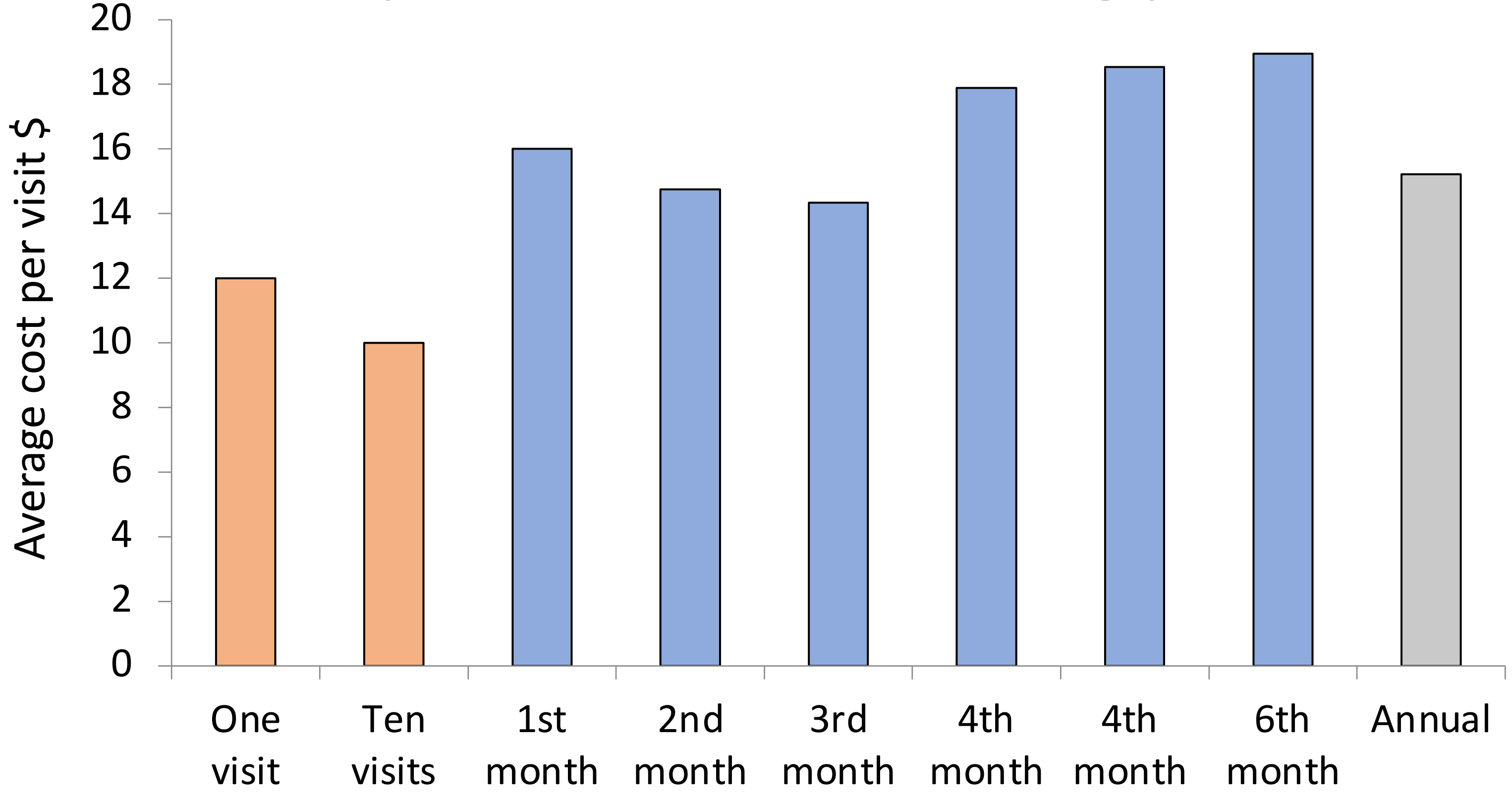
(i) pay \$12 per visit or pay \$100 every 10 visits;

(ii) sign a monthly contract with a fee of around \$85 per month;

(iii) sign an annual contract with a fee of around \$850.

One difference between the monthly and annual contract is that the monthly contract was automatically renewed, while the annual contract was not.

Effective cost per visit to the gym



This plot shows the average price per attendance of new members. We see that in the first six months of membership the average cost per visit was relatively high. Indeed, 80 percent of monthly members would have been better off paying for every ten visits.

It may have been optimal for someone to sign a monthly contract but then switch to paying per visit once they realized how much (or little) they usedthe gym. Do people readjust?

There is little evidence, however, of readjustment. This is particularly the case for those on the monthly contract. Many monthly members appeared to systematically **overestimate their future usage**.

They also put off cancelling their membership. Particularly telling is the average lag of over two months between the last time a person attends the gym and the moment they cancel membership.Such a delay is costly.

Time inconsistency and naivety can explain these results: they calibrate a model of naïve consumers with (β , δ)-preferences where β = 0.7 and δ = 0.9995 that can explain the data, including the average delay of over two months in cancellation.