Lecture 09

Discounting and Cost Benefit Analysis

Ivan Rudik
AEM 4510

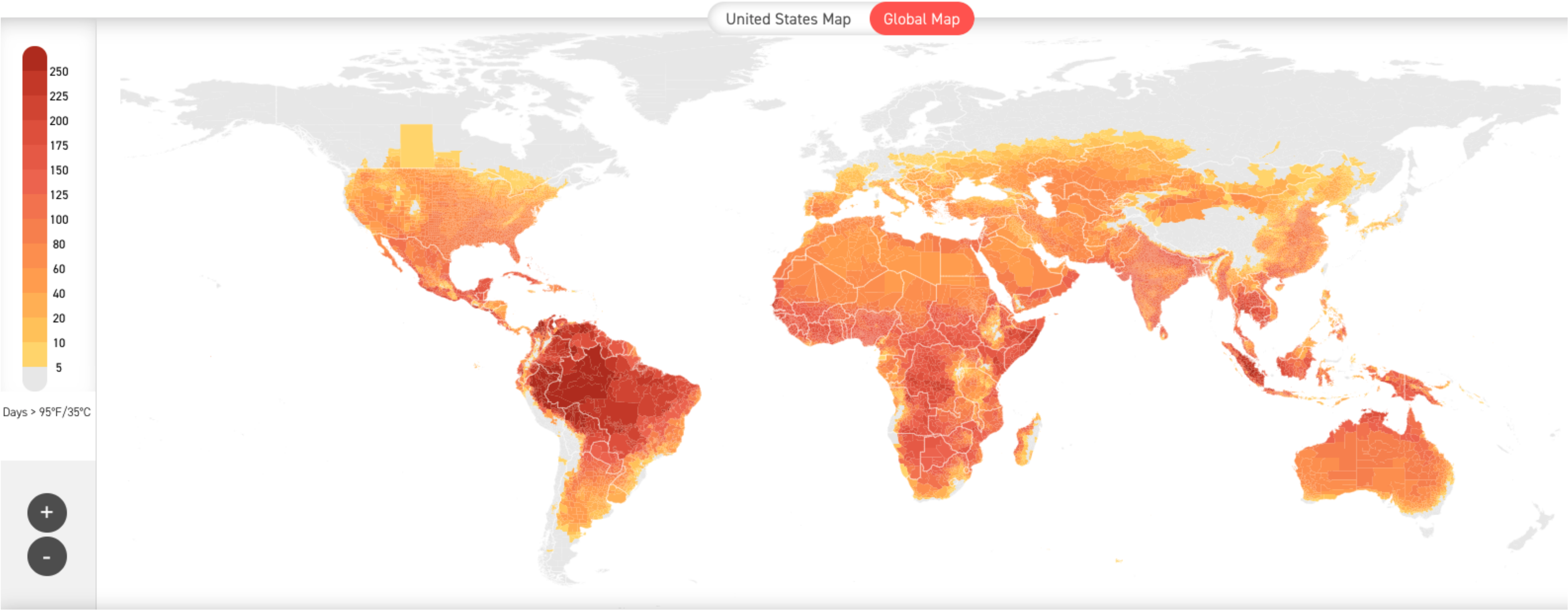
Roadmap

1. What is discounting?
2. What determines the discount rate?
3. What are the implications of discounting on computing the costs and benefits of policies?

Discounting

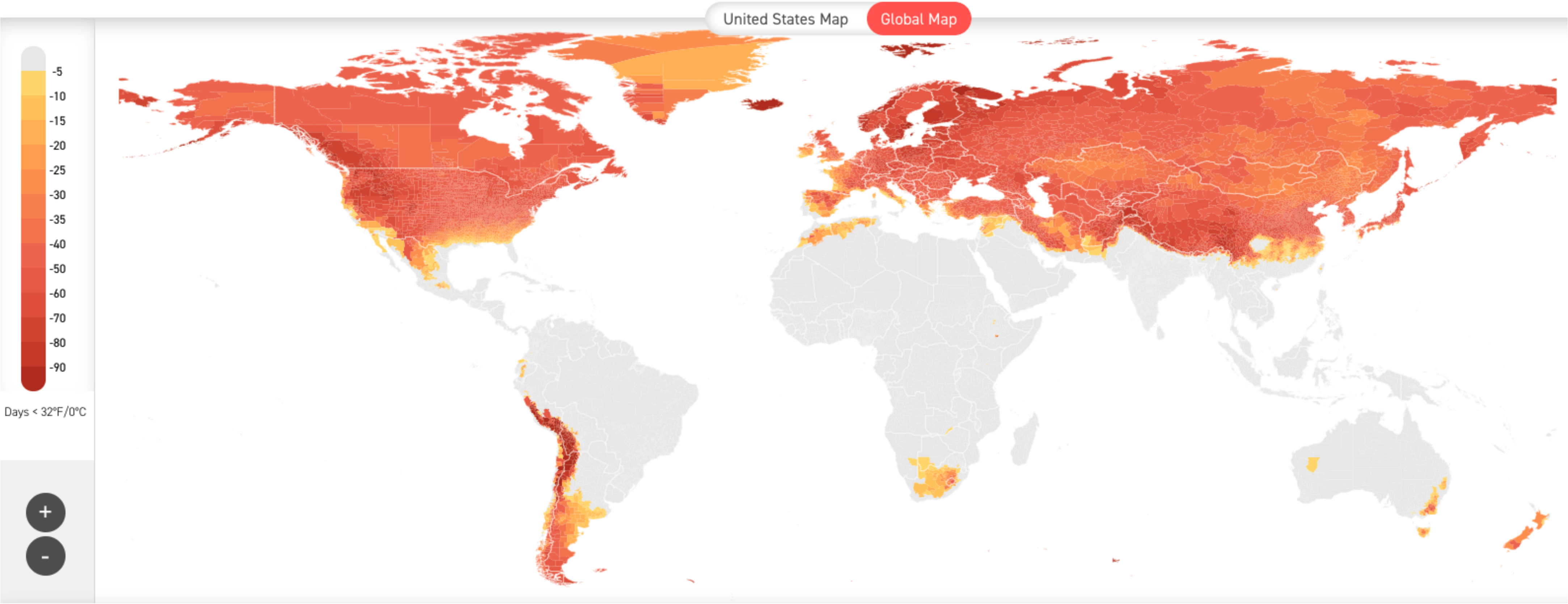
Motivating discounting: http://impactlab.org/map

At the end of the century we will have much more hot days in some places



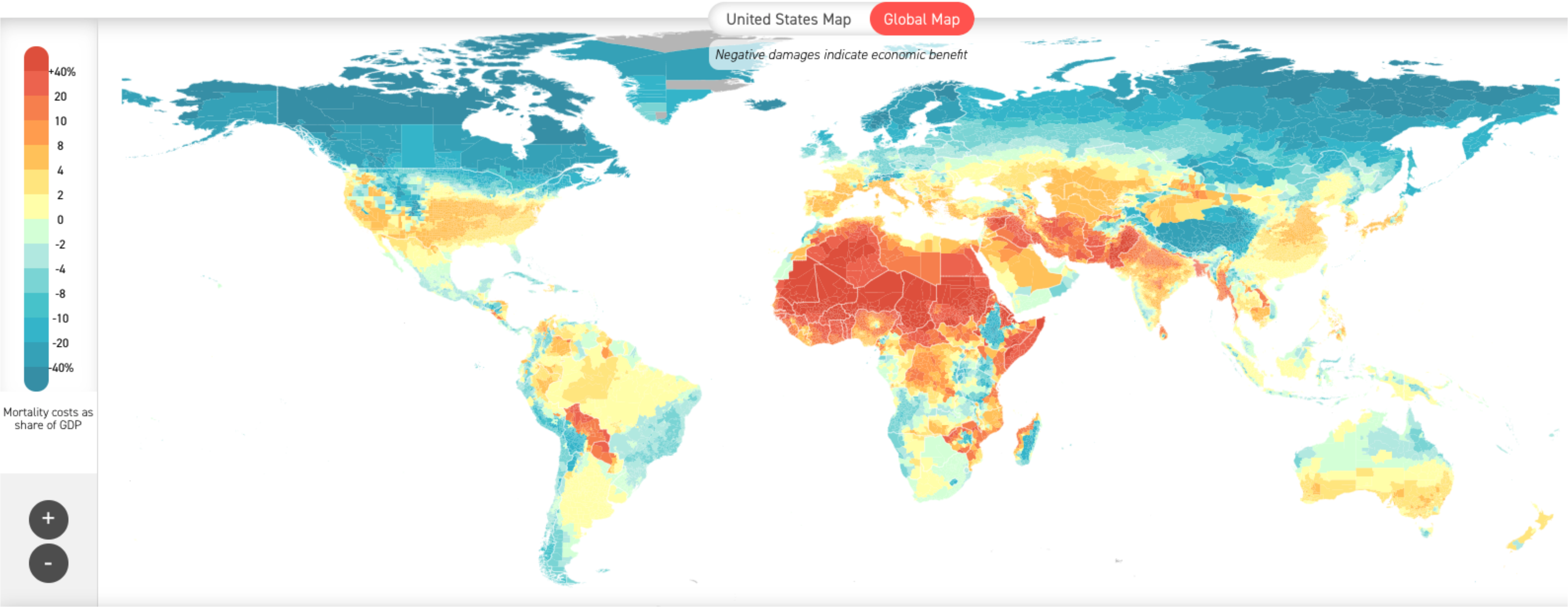
Motivating discounting: http://impactlab.org/map

At the end of the century we will have much fewer freezing days in others



Motivating discounting: http://impactlab.org/map

This has massive implications for mortality



Motivating discounting

Some places are expecting to have huge gains in GDP from mortality risk

Motivating discounting

Some places are expecting to have huge gains in GDP from mortality risk

Others are expecting to have huge losses

Motivating discounting

Some places are expecting to have huge gains in GDP from mortality risk

Others are expecting to have huge losses

This is all happening in 60-80 years

Motivating discounting

Some places are expecting to have huge gains in GDP from mortality risk

Others are expecting to have huge losses

This is all happening in 60-80 years

How do we compare these costs and benefits to those incurred today?

Motivating discounting

Some places are expecting to have huge gains in GDP from mortality risk

Others are expecting to have huge losses

This is all happening in 60-80 years

How do we compare these costs and benefits to those incurred today?

We use a **discount rate:** a value that tells us how much future dollars are worth in today's terms

A simple example

Let r be the discount rate, so $\beta = \frac{1}{1+r}$ is the discount factor

Suppose we are considering two different projects that have costs and benefits that accrue differently over time

Year	Project A Cost	Project A Benefit	Project B Cost	Project B Benefit
0	10000	0	6000	0
1	1000	4000	0	1000
2	0	4000	0	3000
3	0	4000	0	3000

Project A has higher costs and benefits in nominal terms

A simple example

Year	Project A Cost	Project A Benefit	Project B Cost	Project B Benefit
0	10000	0	6000	0
1	1000	4000	0	1000
2	0	4000	0	3000
3	0	4000	0	3000

Project A:

$$PV_A = \frac{4000}{1.05^1} + \frac{4000}{1.05^2} + \frac{4000}{1.05^3} - \frac{10000}{1.05^0} - \frac{1000}{1.05^1} = 1791.76$$

Project B:

$$PV_B = \frac{1000}{1.05^1} + \frac{3000}{1.05^2} + \frac{3000}{1.05^3} - \frac{6000}{1.05^0} = 1648.09$$

What if the discount rate was 3%?

Year	Project A Cost	Project A Benefit	Project B Cost	Project B Benefit
0	10000	0	6000	0
1	1000	4000	0	1000
2	0	4000	0	3000
3	0	4000	0	3000

Project A:

$$PV_A = \frac{4000}{1.03^1} + \frac{4000}{1.03^2} + \frac{4000}{1.03^3} - \frac{10000}{1.03^0} - \frac{1000}{1.03^1} = 2262.35$$

Project B:

$$PV_B = \frac{1000}{1.03^1} + \frac{3000}{1.03^2} + \frac{3000}{1.03^3} - \frac{6000}{1.03^0} = 2144.69$$

Discounting

Discounting results in us placing less value on costs and benefits that accrue in the future

A dollar 1 year from now is worth $\beta = \frac{1}{1+r}$ dollars today

The timing of costs and benefits of projects can then sway which project has greater present value

Return to Manne-Richels

We ignored the idea of discounting in our discussion of the Manne-Richels model

Return to Manne-Richels

We ignored the idea of discounting in our discussion of the Manne-Richels model

Our new problem with discounting is then:

Return to Manne-Richels

We ignored the idea of discounting in our discussion of the Manne-Richels model

Our new problem with discounting is then:

$$\min_{a_1} E[TC] = \underbrace{\frac{1}{2}a_1^2}_{\text{current cost}} + \beta \left[(1-p) \times \underbrace{0}_{\text{good state cost}} + p \times \underbrace{\frac{1}{2}(1-a_1)^2}_{\text{bad state cost}} \right]$$

Return to Manne-Richels

The first-order condition is:

$$\frac{dE[TC]}{da_1} = a_1^* - \beta p(1 - a_1^*) = 0$$

Return to Manne-Richels

The first-order condition is:

$$\frac{dE[TC]}{da_1} = a_1^* - \beta p(1 - a_1^*) = 0$$

This gives us that:

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

Return to Manne-Richels

The first-order condition is:

$$\frac{dE[TC]}{da_1} = a_1^* - \beta p(1 - a_1^*) = 0$$

This gives us that:

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

How does discounting affect our decisionmaking?

Discounting and decisionmaking

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

Discounting and decisionmaking

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

First, notice as $r \to \infty$ we have $\beta = \frac{1}{1+r} \to 0$, we put less and less weight on the future

Discounting and decisionmaking

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

First, notice as $r \to \infty$ we have $\beta = \frac{1}{1+r} \to 0$, we put less and less weight on the future

This means we do less abatement today in period 1!

Discounting and decisionmaking

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

First, notice as $r \to \infty$ we have $\beta = \frac{1}{1+r} \to 0$, we put less and less weight on the future

This means we do less abatement today in period 1!

That's intuitive, let's see what discount actually looks like graphically

Discounting and decisionmaking

$$a_1^* = \frac{\beta p}{1 + \beta p}$$

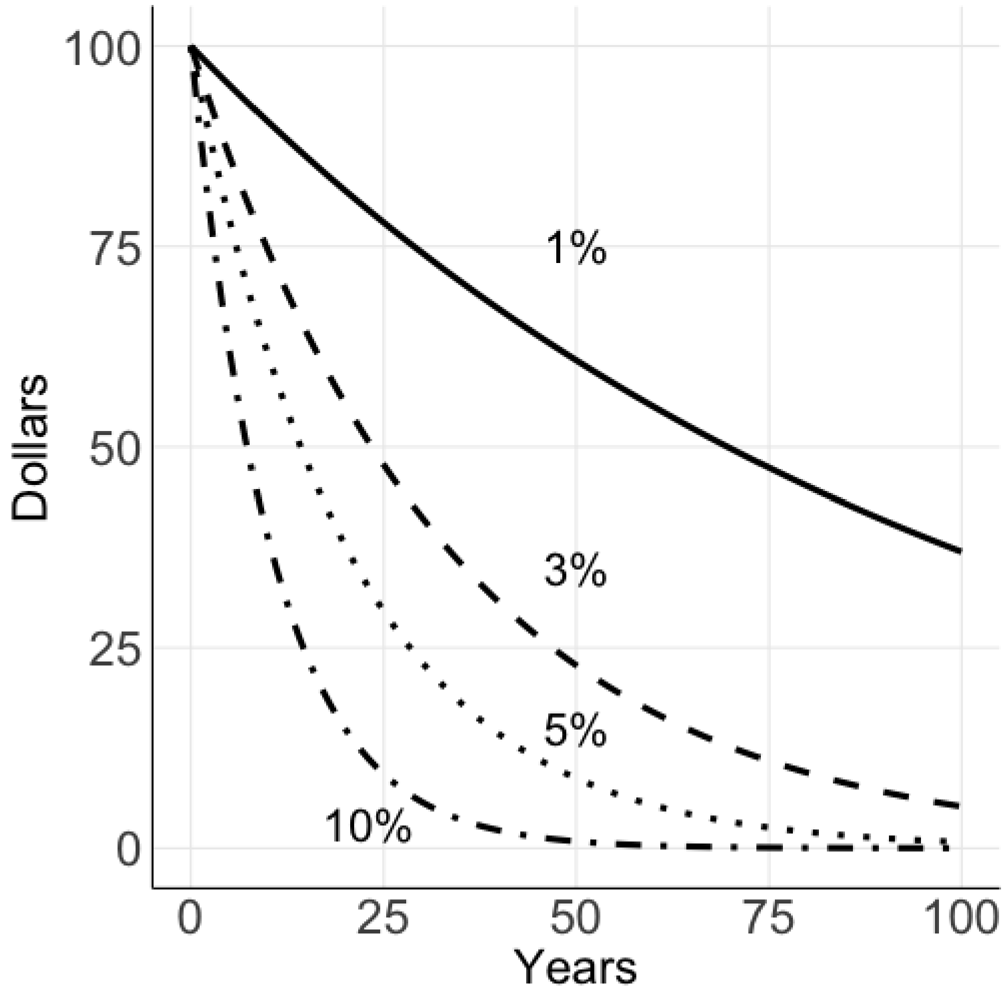
First, notice as $r \to \infty$ we have $\beta = \frac{1}{1+r} \to 0$, we put less and less weight on the future

This means we do less abatement today in period 1!

That's intuitive, let's see what discount actually looks like graphically

What is the value of a future payment of $100?

PV of $100



Higher discount rates place less value on future benefits

Things > 30 years in the future have basically no value with a 10% discount rate

At a 1% discount rate we value things 100 years in the future at almost half their value today

Discounting

Why does this matter?

Discounting

Why does this matter?

Lots of things (like climate change) have costs or benefits that occur **far** in the future

Discounting

Why does this matter?

Lots of things (like climate change) have costs or benefits that occur **far** in the future

e.g. the benefits of taking action against climate change will be mostly borne by future generations, decades from now

Discounting

Why does this matter?

Lots of things (like climate change) have costs or benefits that occur **far** in the future

e.g. the benefits of taking action against climate change will be mostly borne by future generations, decades from now

Depending on our choice of discount rate these costs and benefits can be substantial or trivial

Discounting

1 million in damages in 200 years at a discount rate of r = 2% is worth 19,053 today

Discounting

1 million in damages in 200 years at a discount rate of r = 2% is worth 19,053 today

1 million in damages in 200 years at a discount rate of r = 8% is worth only 21 cents today

Discounting

1 million in damages in 200 years at a discount rate of r = 2% is worth 19,053 today

1 million in damages in 200 years at a discount rate of r = 8% is worth only 21 cents today

5 orders of magnitude difference!

Discounting

1 million in damages in 200 years at a discount rate of r = 2% is worth 19,053 today

1 million in damages in 200 years at a discount rate of r = 8% is worth only 21 cents today

5 orders of magnitude difference!

This makes the choice of the discount rate one of the most important (and contentious) things about climate change policy

Discounting: how do we choose?

How do we choose the discount rate?

Discounting: how do we choose?

How do we choose the discount rate?

Option 1: take the market rate

Discounting: how do we choose?

How do we choose the discount rate?

Option 1: take the market rate

This is just the real interest paid on certain investments

Discounting: how do we choose?

How do we choose the discount rate?

Option 1: take the market rate

This is just the real interest paid on certain investments

In a perfect market equilibrium, it is the productivity of capital

Discounting: how do we choose?

How do we choose the discount rate?

Option 1: take the market rate

This is just the real interest paid on certain investments

In a perfect market equilibrium, it is the productivity of capital

Why might this not be the rate we want to choose as a regulator?

Discounting: how do we choose?

Issues with market rates:

Discounting: how do we choose?

Issues with market rates:

Market rates don't reflect externalities

Discounting: how do we choose?

Issues with market rates:

Market rates don't reflect externalities

Super-responsibility of government: the government represents future generations as well as current generations (only current ones are represented in the market)

Discounting: how do we choose?

Issues with market rates:

Market rates don't reflect externalities

Super-responsibility of government: the government represents future generations as well as current generations (only current ones are represented in the market)

Dual-role of individuals: in political roles, people are more concerned about future generations than in their day-to-day behavior which determines the market rate

Discounting: how do we choose?

Option 2: social discounting

Discounting: how do we choose?

Option 2: social discounting

With social discounting with determine the discount rate from economic and ethical considerations

Discounting: how do we choose?

Option 2: social discounting

With social discounting with determine the discount rate from economic and ethical considerations

Why should we discount the future?

Discounting: how do we choose?

Option 2: social discounting

With social discounting with determine the discount rate from economic and ethical considerations

Why should we discount the future?

First, time: people are impatient

Discounting: how do we choose?

Option 2: social discounting

With social discounting with determine the discount rate from economic and ethical considerations

Why should we discount the future?

First, time: people are impatient

And growth: if someone is richer in 10 years, a dollar is worth more to them today than in 10 years in utility terms

Ramsey Discounting

With a decent amount of math we can show that the social discount rate r is composed of three terms:

$$r = \delta + \eta \times g$$

Ramsey Discounting

With a decent amount of math we can show that the social discount rate r is composed of three terms:

$$r = \delta + \eta \times g$$

δ is called the **pure rate of time preference** or **utility discount rate**: how much do we value future *utility*

Ramsey Discounting

With a decent amount of math we can show that the social discount rate r is composed of three terms:

$$r = \delta + \eta \times g$$

δ is called the **pure rate of time preference** or **utility discount rate**: how much do we value future *utility*

η is the **elasticity of marginal utility**: how quickly does marginal utility (benefit) decline in consumption?

Ramsey Discounting

With a decent amount of math we can show that the social discount rate r is composed of three terms:

$$r = \delta + \eta \times g$$

δ is called the **pure rate of time preference** or **utility discount rate**: how much do we value future *utility*

η is the **elasticity of marginal utility**: how quickly does marginal utility (benefit) decline in consumption?

g is the **growth rate**: how fast does consumption grow over time?

Ramsey Discounting

Here's some alternative descriptions of how to think about these terms:

Ramsey Discounting

Here's some alternative descriptions of how to think about these terms:

δ: how much is 1 util tomorrow worth today?

Ramsey Discounting

Here's some alternative descriptions of how to think about these terms:

δ: how much is 1 util tomorrow worth today?

η: how much do we value poorer vs richer times/generations? Bigger $\eta \rightarrow$ more averse to inequality over time

- $\eta = -\frac{U''(X)X}{U'(X)}$, how many percent does MU change if consumption changes by 1%

Ramsey Discounting

Here's some alternative descriptions of how to think about these terms:

δ: how much is 1 util tomorrow worth today?

η: how much do we value poorer vs richer times/generations? Bigger $\eta \rightarrow$ more averse to inequality over time

- $\eta = -\frac{U''(X)X}{U'(X)}$, how many percent does MU change if consumption changes by 1%

g: how rich will we / future generations be compared to today?

Ramsey Discounting

$$r = \delta + \eta \times g$$

What this means is that if we have values for r, η, and g, we can compute the "correct" discount rate

Ramsey Discounting

$$r = \delta + \eta \times g$$

What this means is that if we have values for r, η, and g, we can compute the "correct" discount rate

How do we get values for these terms?

Ramsey Discounting

$$r = \delta + \eta \times g$$

What this means is that if we have values for r, η, and g, we can compute the "correct" discount rate

How do we get values for these terms?

Two common approaches: descriptive and prescriptive

Ramsey Discounting: the descriptive approach

The descriptive approach aims to calibrate the discount rate to the real world

Ramsey Discounting: the descriptive approach

The descriptive approach aims to calibrate the discount rate to the real world

We can observe g in the data / forecasts

Ramsey Discounting: the descriptive approach

The descriptive approach aims to calibrate the discount rate to the real world

We can observe g in the data / forecasts

We can sometimes estimate η from observed behavior over time

Ramsey Discounting: the descriptive approach

The descriptive approach aims to calibrate the discount rate to the real world

We can observe g in the data / forecasts

We can sometimes estimate η from observed behavior over time

Once we pick a δ we have our discount rate r

Ramsey Discounting: the descriptive approach

The descriptive approach aims to calibrate the discount rate to the real world

We can observe g in the data / forecasts

We can sometimes estimate η from observed behavior over time

Once we pick a δ we have our discount rate r

The descriptive approach generally chooses δ so r matches market rates

Ramsey Discounting: the prescriptive approach

First we decide on the 'correct' level of δ and η

Ramsey Discounting: the prescriptive approach

First we decide on the 'correct' level of δ and η

Then we observe g in the data / forecasts

Ramsey Discounting: the prescriptive approach

First we decide on the 'correct' level of δ and η

Then we observe g in the data / forecasts

That gives us r

What's the utility discount rate?

Both approaches depend on us choosing δ

What's the utility discount rate?

Both approaches depend on us choosing δ

What is the right value for δ?

What's the utility discount rate?

Both approaches depend on us choosing δ

What is the right value for δ?

Ramsey (1928): placing different weights upon the utility of different generations is ‘ethically indefensible'

What's the utility discount rate?

Both approaches depend on us choosing δ

What is the right value for δ?

Ramsey (1928): placing different weights upon the utility of different generations is ‘ethically indefensible'

Harrod (1948): discounting utility represented a 'polite expression for rapacity and the conquest of reason by passion'

What's the utility discount rate?

Both approaches depend on us choosing δ

What is the right value for δ?

Ramsey (1928): placing different weights upon the utility of different generations is ‘ethically indefensible'

Harrod (1948): discounting utility represented a 'polite expression for rapacity and the conquest of reason by passion'

The above arguments are ethical arguments, so are typically used by those favoring the prescriptive approach

What's the discount rate? Descriptive

The descriptive approach often results in δ being between 2-3% from reverse engineering the observed market rates

What's the discount rate? Descriptive

The descriptive approach often results in δ being between 2-3% from reverse engineering the observed market rates

η is then often engineered to be between 1 and 4

What's the discount rate? Descriptive

The descriptive approach often results in δ being between 2-3% from reverse engineering the observed market rates

η is then often engineered to be between 1 and 4

g is observed and generally between 1 and 3%

What's the discount rate? Descriptive

The descriptive approach often results in δ being between 2-3% from reverse engineering the observed market rates

η is then often engineered to be between 1 and 4

g is observed and generally between 1 and 3%

Thus the discount rate usually lies between 2 and 7%

What's the discount rate? Descriptive

The descriptive approach often results in δ being between 2-3% from reverse engineering the observed market rates

η is then often engineered to be between 1 and 4

g is observed and generally between 1 and 3%

Thus the discount rate usually lies between 2 and 7%

Quick example: $\delta = 2\%, \eta = 2, g = 2\% \rightarrow r = 6\%$

What's the discount rate? Prescriptive

The prescriptive approach often results in δ being zero or nearly zero for the ethical reasons described above

What's the discount rate? Prescriptive

Choosing η also conveys ethical choices: how do we weigh the distribution of consumption across generations

What's the discount rate? Prescriptive

Choosing η also conveys ethical choices: how do we weigh the distribution of consumption across generations

What's the discount rate? Prescriptive

Choosing η also conveys ethical choices: how do we weigh the distribution of consumption across generations

- $\eta = 0$: consumption in the future doesn't change our willingness to save/invest today (r is independent of g)

What's the discount rate? Prescriptive

Choosing η also conveys ethical choices: how do we weigh the distribution of consumption across generations

- $\eta = 0$: consumption in the future doesn't change our willingness to save/invest today (r is independent of g)
- η is large: if there is positive growth, we are **less** likely to invest in the future (future generations will be rich anyway)

What's the discount rate? Prescriptive

Choosing η also conveys ethical choices: how do we weigh the distribution of consumption across generations

- $\eta = 0$: consumption in the future doesn't change our willingness to save/invest today (r is independent of g)
- η is large: if there is positive growth, we are **less** likely to invest in the future (future generations will be rich anyway)
- η is large: if there is negative growth, we are **more** likely to invest in the future (future generations will be poorer than today)

Distributive justice

Rawl's theory of justice applied here would set $\delta = 0$ and $\eta = \infty$: fairness for all

Distributive justice

Rawl's theory of justice applied here would set $\delta = 0$ and $\eta = \infty$: fairness for all

More egalitarian perspectives with respect to:

time

Distributive justice

Rawl's theory of justice applied here would set $\delta = 0$ and $\eta = \infty$: fairness for all

More egalitarian perspectives with respect to:

time yields a smaller δ and r

Distributive justice

Rawl's theory of justice applied here would set $\delta = 0$ and $\eta = \infty$: fairness for all

More egalitarian perspectives with respect to:

time yields a smaller δ and r

intergenerational inequality

Distributive justice

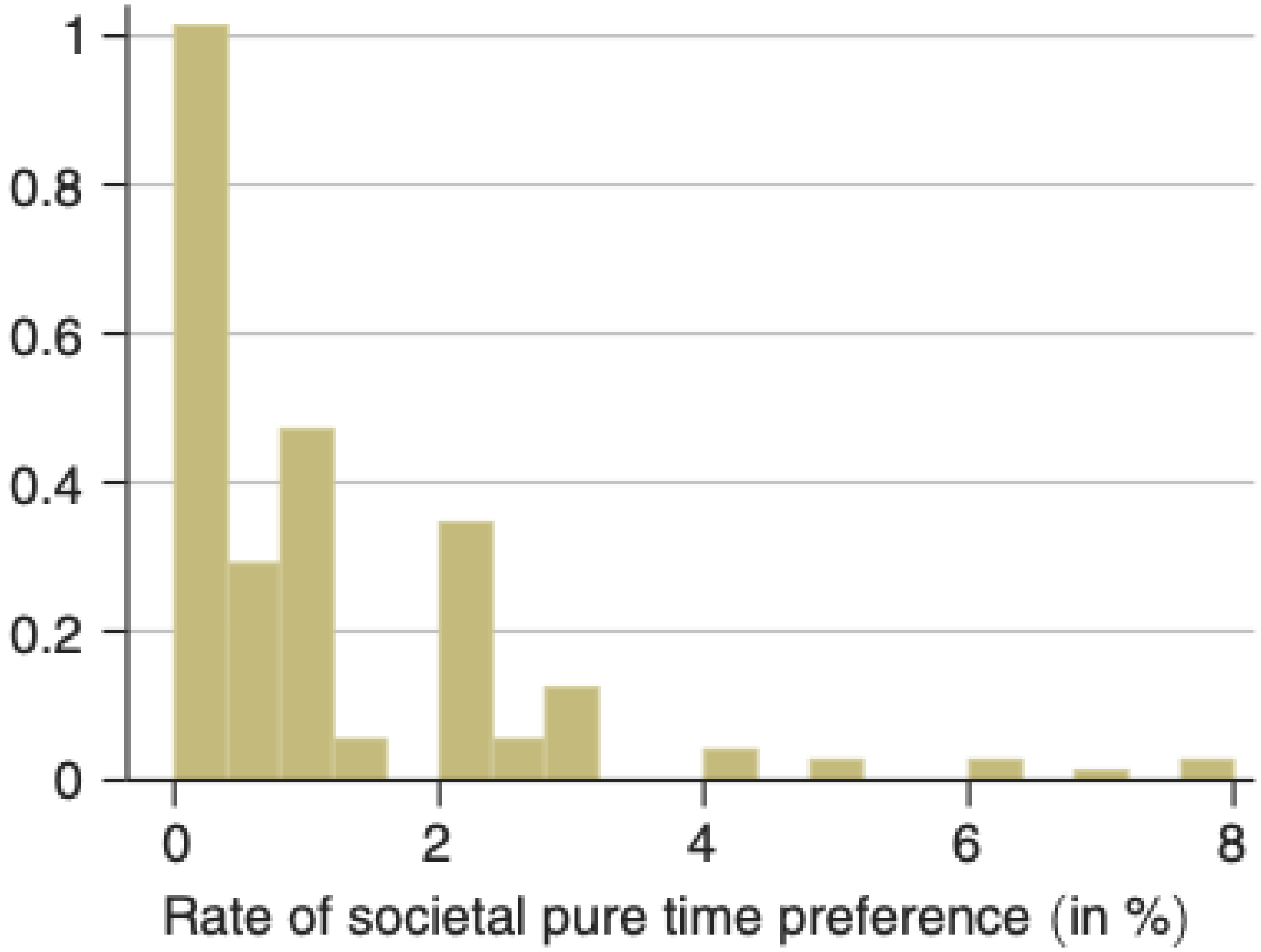
Rawl's theory of justice applied here would set $\delta = 0$ and $\eta = \infty$: fairness for all

More egalitarian perspectives with respect to:

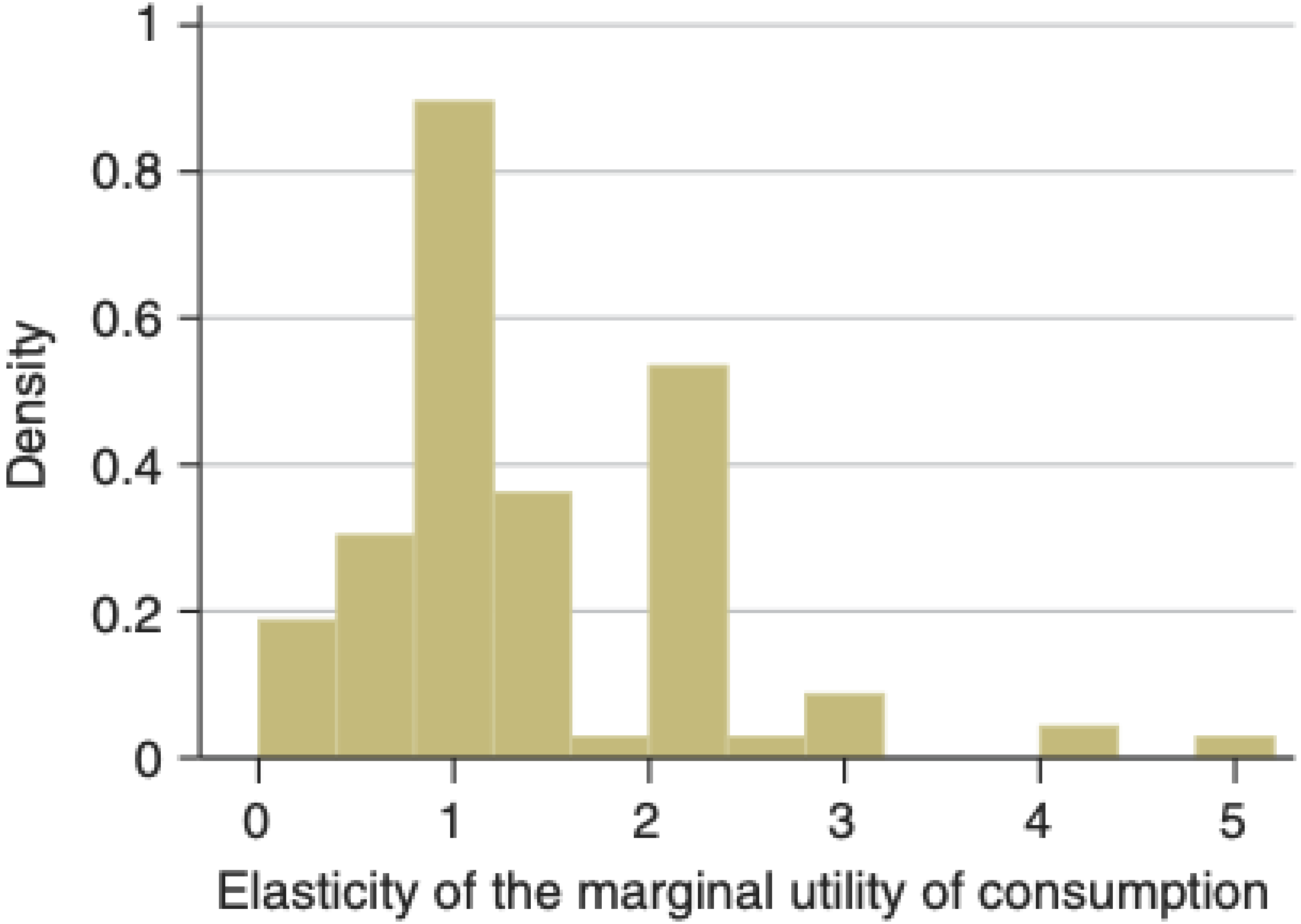
time yields a smaller δ and r

intergenerational inequality yields a larger η and larger r if growth is positive

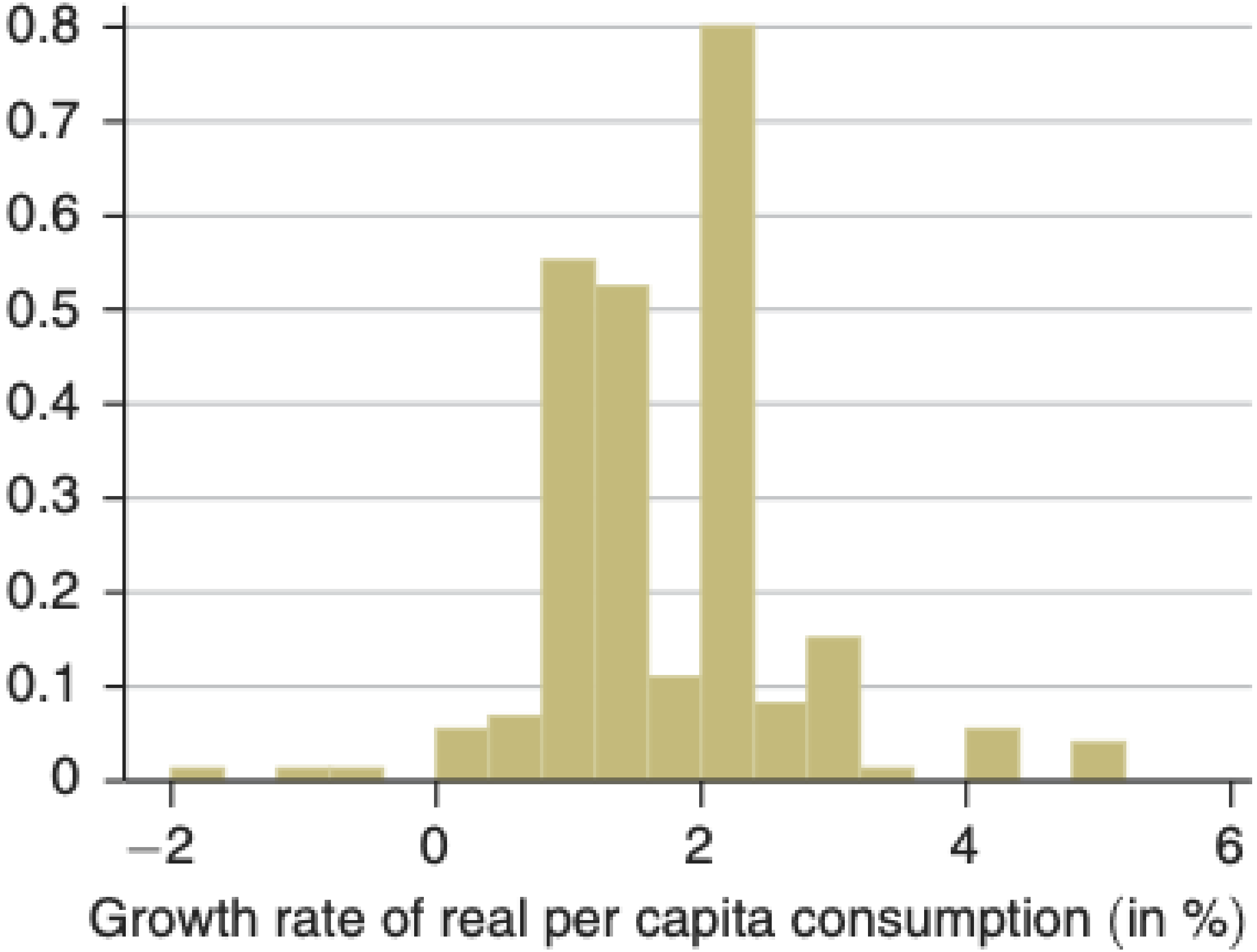
What do the experts think? Drupp et al. (2018)



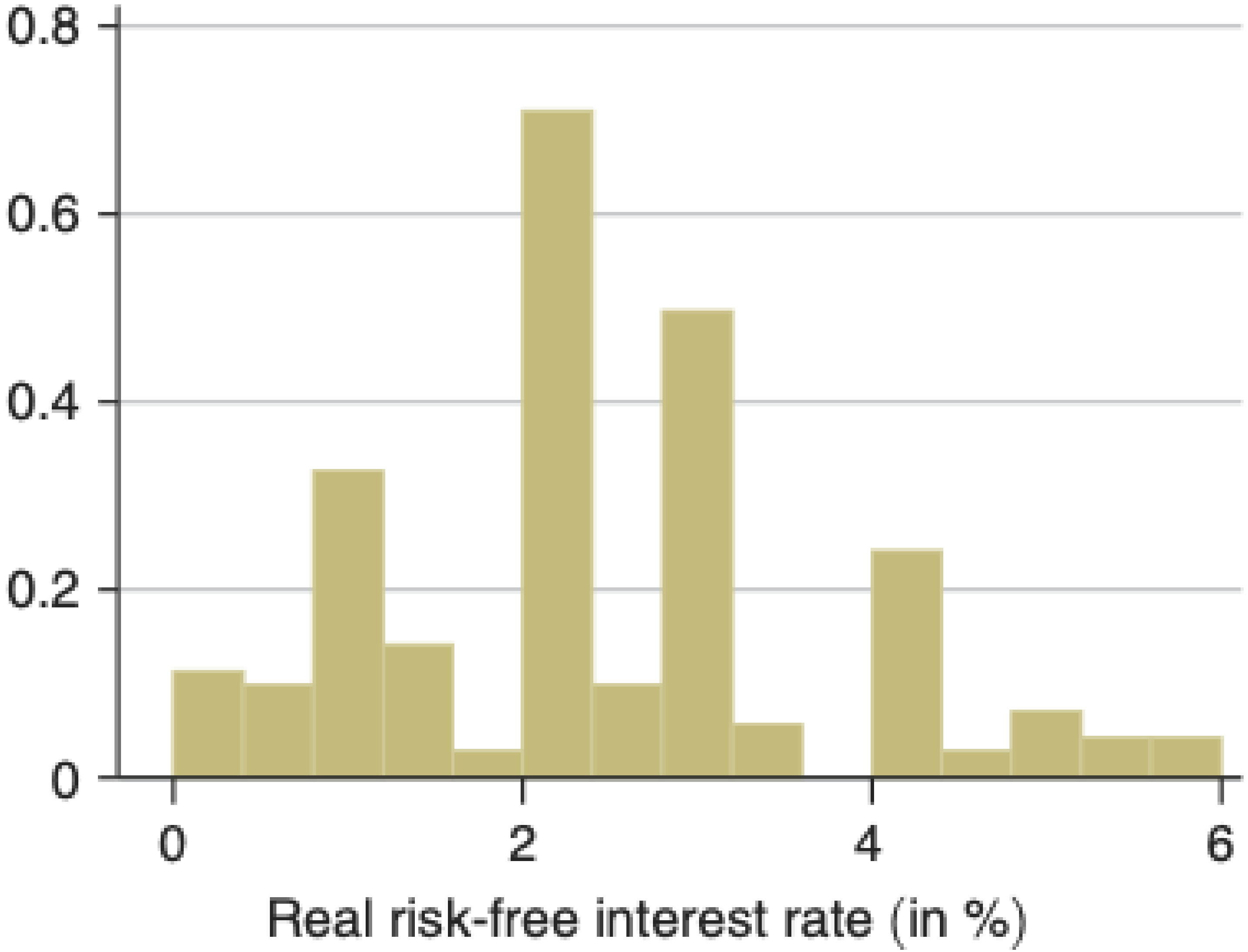
What do the experts think? Drupp et al. (2018)



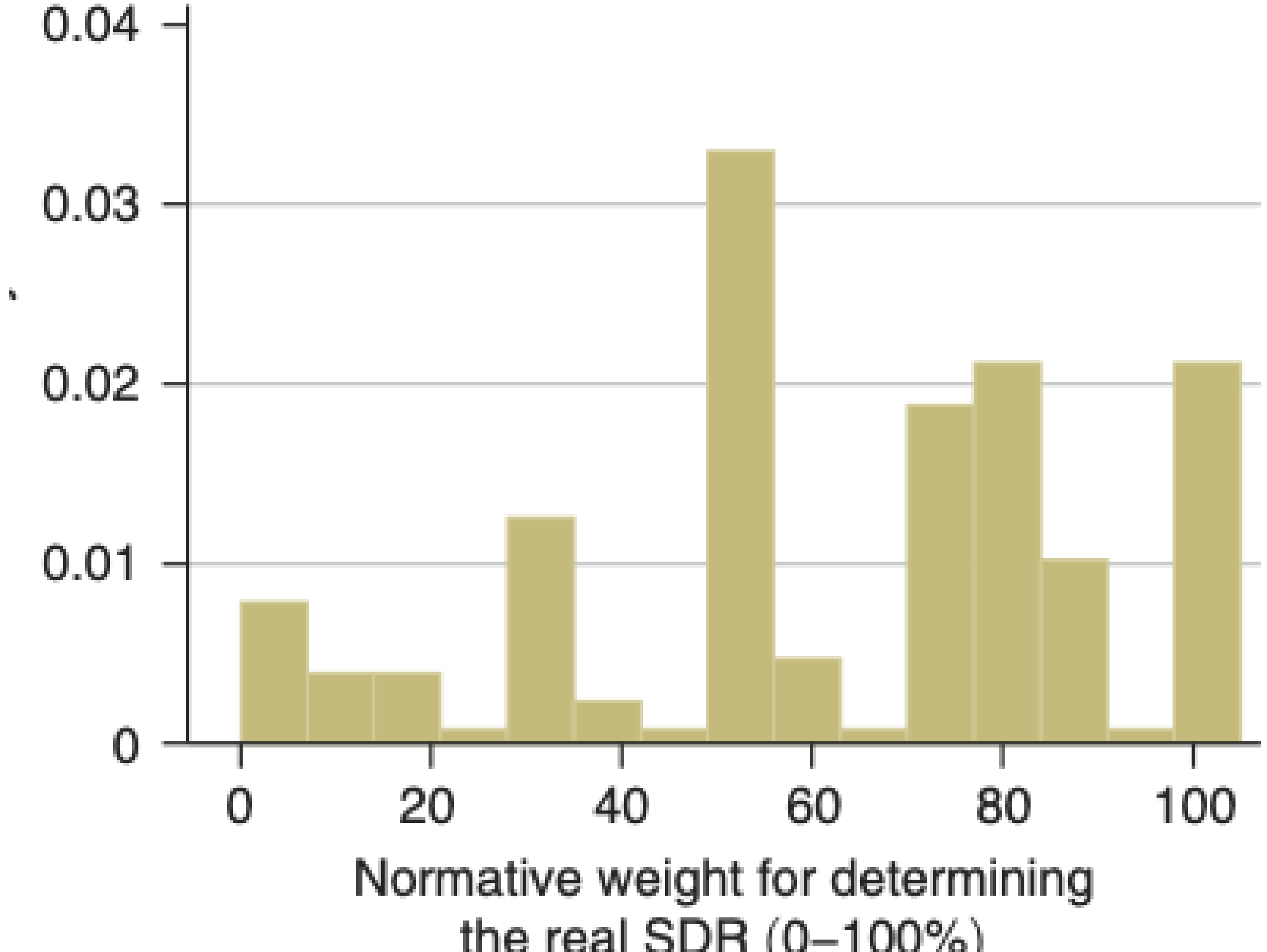
What do the experts think? Drupp et al. (2018)



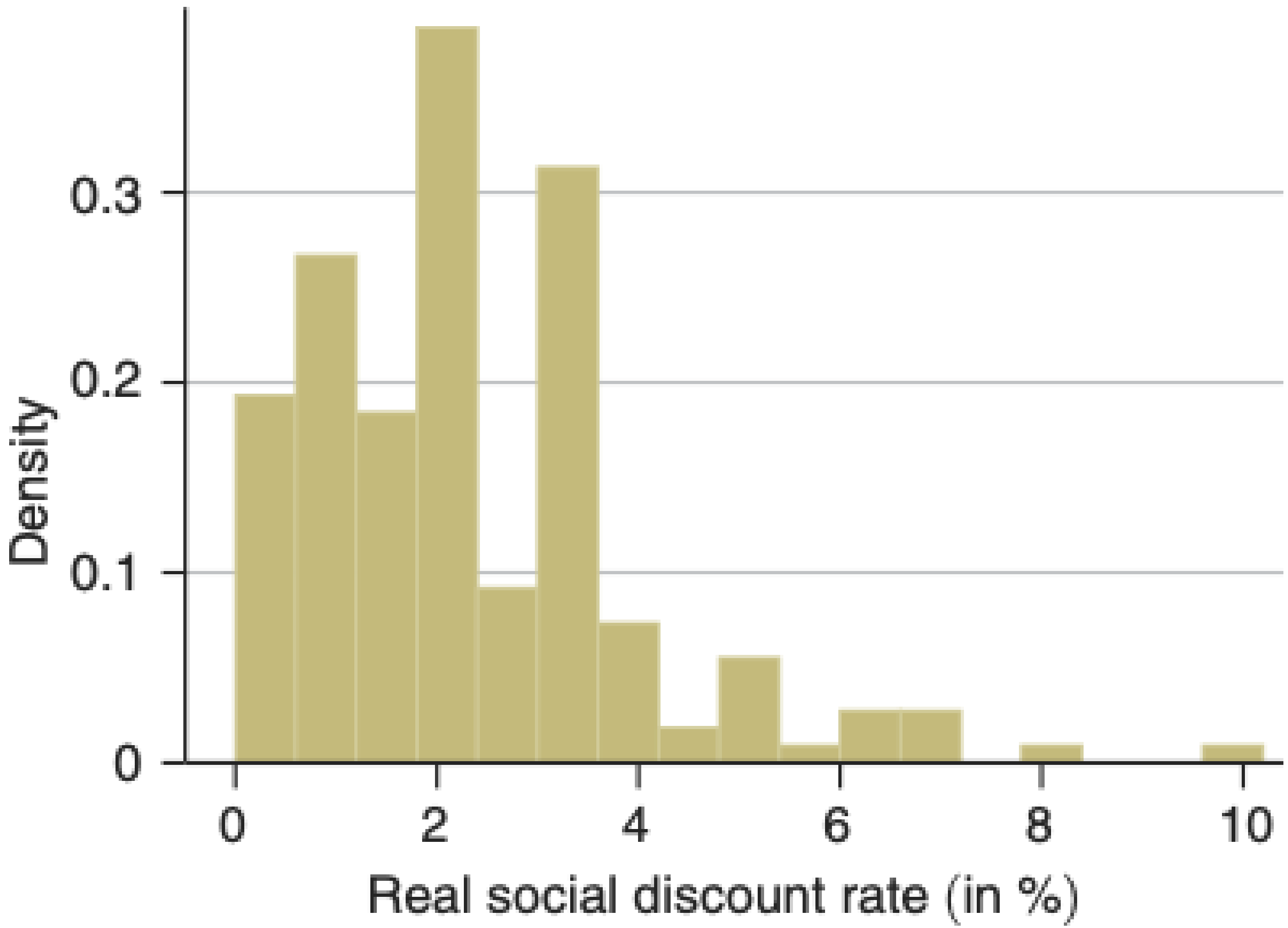
What do the experts think? Drupp et al. (2018)



What do the experts think? Drupp et al. (2018)



What do the experts think? Drupp et al. (2018)



Discount rates are being significantly revised

Council of Economic Advisers
@WhiteHouseCEA

Today, OMB released an important proposed update to Circular A-4, guidance that Federal agencies use to analyze the benefits and costs of proposed Federal regulations. It has not been updated since it was first issued in 2003. 1/

Discount rates are being significantly revised

Council of Economic Advisers @WhiteHouseCEA · 17h

Replying to @WhiteHouseCEA

Federal regulations affect issues ranging from environmental protection, to workplace safety, to education, to health. Newly proposed regulations may have billions of dollars in economic impacts in a given year. 2/

2 3 10 1,575

Council of Economic Advisers @WhiteHouseCEA · 17h

In the 20 years since Circular A-4 was issued, economic conditions and best practices for benefit-cost analysis have evolved, and updating the Circular will make it easier to promote regulations that most enhance wellbeing. 3/

2 3 12 1,430

Discount rates are being significantly revised

Council of Economic Advisers @WhiteHouseCEA · 17h

The proposed revision substantially expands guidance on assessing distributional effects. It helps empower agencies to use income-weighted estimates in their analyses by providing them with a weighting methodology if they choose to do so. 6/

2 6 15 2,138

Council of Economic Advisers @WhiteHouseCEA · 17h

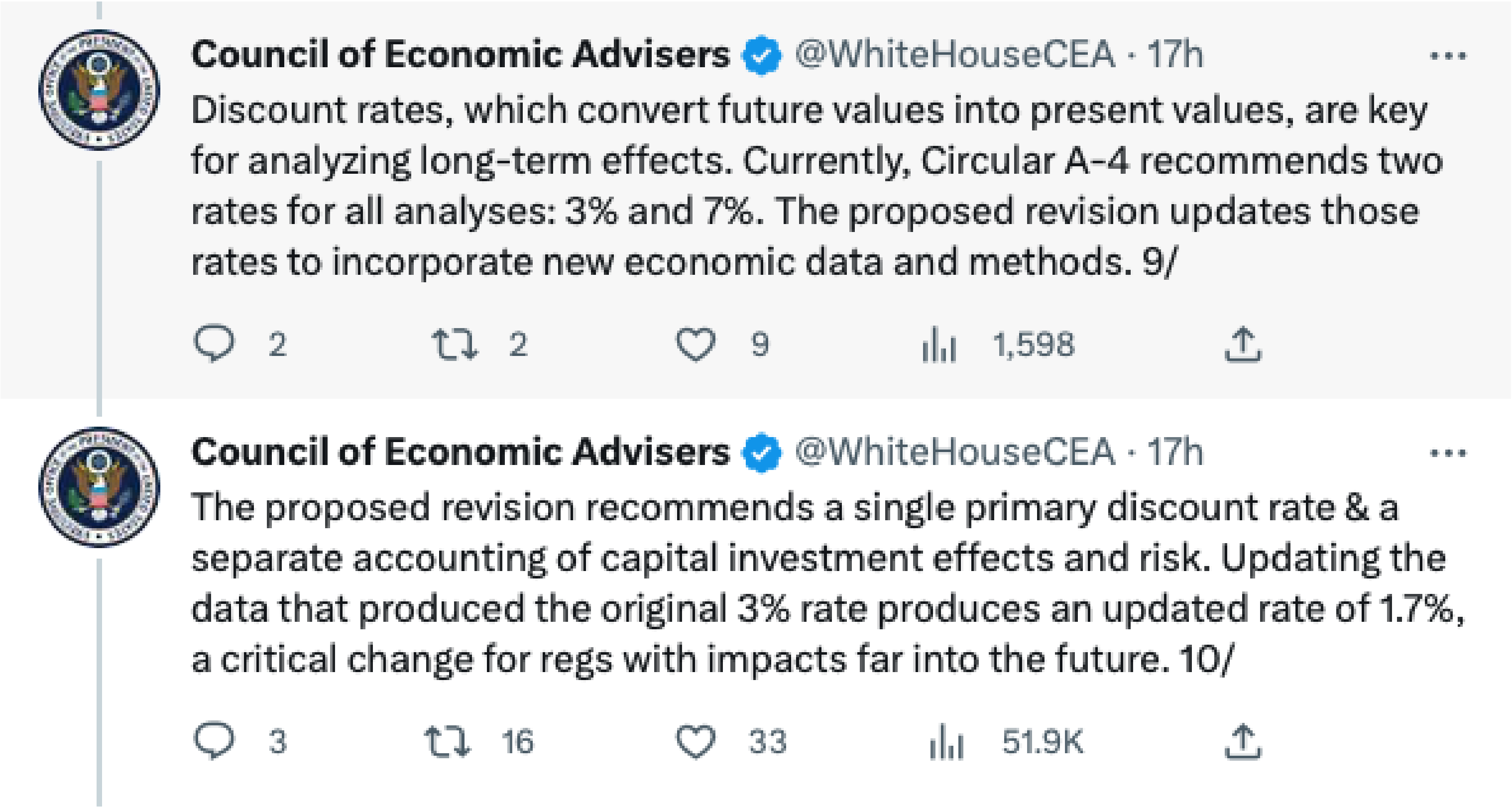
This option could be especially important in any context where regulations impact disadvantaged communities, which tend to have lower average income & lower property values. Income-weighted analysis can help ensure effects on these communities are not undervalued. 7/

2 2 11 1,246

Council of Economic Advisers @WhiteHouseCEA · 17h

The proposed revision removes the assumption that individuals affected by regulations are risk neutral. Risk aversion could be consequential for regulations that address areas such as climate change, student loan repayment, health insurance take-up, & pandemic preparedness. 8/

Discount rates are being significantly revised



Council of Economic Advisers @WhiteHouseCEA · 17h

Discount rates, which convert future values into present values, are key for analyzing long-term effects. Currently, Circular A-4 recommends two rates for all analyses: 3% and 7%. The proposed revision updates those rates to incorporate new economic data and methods. 9/

2 2 9 1,598

Council of Economic Advisers @WhiteHouseCEA · 17h

The proposed revision recommends a single primary discount rate & a separate accounting of capital investment effects and risk. Updating the data that produced the original 3% rate produces an updated rate of 1.7%, a critical change for regs with impacts far into the future. 10/

3 16 33 51.9K

Discount rates in the (very) long run

How should we think about discounting in the **very** long run?

Discount rates in the (very) long run

How should we think about discounting in the **very** long run?

100, 100, 300 years into the future when we expect climate change impacts to be their worst?

Discount rates in the (very) long run

How should we think about discounting in the **very** long run?

100, 100, 300 years into the future when we expect climate change impacts to be their worst?

Giglo, Maggiori, and Stroebel (2015) come up with a clever way to think about discount rates in the far future: looking at UK and Singaporean housing markets

Discount rates in the (very) long run

In the UK and Singapore, properties are acquired via **leasehold** or **freehold**

Discount rates in the (very) long run

In the UK and Singapore, properties are acquired via **leasehold** or **freehold**

- **Leasehold:** temporary, pre-paid, tradable ownership contracts with maturities of 99-999 years, one it expires, you lose the property

Discount rates in the (very) long run

In the UK and Singapore, properties are acquired via **leasehold** or **freehold**

- **Leasehold:** temporary, pre-paid, tradable ownership contracts with maturities of 99-999 years, one it expires, you lose the property
- **Freeholds:** same, but **perpetual** ownership, you never lose the property

Discount rates in the (very) long run

In the UK and Singapore, properties are acquired via **leasehold** or **freehold**

- **Leasehold:** temporary, pre-paid, tradable ownership contracts with maturities of 99-999 years, one it expires, you lose the property

- **Freeholds:** same, but **perpetual** ownership, you never lose the property

Imagine there are two properties A and B, identical in every way except A is a leasehold with 500 years left until maturity and B is a freehold

Property prices, what do they tell us?

Suppose we observe A selling for 900,000 dollars and B selling for 1,000,000 dollars

What do these prices mean? What value do they capture?

Property prices, what do they tell us?

Suppose we observe A selling for 900,000 dollars and B selling for 1,000,000 dollars

What do these prices mean? What value do they capture?

Let's think about a simple example: imagine you are a real estate investor deciding on purchasing a property to add to your rental portfolio in a competitive property market

Property prices, what do they tell us?

A property makes sense to buy if its cost is less than its benefits

Property prices, what do they tell us?

A property makes sense to buy if its cost is less than its benefits

The benefit of the property is the present value of the sum of future rental payments

Property prices, what do they tell us?

A property makes sense to buy if its cost is less than its benefits

The benefit of the property is the present value of the sum of future rental payments

Suppose buyers were competing for a property that has a present value future rental stream of $900,000, what market price would we expect someone to pay for this?

Property prices, what do they tell us?

A property makes sense to buy if its cost is less than its benefits

The benefit of the property is the present value of the sum of future rental payments

Suppose buyers were competing for a property that has a present value future rental stream of $900,000, what market price would we expect someone to pay for this?

$900,000! investors will compete, bidding higher and higher prices until it reaches the benefits of owning the property (same logic as why prices are the MB of other goods)

Discount rates in the (very) long run

The price of a house tells us the present value of the future stream of rental payments!

Discount rates in the (very) long run

The price of a house tells us the present value of the future stream of rental payments!

Now let's go back to the original example:

Discount rates in the (very) long run

The price of a house tells us the present value of the future stream of rental payments!

Now let's go back to the original example:

Suppose we observe A selling for 900,000 dollars and B selling for 1,000,000 dollars

What does the price difference between the two properties tell us?

Discount rates in the (very) long run

Both properties are identical until year 500 when **poof**, you no longer own property A but you still own property B

Discount rates in the (very) long run

Both properties are identical until year 500 when **poof**, you no longer own property A but you still own property B

The difference in prices is telling us the present value of property B rental payments starting **500 years from now**

Discount rates in the (very) long run

Both properties are identical until year 500 when **poof**, you no longer own property A but you still own property B

The difference in prices is telling us the present value of property B rental payments starting **500 years from now**

The prices tell us about how the market discounts cash flows very, very far in the future, outside anyone's expected lifespan

Why do discount rates change over time?

Discount rates for cash flows this year versus 500 years in the future may be different for a lot of reasons

Why do discount rates change over time?

Discount rates for cash flows this year versus 500 years in the future may be different for a lot of reasons

- **Changes in growth:** if growth slows down, discount rates fall
  - The future is getting richer slower, so the future's marginal value of a dollar is higher than if growth did not slow

Why do discount rates change over time?

Discount rates for cash flows this year versus 500 years in the future may be different for a lot of reasons

- **Changes in growth:** if growth slows down, discount rates fall
  - The future is getting richer slower, so the future's marginal value of a dollar is higher than if growth did not slow
- **Uncertainty:** if we are uncertain about future economic conditions determining the discount rate, the discount rate we should use is lower than the average (expected) discount rate

Why do discount rates change over time?

Let's get a sense of how uncertainty over the proper discount rate matters

Why do discount rates change over time?

Let's get a sense of how uncertainty over the proper discount rate matters

Suppose climate change is going to impose 1 trillion dollars of costs in 100 years

Why do discount rates change over time?

Let's get a sense of how uncertainty over the proper discount rate matters

Suppose climate change is going to impose 1 trillion dollars of costs in 100 years

Suppose the pure rate of time preference $\delta = 1$, and the elasticity of marginal utility $\eta = 1$ so that the discount rate $r = 1$

Why do discount rates change over time?

Let's get a sense of how uncertainty over the proper discount rate matters

Suppose climate change is going to impose 1 trillion dollars of costs in 100 years

Suppose the pure rate of time preference $\delta = 1$, and the elasticity of marginal utility $\eta = 1$ so that the discount rate $r = 1$

We think that in 100 years growth will either be 0% or 6%, each with 50% chance

Why do discount rates change over time?

Let's get a sense of how uncertainty over the proper discount rate matters

Suppose climate change is going to impose 1 trillion dollars of costs in 100 years

Suppose the pure rate of time preference $\delta = 1$, and the elasticity of marginal utility $\eta = 1$ so that the discount rate $r = 1$

We think that in 100 years growth will either be 0% or 6%, each with 50% chance

What are the current expected costs of the damage?

Why do discount rates change over time?

The current expected costs are just the costs averaged over either of the potential real discount rates:

$$\frac{1}{2}\frac{\$1 \text{ trillion}}{1.01^{100}} + \frac{1}{2}\frac{\$1 \text{ trillion}}{1.07^{100}} = \$185 \text{ billion}$$

Why do discount rates change over time?

The current expected costs are just the costs averaged over either of the potential real discount rates:

$$\frac{1}{2}\frac{\$1 \text{ trillion}}{1.01^{100}} + \frac{1}{2}\frac{\$1 \text{ trillion}}{1.07^{100}} = \$185 \text{ billion}$$

Now lets compute the value of the damages if we used the expected discount rate, the average of the two: 4%

$$\frac{\$1 \text{trillion}}{1.04^{100}} = \$20 \text{ billion}$$

Why do discount rates change over time?

The expected discount rate of 4% generated costs that were 10 times smaller than the actual costs!

This means that the expected discount rate is too high compared to the actual discount rate we should be using if we are uncertain about future discount rates

Why do discount rates change over time?

The expected discount rate of 4% generated costs that were 10 times smaller than the actual costs!

This means that the expected discount rate is too high compared to the actual discount rate we should be using if we are uncertain about future discount rates

What discount rate should we use?

Why do discount rates change over time?

The expected discount rate of 4% generated costs that were 10 times smaller than the actual costs!

This means that the expected discount rate is too high compared to the actual discount rate we should be using if we are uncertain about future discount rates

What discount rate should we use?

$$\frac{\$1 \text{ trillion}}{(1+r)^{100}} = \$185 \text{ billion} \qquad \rightarrow r = .017 = 1.7\%$$

Why do discount rates change over time?

If we expected the future discount rate to be either 1% or 7%, the proper discount rate to use was actually 1.7%, **not** the average 4%!

Why do discount rates change over time?

If we expected the future discount rate to be either 1% or 7%, the proper discount rate to use was actually 1.7%, **not** the average 4%!

1.7% is called the **certainty-equivalent** discount rate: the certain discount rate that delivers the same present value as the possible set of uncertain rates (1% and 7%)

Why do discount rates change over time?

If we expected the future discount rate to be either 1% or 7%, the proper discount rate to use was actually 1.7%, **not** the average 4%!

1.7% is called the **certainty-equivalent** discount rate: the certain discount rate that delivers the same present value as the possible set of uncertain rates (1% and 7%)

Main takeaway: Uncertainty about the future economic conditions governing the discount rate makes the discount rate we should be using lower than expected

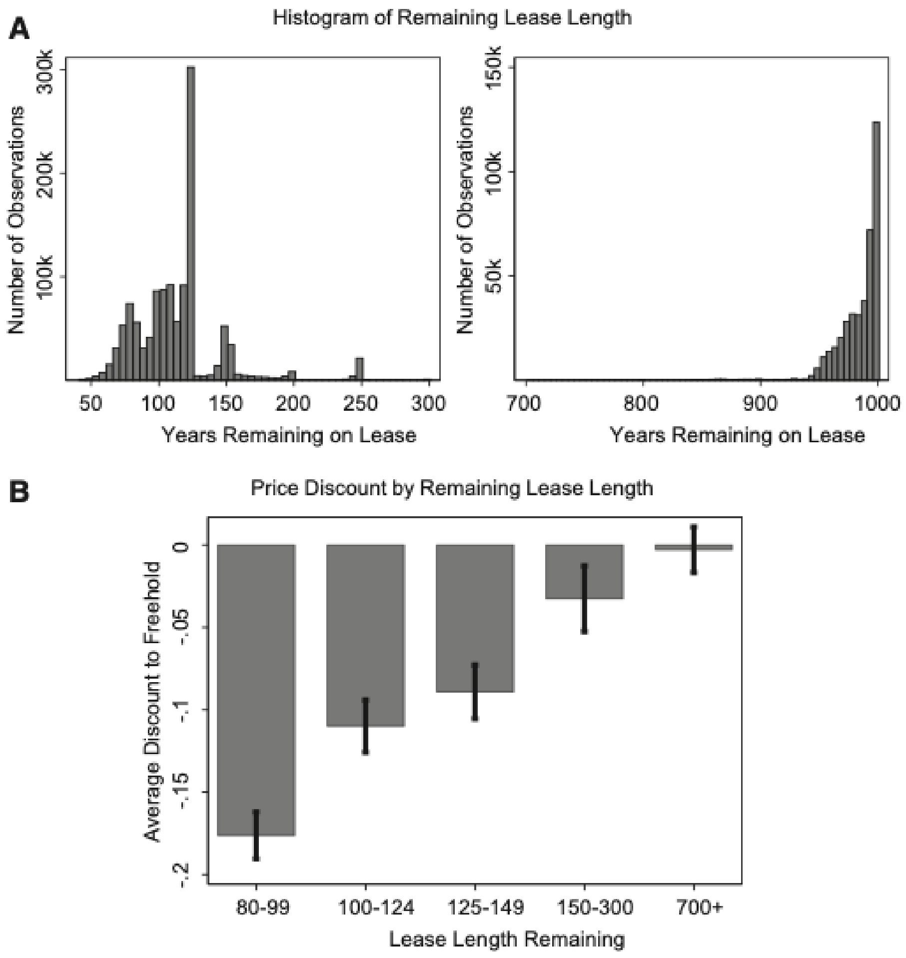
Discount rates in the (very) long run: United Kingdom

What are these long run discount rate?

In the UK:

- leases expiring with 100 years cost 17% less than a freehold
- leases expiring 150-300 years from now cost 5% less

Implies a discount rate of about **2.6%**



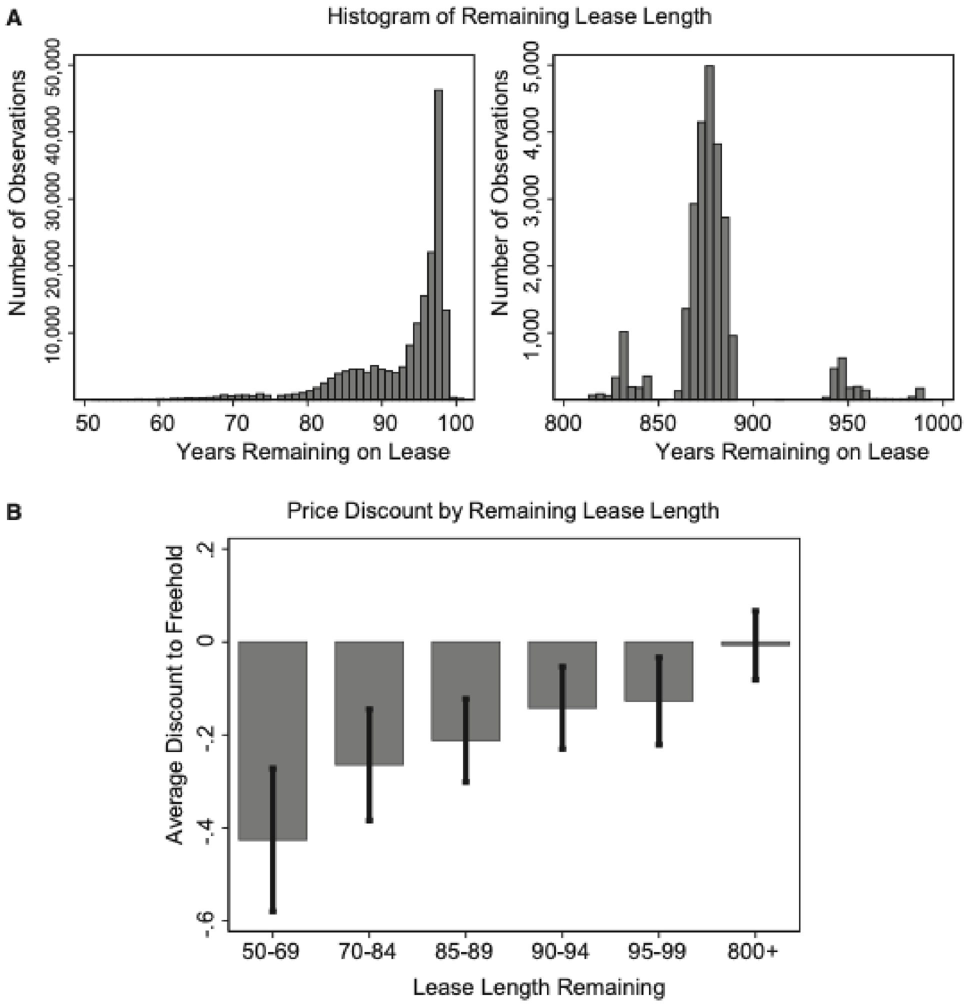
Discount rates in the (very) long run: Singapore

What are these long run discount rate?

In Singapore:

- leases expiring with 70 years cost 40% less than a freehold
- leases expiring 95-99 years from now cost 15% less

Implies a discount rate of about **2.6%**



Discount rates on rental payments

We can check the validity of these estimates by seeing whether **rental payments** depend on the length remaining of the contract

Discount rates on rental payments

We can check the validity of these estimates by seeing whether **rental payments** depend on the length remaining of the contract

There's no reason the rent you pay for your house should depend on how much longer the owner has property rights

Discount rates on rental payments

Rental rates (mostly) do not depend on the remaining lease time!