Discounting and the Value of Time

EES 3310/5310

Global Climate Change

Jonathan Gilligan

Class #32: Monday, Nov. 5 2018

Announcements

Announcement

- **Lab:** beginning next week you will work with a partner on a project to study decarbonization in detail.
  - Choose a country
  - Study its energy supply, and trends in Kaya variables
  - Find out its pledge in the Paris agreement (http://spappssecext.worldbank.org/sites/indc/Pages/INDCHome.aspx)
    - What year?
    - What emissions reduction?
  - Decide how much farther you think it could go by 2050
  - Make a plan for how the country should achieve:
    1. Its Nationally Determined Contribution for the Paris Agreement
    2. Your goal for 2050.
  - Presentation in lab on Mon. December 3rd
  - Written report due on Wed. December 5th

Announcement

- Take-home, open book, open notes
- Two essay questions
  - Connecting science and policy
  - Make connections among big ideas we’ve studied
  - Suggested length: around 2–3 pages double-spaced for each question
- I will post the exam on Wed. Dec. 5
- Due Thurs. Dec. 13 (by email)

Should we spend more today
to offset damages in the future?

Should we pay \$100 for a bond today that will pay \$1000 in 50 years?

- What would you expect to earn if you invested \$100 today in something else?
- Compounding interest:

$$V_{\text{future}} = V_{\text{present}} \times (1 + r)^n,$$

where:
  - V is value
  - r is interest rate (4% $\rightarrow r = 0.04$)
  - n is number of years
- Alternate formula:

$$V_{\text{future}} = V_{\text{present}} \times \exp(r \times n)$$

- Rule of 72:
  - The number of years to double your investment is roughly 72 / (percent interest rate)

Should we pay \$100 for a bond today that will pay \$1000 in 50 years?

- What would you expect to earn if you invested \$100 today in something else?
- Assume real interest rate is 4%
  - Compounding interest:

$$V_{\text{future}} = V_{\text{present}} \times (1 + r)^n,$$

$$\begin{aligned} V_{\text{present}} &= \$100 \\ V_{\text{future}} &= V_{\text{present}} \times (1 + r)^n \\ &= \$100 \times 1.04^{50} \\ &= \$711. \end{aligned}$$

- $\$1000 > \$711$, so it's a good deal.

Should we pay $100 for a bond today that will pay $1000 in 50 years?

- Formula for net present value (NPV) is the inverse of the interest formula:

$$
\begin{aligned}
V_{\text{future}} &= V_{\text{present}} \times (1+r)^n \\
V_{\text{present}} &= \frac{V_{\text{future}}}{(1+r)^n}
\end{aligned}
$$

$$
\begin{aligned}
V_{\text{future}} &= \$1000 \\
V_{\text{present}} &= \frac{\$1000}{1.04^{50}} \\
&= \frac{\$1000}{7.11} \\
&= \$141 > \$100.
\end{aligned}
$$

Different Discount Rates

- Higher rate (10%)

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1+r)^n} = \frac{1000}{1.10^{50}} = \$9 < \$100$$

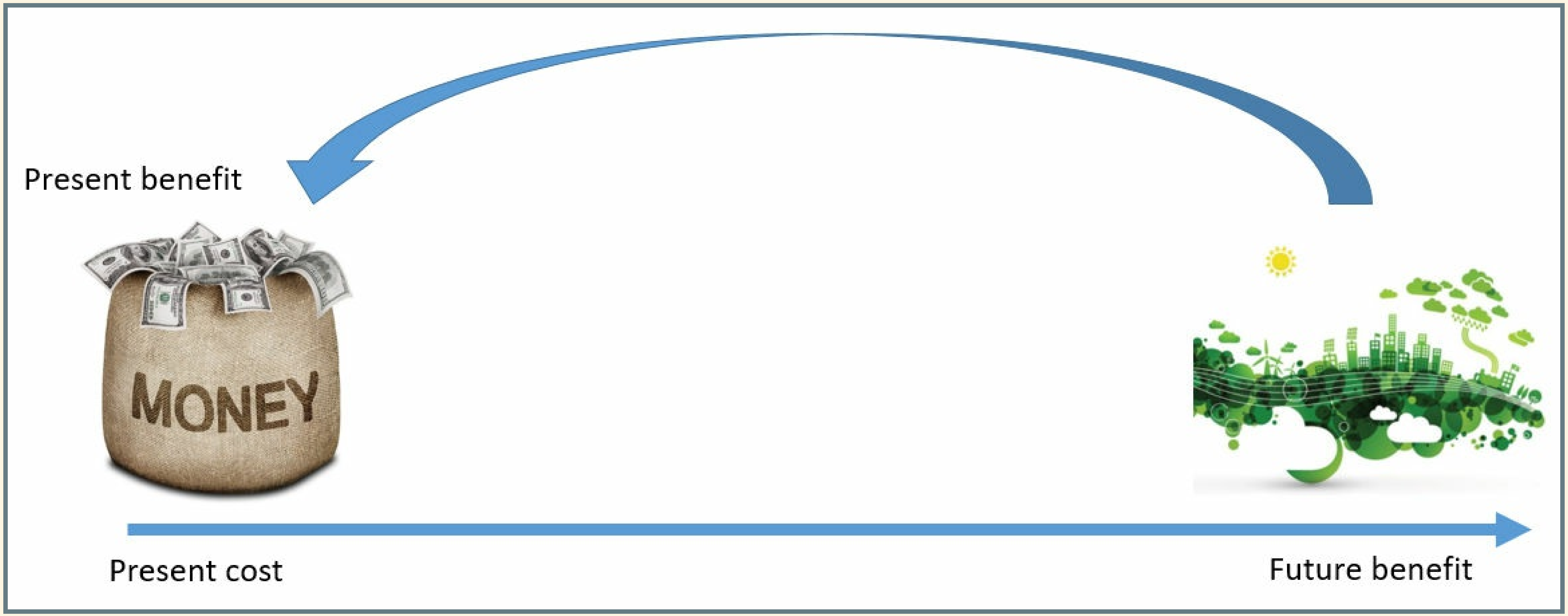
- Lower rate (1%)

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1+r)^n} = \frac{1000}{1.01^{50}} = \$608 > \$100$$

Future Generations

Should we spend money today to offset damages in the future?

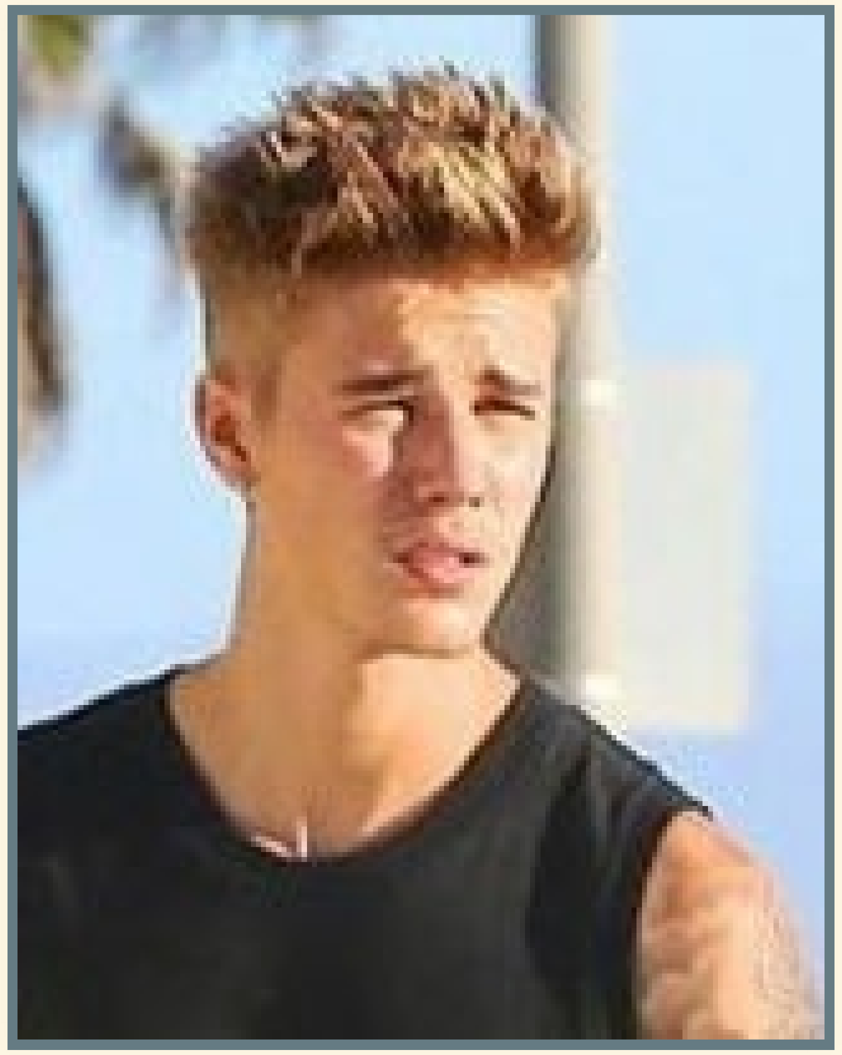
How much is it worth to us **today** to avoid climate disruption **in 100 years**?



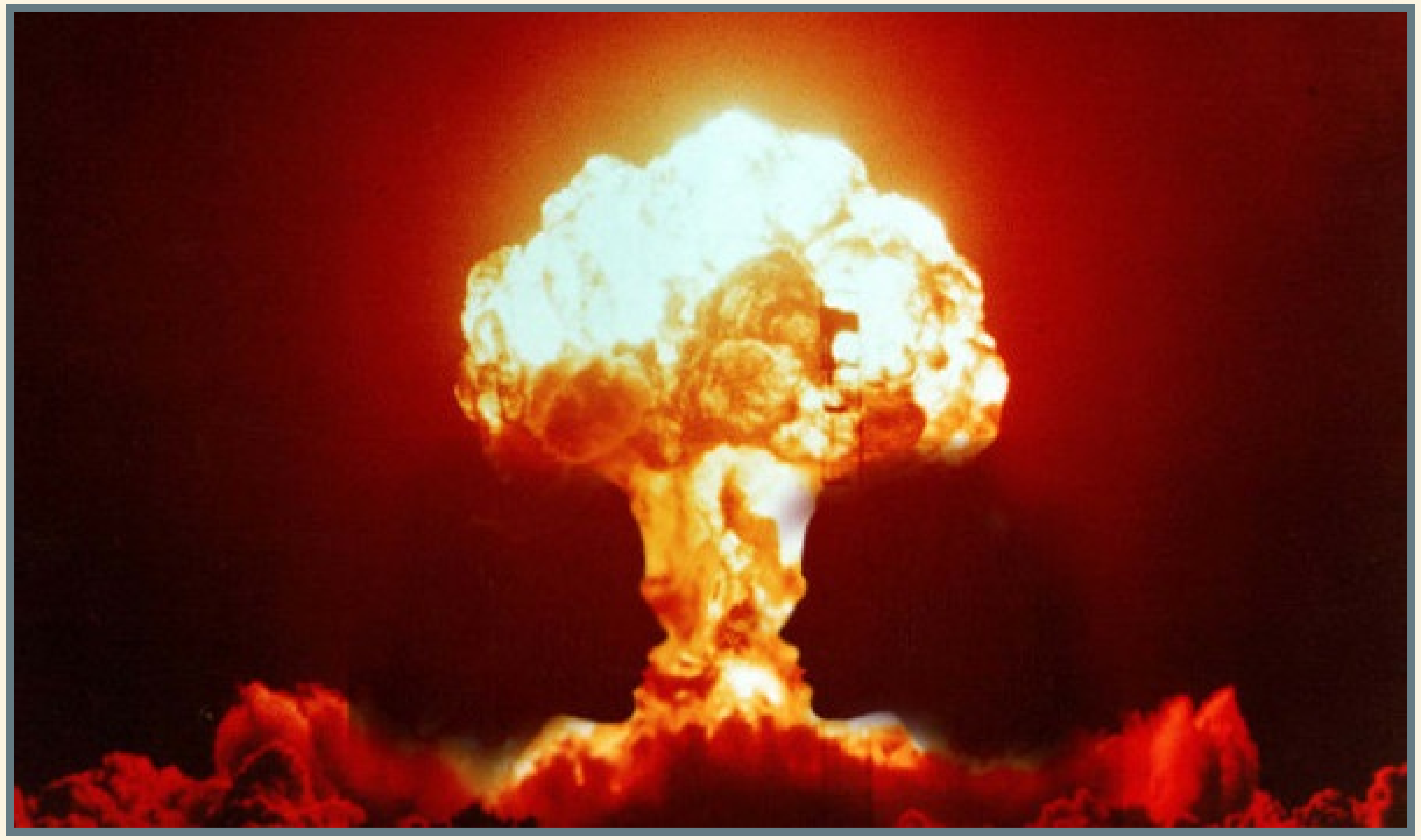
- How much is the welfare of your children worth, relative to your own welfare?
- Your grandchildren?
- Your great-grandchildren?
- Your great-great grandchildren?
- Your great^3 grandchildren?
- At what great^n do we stop?

Assume each future generation is worth half of the previous generation

$$1 + \frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \cdots = 2$$



=



Assume each generation is equal

$$1 + 1 + 1 + 1 + \cdots = \infty$$

Valuing the present (high discount rate)

- We’re poor relative to the future!
- Don’t take from the poor (that’s us) to give to the rich (future generations)
- But if we apply this to **spatial** inequalities that exist **now** … justifies massive wasteful transfers from rich to poor

Rates Matter!

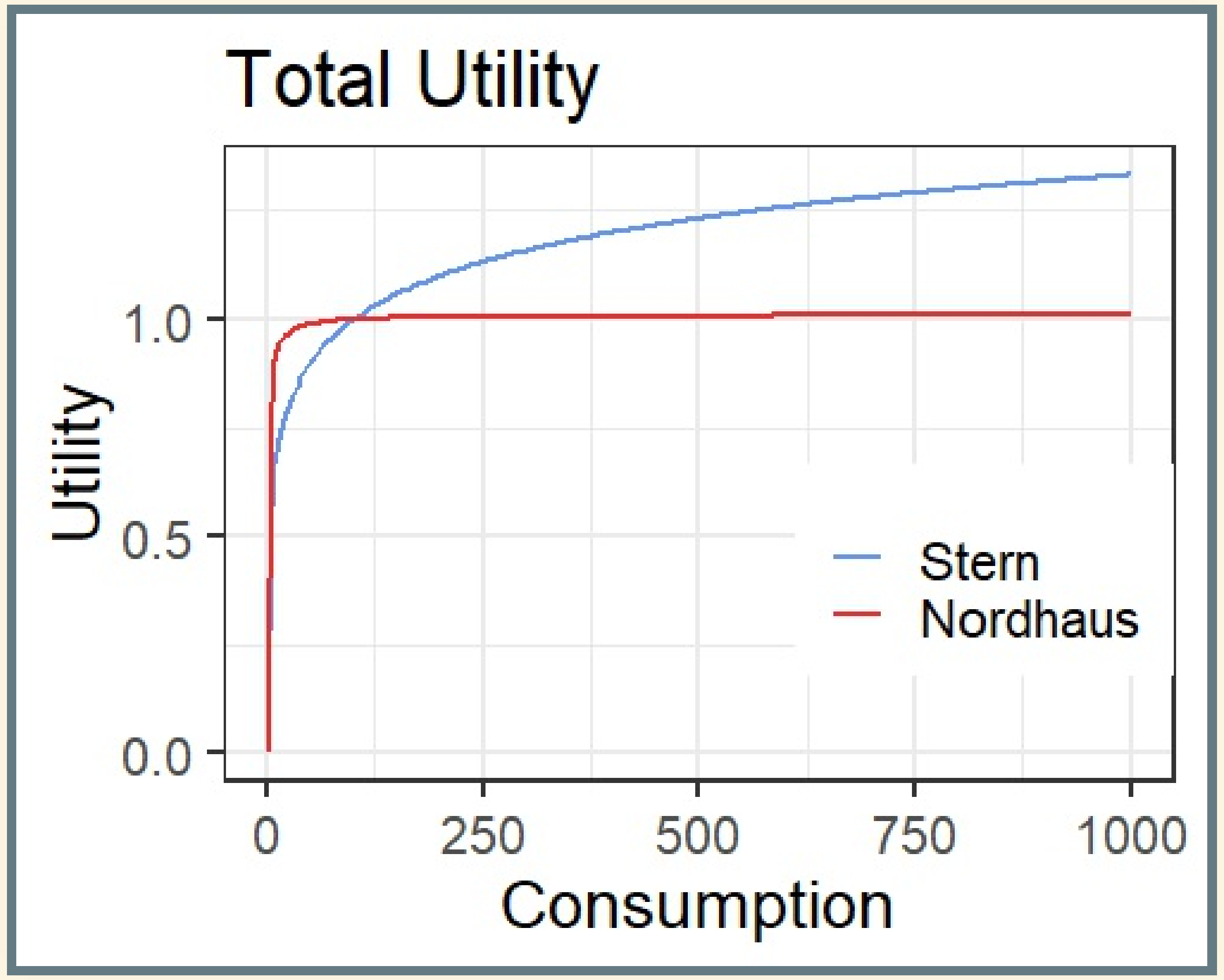
Stern vs. Nordhaus

Stern vs. Nordhaus

$$r = \rho + \eta g$$

Consumption elasticity η

- Proportional rate at which marginal utility of consumption is reduced as consumption increases (***What***?)
- Giving $100 to someone in poverty adds more to total well-being than giving $100 to Donald Trump
- High η: Value current consumption, strong benefots for redistribution from rich to poor
- Low η: Value future consumption, weak benefits for redistribution from rich to poor



- Stern: $\eta = 1$
- Nordhaus: $\eta = 2$

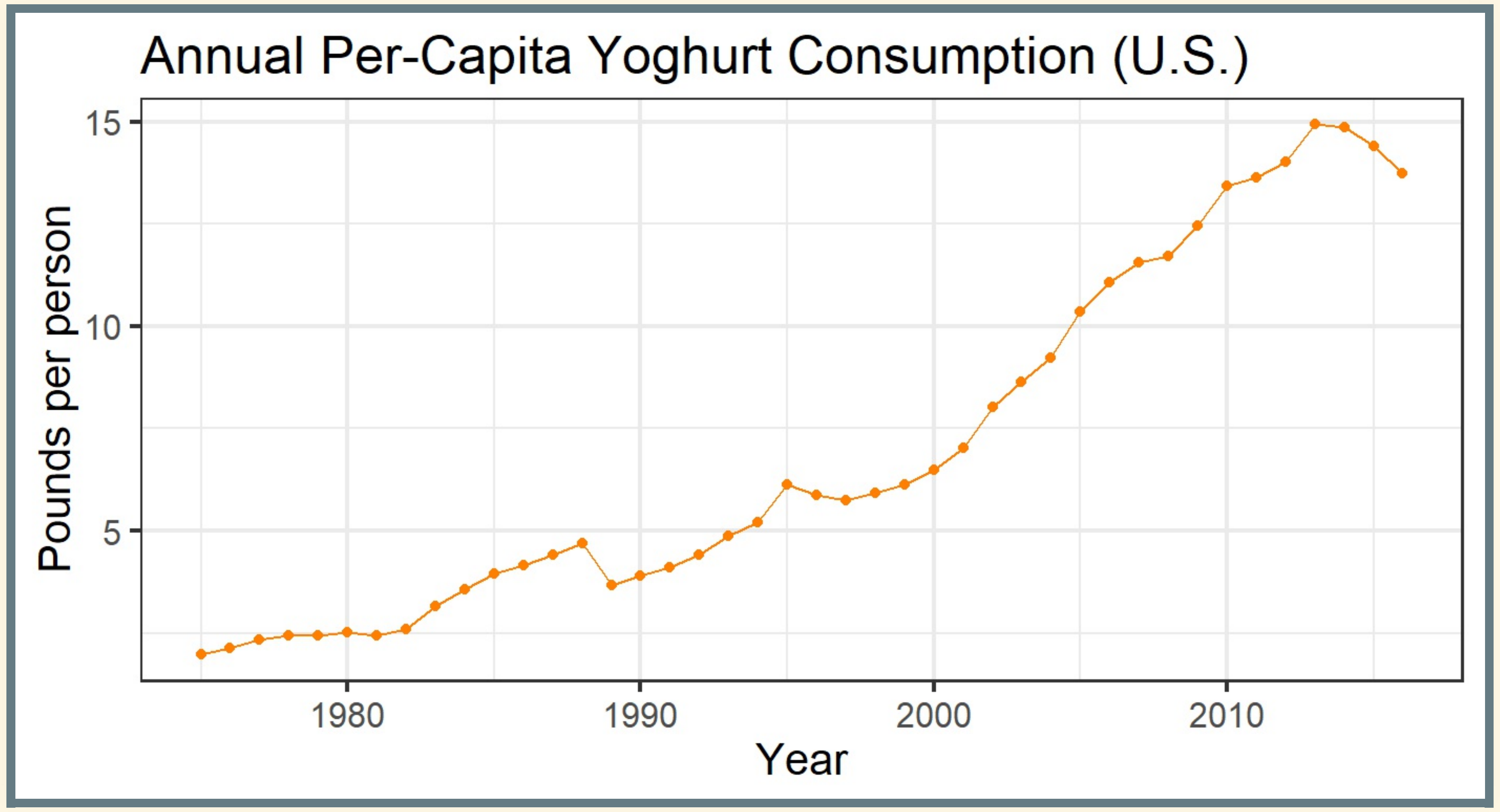
Time discount rate ρ

- How do we value future welfare, relative to our own?
- $\rho = 0$: All generations equal
- $\rho > 0$: Future generations count less than our own
- $\rho < 0$: Future generations count more than our own

- Stern: $\rho = 0.1\%$
- Nordhaus: $\rho = 1.5\%$

Per-capita consumption growth rate, g

- Stern: $g = 1.3\%$
- Nordhaus: $g = 1.3\%$



Real return on capital r

- Potential of capital to create value
- High $r \longrightarrow$ Wait and reduce emissions in the **future** (capital yield is higher in future)
- Low $r \longrightarrow$ Reduce emissions in the **present** (future damages likely to exceed future output)

Stern vs. Nordhaus

$$r = \rho + \eta g$$

$r = 1.4$

$r = 4.1$

Discount Rates and Decarbonization

Discount Rates and Decarbonization

- Investing \$10 million in wind today produces \$100 million in real value 50 years from now
  - Rate of 1%: $V_{\text{present}} = \frac{\$100\text{M}}{1.01^{50}} = \$61\text{M} > \$10\text{M}$ 
  - Rate of 4%: $V_{\text{present}} = \frac{\$100\text{M}}{1.04^{50}} = \$14\text{M} > \$10\text{M}$ 
  - Rate of 7%: $V_{\text{present}} = \frac{\$100\text{M}}{1.07^{50}} = \$3\text{M} > \$10\text{M}$ 

Stern vs. Nordhaus on Implications of Discount Rate

Nordhaus

… we need to use a discount rate that reflects the actual market opportunities that societies face, not an abstract definition of equity taken out of the context of market realities.

Stern

… the benefits of strong early action far outweigh the economic costs of not acting.

… even at moderate levels of warming, all the evidence … shows that climate change will have serious impacts on world output, on human life, and on the environment.

Stern Review, pp. xv–xvi

Stern

… we should go beyond the narrow framework of social welfare functions to consider other ethical approaches, including those involving rights and sustainability.

… disaggregated approach to consequences — looking at different dimensions, places, and times — and a broad ethical approach.