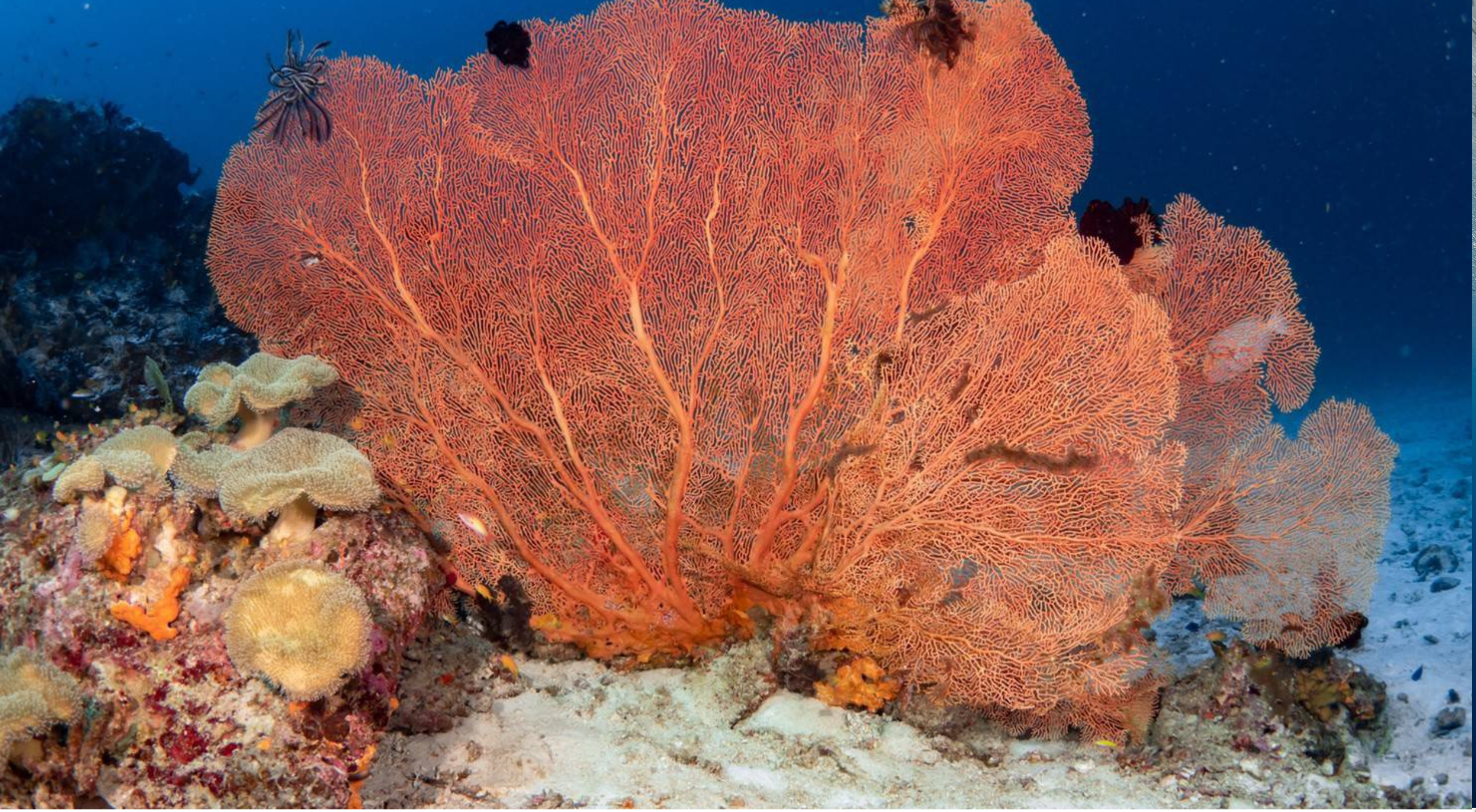
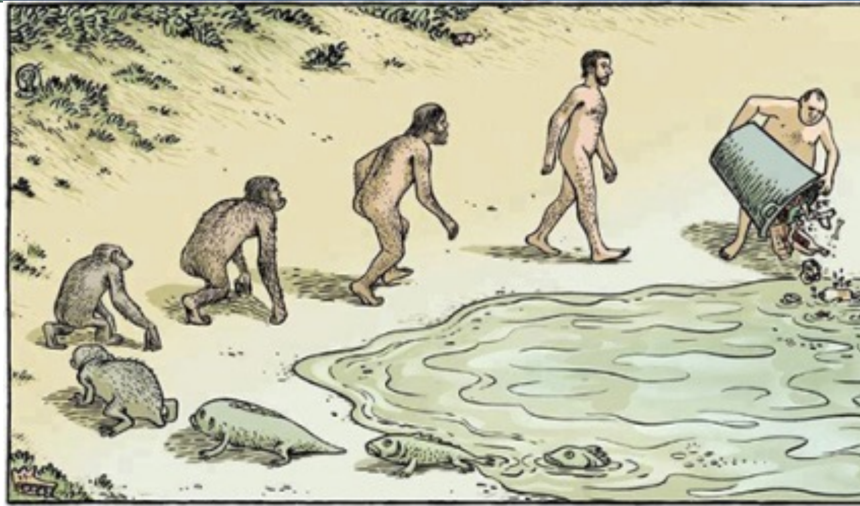


EE476
Environmental Economics

Lecture 8

2022



Cost benefit analysis (CBA)

- a tool for policy analysis that attempts to monetize all the costs and benefits of a proposed action to determine the net benefit.

Cost–Benefit Analysis of Proposed Ozone Standards in the United States, Relative to Baseline Standard (75 ppb)

	70 ppb Standard	65 ppb Standard	60 ppb Standard
Annual Compliance Costs (billions of dollars)	$4.7	$16.6	$41.2
Annual Avoided Deaths	1,400–2,100	4,100–6,400	7,600–11,800
Annual Monetized Benefits (billions of dollars)	$7.5–$15.0	$21.2–$42.1	$37.2–$75.9
Annual Net Benefits (billions of dollars)	$2.8–$10.3	$4.6–$25.5	–$4.0–$34.7
Benefit-Cost Ratio	1.6–3.2	1.3–2.5	0.9–1.8

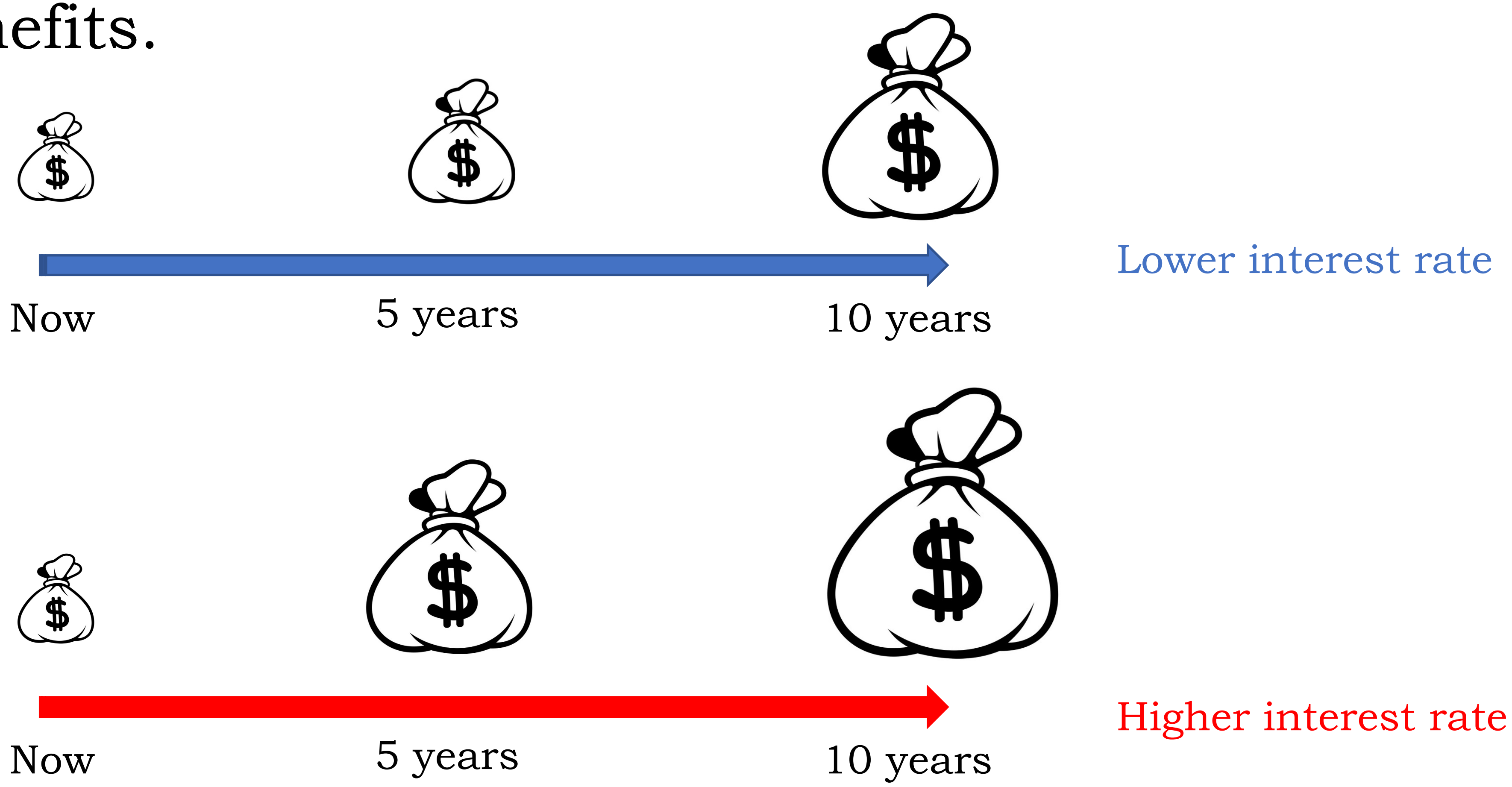
BALANCING THE PRESENT AND FUTURE: THE DISCOUNT RATE

There are a number of reasons why people may prefer a monetary benefit now rather than later.

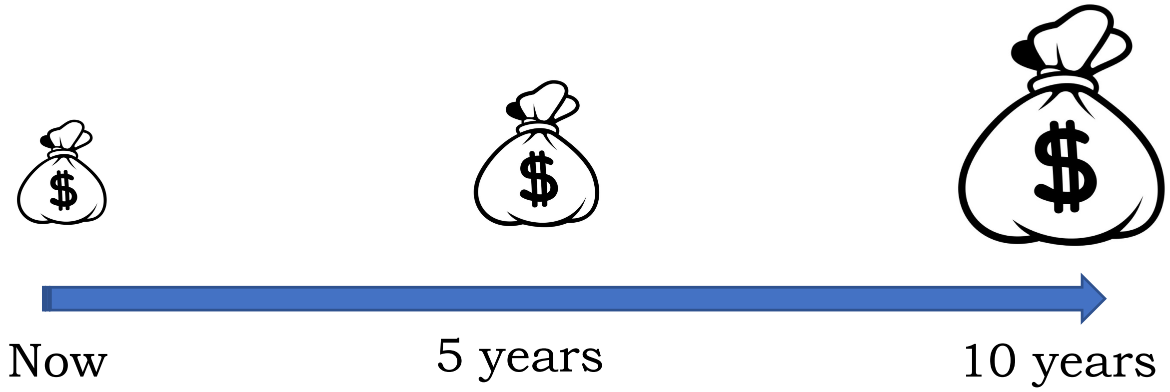
1. Money available now can usually be invested to get a positive real (inflation-adjusted) return. $100 today will grow into, say, $200 ten years from now. In this sense, $100 today is equivalent to $200 ten years from now.
2. Another reason for preferring money now may be uncertainty about the future—if we get the benefit now we don't have to worry about whether we will actually get it in the future.
3. Then there is simple impatience—the natural human tendency to focus on the present more than the future.

Discounting

- the concept that costs and benefits that occur in the future should be assigned less weight (discounted) relative to current costs and benefits.



Time value of money



Doposit \$A in your bank account today with interest rate of r%

After 1 year	A + rA	= A(1+r)	
After 2 years	A(1+r) + r[A(1+r)]	= A(1+r)(1+r)	$= A(1+r)^2$
After 3 years	$A(1+r)^2 + r[A(1+r)^2]$	$= A(1+r)^2(1+r)$	$= A(1+r)^3$
....	....	....	....
After t years	....		$= A(1+r)^t$

Future value at year t = Initial value $(1+r)^t$

$$\mathbf{FV_t = PV(1+r)^t}$$

$$PV = FV_t\left[\frac{1}{(1+r)^t}\right]$$

Deposit \$100 today (r = 4%)

\$100 → $\$100(1+0.04)^{10} = \$148.024$

$\$100 = 148.024\left[\frac{1}{(1+0.04)^{10}}\right]$ ← \$148.024

Present value, discount rate, discount factor

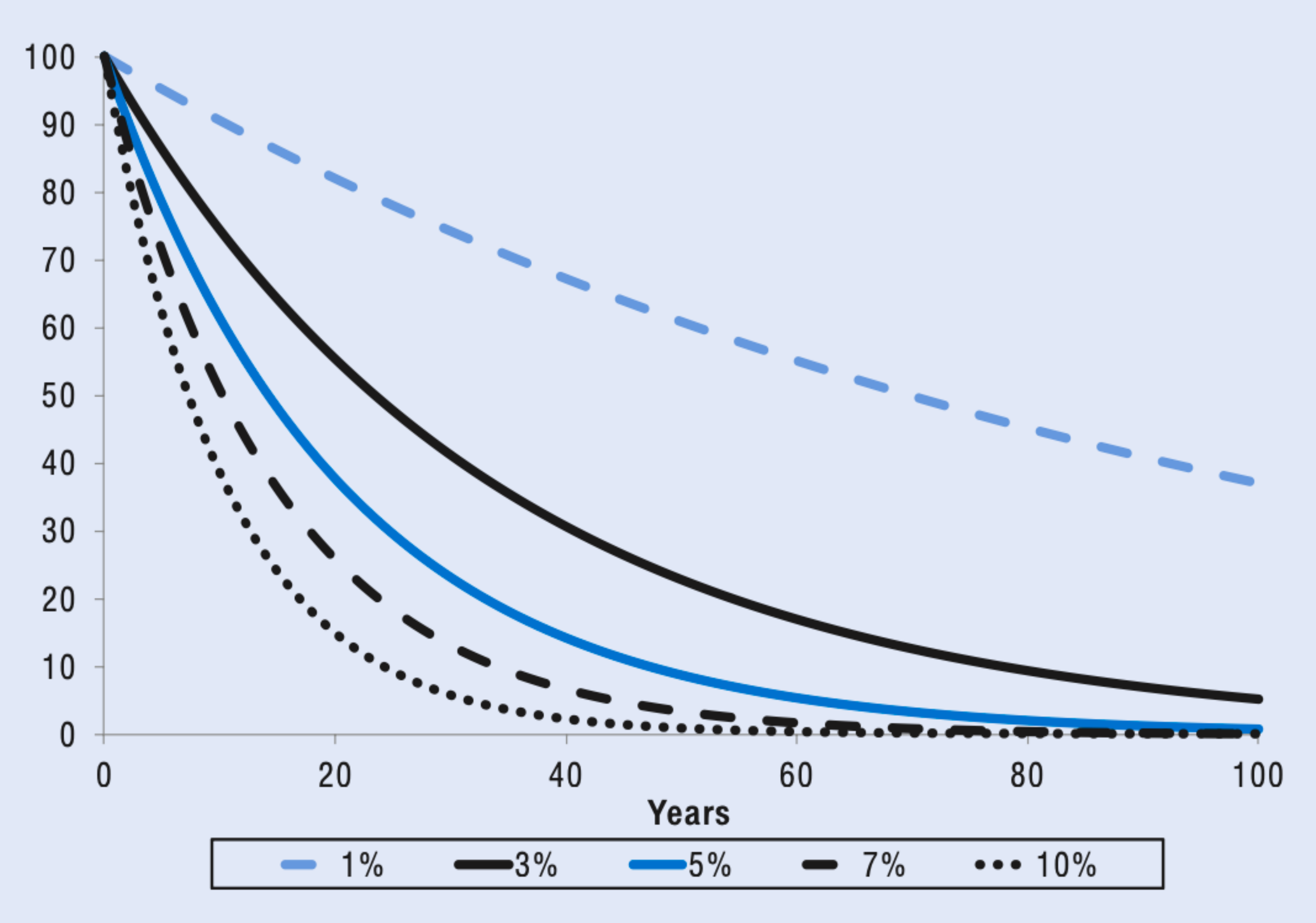
- **present value** the current value of a stream of future costs or benefits; a discount rate is used to convert future costs or benefits to present values.
- **discount rate (r)** the annual rate at which future benefits or costs are discounted relative to current benefits or costs.
- **discount factor [$1/(1+r)^t$]** the factor converting future values to present values

Discount factors

(PV of value of $1 in year t with r%)

Years	1%	2%	5%	10%
1	0.9901	0.9804	0.9524	0.9091
2	0.9803	0.9612	0.9070	0.8264
5	0.9515	0.9057	0.7835	0.6209
10	0.9053	0.8203	0.6139	0.3855
20	0.8195	0.6730	0.3769	0.1486
50	0.6080	0.3715	0.0872	0.0085
…	…	…	…	…
100	0.36971	0.13803	0.0076	0.0001

Present value of a $100, by year and discount rate



- A high discount rate will highly favor the present over the future, while a low discount rate will give more weight to future costs or benefits.
- In many environmental applications, the benefits occur in the future while the costs are paid in the short term.
- Climate change : the costs of mitigating climate change would occur in the near term while the benefits (i.e., reduced damages) would occur decades and even centuries in the future.
- Thus a low discount rate will generally support a higher degree of environmental protection.

“correct” discount rate?

- One approach to determine the discount rate is to set it equal to the rate of return on low-risk investments such as government bonds.
- The rationale : funds used for a beneficial public project could otherwise be invested with interest to provide society with greater resources in the future.
- In other words, the market rate of return represents the opportunity cost of spending money now.

Social discount rate, or **social rate of time preference (SRTP)**,

A different approach to determining the discount rate is based on two justifications for discounting:

1. **pure rate of time preference** natural human tendency to prefer the present over the future.

2. Given that the **economic growth** continues, people in the future will be richer than people now. So $100 in damages (in real terms) to them is "less damaging" than a $100 damage now, because it will represent a smaller share of their wealth and thus have a smaller effect on their welfare. Similarly, $100 in benefits will be less valuable to people in the future than $100 to people today, just as $100 is less important to a rich person than to a poor person. In more technical terms, utility is assumed to be a **diminishing marginal function of consumption.**

$$SRTP = \rho + \epsilon g$$

Social rate of time preference (SRTP),

$$SRTP = \rho + \epsilon g$$

- ρ is the pure rate of time preference : the rate of preference for obtaining benefits now as opposed to the future
- g is the annual growth rate of consumption, and
- ϵ is the elasticity of the marginal utility of consumption ; the rate at which the extra satisfaction from increased consumption declines as consumption increases

$\epsilon g \Rightarrow$ how much better off a society is as it gets richer.

Social rate of time preference (SRTP),

$$SRTP = \rho + \epsilon g$$

- Estimates of the historical growth rate of consumption can be obtained from government data sources. In projecting real consumption growth rates into the future, the Stern Review (a famous cost-benefit analysis of global climate change) uses a value of g = 1.3 percent. Estimates of the value of ϵ are about 1.0-2.0.
- A vigorous debate among economists has focused on the value of ρ.
- The Stern Review used a value of ρ = 0.1. The justification is that one generation's welfare is not inherently more important than another generation's welfare.
- Stern Review using g = 1.3 percent, ϵ = 1.0, and ρ = 0.1, a final discount rate of 1.4 percent is obtained.

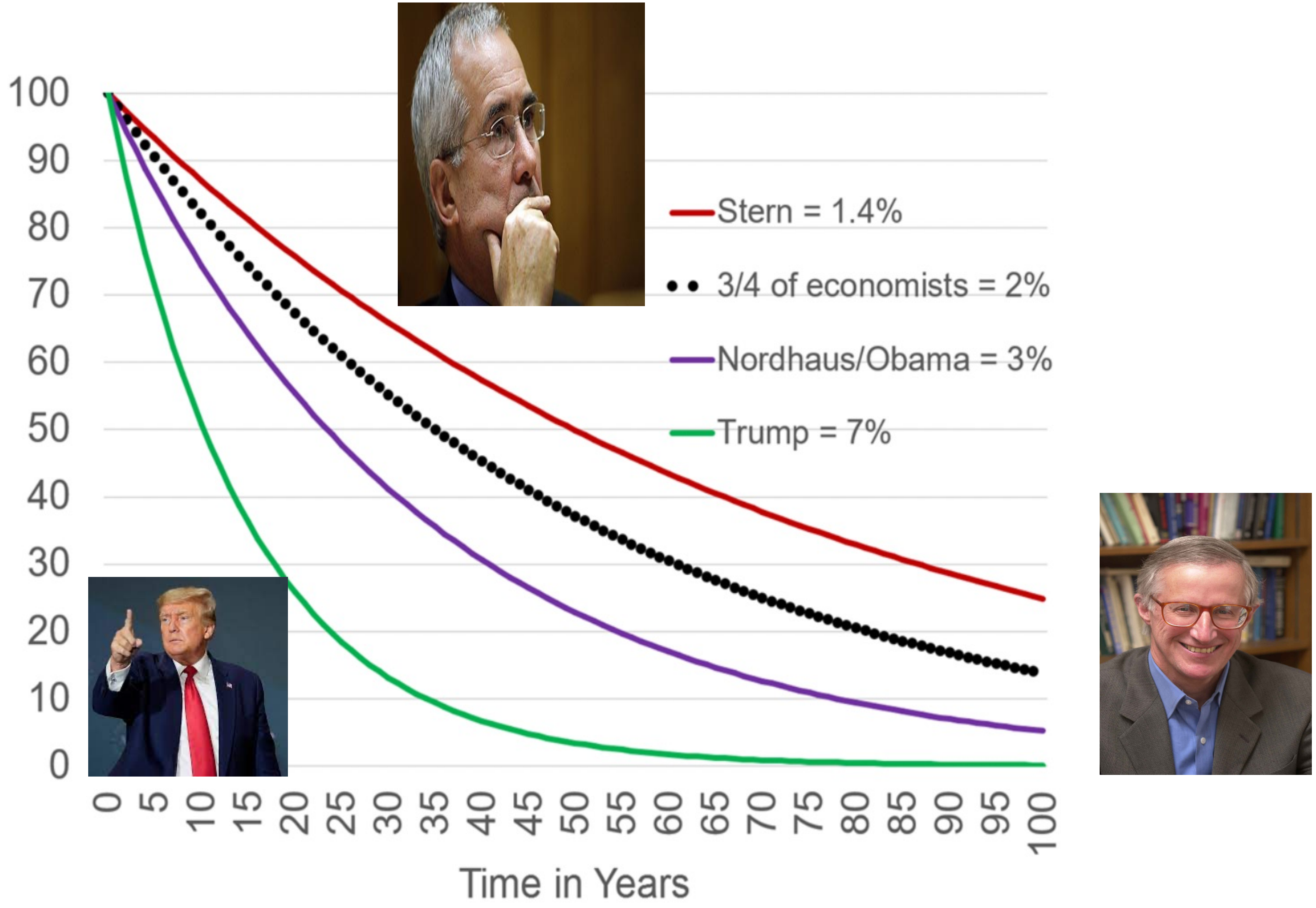
Social rate of time preference (SRTP),

$$SRTP = \rho + \epsilon g$$

- Many economic analyses use higher discount rates based on higher values for ρ and ε.
- these values more closely align with the time preference implied by financial market decisions. For example, using the same value of g = 1.3 percent, setting ρ = 1.5 and ϵ = 1.4 yields a final discount rate of 3.4 percent.
- Compared with a 1.4 percent discount rate, using a rate of 3.4 percent will yield a present value for an impact 100 years in the future only one-seventh as large.

Distance future & Discount rate

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



HM Treasury UK (3.5%)

Years ahead	31-75	76-125	126-200	201-300	301+
Discount rate	3.0%	2.5%	2.0%	1.5%	1.0%