

# EC1340-Fall 2023

## Problem Set 7 solutions

*(Updated 31 July 2023)*

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1. To make this problem easier to handle, define  $\delta_1 = \frac{1.015}{1+r}$  and  $\delta_2 = \frac{1.005}{1+r}$ . With this notation in place, we have

$$\begin{aligned}
 W_1 &= \sum_{t=0}^{\infty} \delta_1^t Y_0 \\
 &= \frac{1}{1 - \delta_1} Y_0 \\
 W_2 &= \sum_{t=0}^{49} \delta_1^t Y_0 + \delta_1^{50} \sum_{t=0}^{\infty} \delta_2^t Y_0 \\
 &= \frac{1 - \delta_1^{50}}{1 - \delta_1} Y_0 + \delta_1^{50} \frac{1}{1 - \delta_2} Y_0 \\
 W_3 &= \sum_{t=0}^{99} \delta_1^t Y_0 + \delta_1^{100} \sum_{t=0}^{\infty} \delta_1^t (0.95 Y_0) \\
 &= \frac{1 - \delta_1^{100}}{1 - \delta_1} Y_0 + \delta_1^{100} \frac{1}{1 - \delta_1} (0.95 Y_0)
 \end{aligned}$$

- (a) We evaluate  $W_1 - W_2$  using the formulas above, to get

$$\begin{aligned}
 W_1 - W_2|_{r=.02} &= 6700 \text{ trillion} \\
 W_1 - W_2|_{r=.055} &= 48.11 \text{ trillion}
 \end{aligned}$$

- (b) We evaluate  $W_1 - W_3$  using the formulas above, to get

$$\begin{aligned}
 W_1 - W_3|_{r=.02} &= 393.12 \text{ trillion} \\
 W_1 - W_3|_{r=.055} &= 1.74 \text{ trillion}
 \end{aligned}$$

- (c) From figure 5-1 the value of the backstop policy is about 17 trillion dollars.
- (d) The discount rate is very important in determining the value of climate change policy. However, since the growth rate also enters in to our calculations exponentially, it too is very important. In particular, even if we use Stern's discount rate, it's hard to conclude that global warming is a catastrophe if it just causes a 5% drop in GDP in 100 years. When we start to consider impacts on the growth rate, however, it becomes much easier to generate catastrophic impacts on welfare. That is, global warming starts to look like an important problem.

2. This table shows all of the data and calculations you need to answer this question. The 2000 data is pre-entered in the spreadsheet.

Cell	Description	2000	205	2020
b4	World GDP, Trillions USD2015/year <a href="https://data.worldbank.org/indicator/NY.GDP.MKTP.CD">https://data.worldbank.org/indicator/NY.GDP.MKTP.CD</a> (August 2022)	33.8	47.8	85.0
.	Gt Fossil CO <sub>2</sub> per year from IPCC (lecture 1)	24	26	40*
b5	Base year emissions Gt C	6.6	7.1	10.9
.	Convert CO <sub>2</sub> to C Base year concentration (ppm) <a href="https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt">https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt</a> (August 2022)	370	380	414
b6	Base year concentration Gt C ( $ppm \times 2.12$ )	784.4	805.6	877.7
b7	World population in billions <a href="https://data.worldbank.org/indicator/SP.POP.TOTL">https://data.worldbank.org/indicator/SP.POP.TOTL</a> (August 2022)	6.11	6.51	7.76
b54	[PVT Damages + PVT Abatement Costs] (tril. 2015USD)	26.7	38.1	72.9
b56	Social Cost of Carbon	203.1	267.1	309.3
b58	Social Cost of CO <sub>2</sub>	55.4	72.8	84.4
	Social Cost of CO <sub>2</sub> 2005USD Nordhaus, Table 5-4	.	27.3	47.6**
	Social Cost of CO <sub>2</sub> 2015USD Nordhaus	.	36.3	63.3
b56	[PVT Damages + PVT Abatement Costs] (tril. 2015USD) (2020, pure time preference = 0.1%)	.	.	146.2
b58	[PVT Damages + PVT Abatement Costs] (tril. 2015USD) (2020, 0.7 CO <sub>2</sub> in atmosphere)	.	.	80.5

\* I just estimated fossil emissions from the figure in lecture #1, and rounded up to go from 2019 to 2020.\*\* Average of 2015 and 2025 table entries.