ESM 204 HW 4:
Calculating the SCC and policy choice under uncertainty

Spring, 2021 (due May 28, 5:00 pm)

As discussed in Homework 3, the Biden Administration recently tasked an Inter-agency Working Group (IWG) with updating the United States Government's Social Cost of Carbon (SCC). In this homework, you will use new estimates of the future impacts of climate change to inform an update to the SCC.

We recommend using `R` and writing functions to compute your answers wherever possible.

In the provided dataset "damages.csv" you have new model estimates of the annual total damages from climate change at different levels of warming (in degrees C). The other dataset "warming.csv" contains estimates of a baseline future climate trajectory (in degrees C) until 2100, and a second trajectory that adds a one-time pulse of CO_2 today to the atmosphere. The pulse is 35 billion tons of carbon, which is roughly equal to annual global emissions. You can think of this as a "small" one-time pulse in carbon emissions.

1. Using damages.csv, estimate a quadratic damage function relating the dollar value of damages to the change in global mean temperature. Omit an intercept term; damages by construction must equal zero when there is no climate change. Plot your estimated damage function, overlaid with a scatterplot of the underlying data.

2. Use warming.csv and your estimated damage function to predict damages in each year under the baseline climate and the pulse scenario. Make four plots: (1) damages over time without the pulse, (2) damages over time with the pulse, (3) the difference in damages over time that arises from the pulse, and (4) the difference in damages over time from the pulse *per ton of* CO_2 (you can assume that each ton of the pulse causes the same amount of damage).

3. The SCC is the present discounted value of the stream of future damages caused by one additional ton of CO_2. The Obama Administration used a discount rate of 3% to discount damages. Recently, New York State used a discount rate of 2%. Calculate and make a plot of the SCC (y-axis) against the discount rate (x-axis) for a reasonable range of discount rates.

4. The National Academies of Sciences, Engineering, and Medicine advised the government in a 2017 report to use the Ramsey Rule when discounting within the SCC calculation:

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

   Using $\rho = 0.001$, $\eta = 2$, and $g = 0.01$, what is the SCC? Locate this point on your graph from above.

5. Now suppose there are two possible climate policies that can be pursued. Policy A is business as usual and Policy B is to take immediate and strong action on climate change. Use these facts

   - If you undertake Policy A there are two possible outcomes. Either warming will occur as in the "baseline" (i.e. "no-pulse") dataset above (this happens with probability 0.5) or warming each year will be 1.5 times that in the "baseline" dataset (with probability 0.5).
   - Under Policy B, warming will continue until 2050 as in the "baseline" dataset, and then will stabilize at 1.29 degrees and stay that way forever.

- Society is risk neutral
- Use a discount rate of 2%

What is the expected present value of damages up to 2100 under Policy A? What is the expected present value of damages up to 2100 under Policy B? Suppose undertaking Policy A costs zero and undertaking Policy B costs X. How large could X be for it to still make economic sense to pursue Policy B instead of Policy A? Qualitatively, how would your answer change if society were risk averse?