ESM204: Assignment 4

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First, we built out the structure for Functions 1 - 5.

Then, we created data frames for the temperature, economic retention, consumption, and utility over time under our three climate scenarios: no climate change (T = 0), modest climate change (T = 2), and extreme climate change (T = 8).

Data Frames for Plots

Givens for Part 1

t_diff = 5 # T B = .05 g = .01 n = .5 d = .005 # delta

T = 0

T = 2

T = 8

Question 1

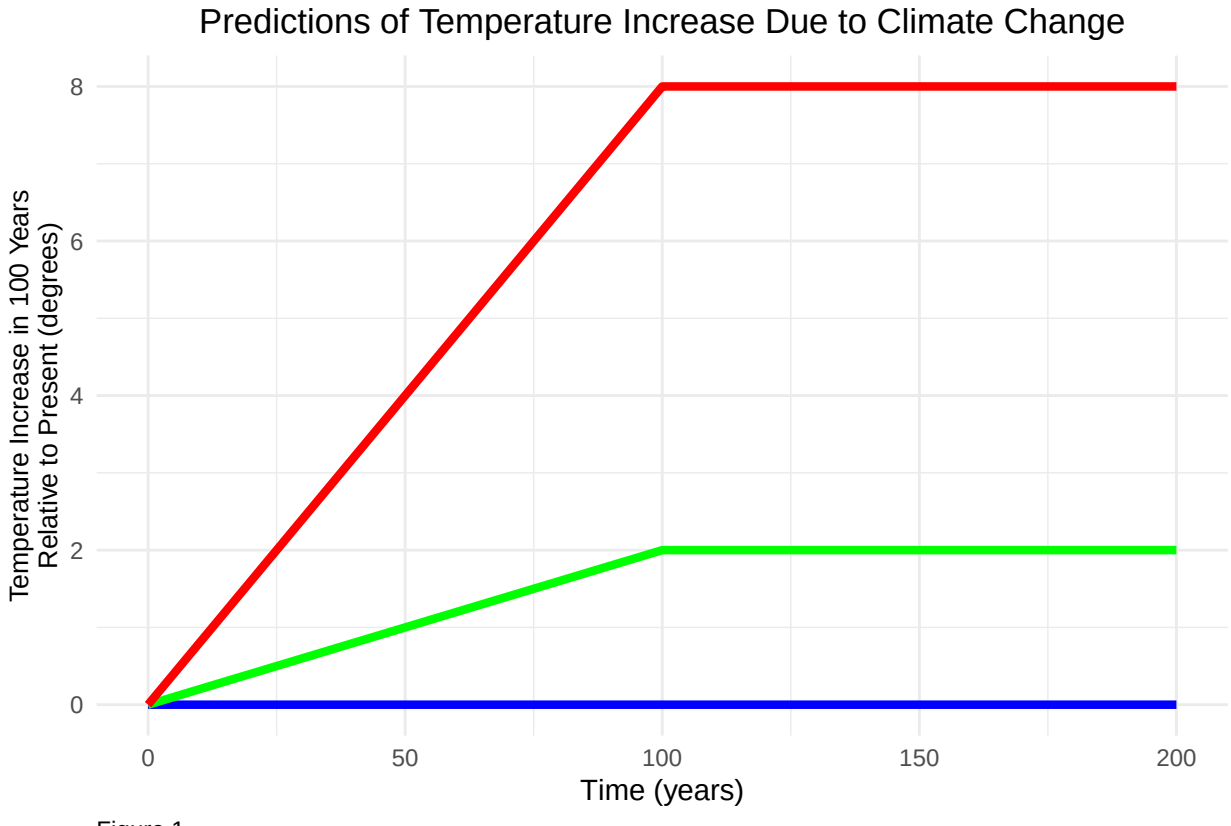

Figure 1

Plot 1a

Figure 1 (above) plots estimated temperature change over time for three possible climate scenarios. In order from bottom to top we have temperature changes over time for: no climate change (blue), modest climate change (green), and extreme climate change (red).

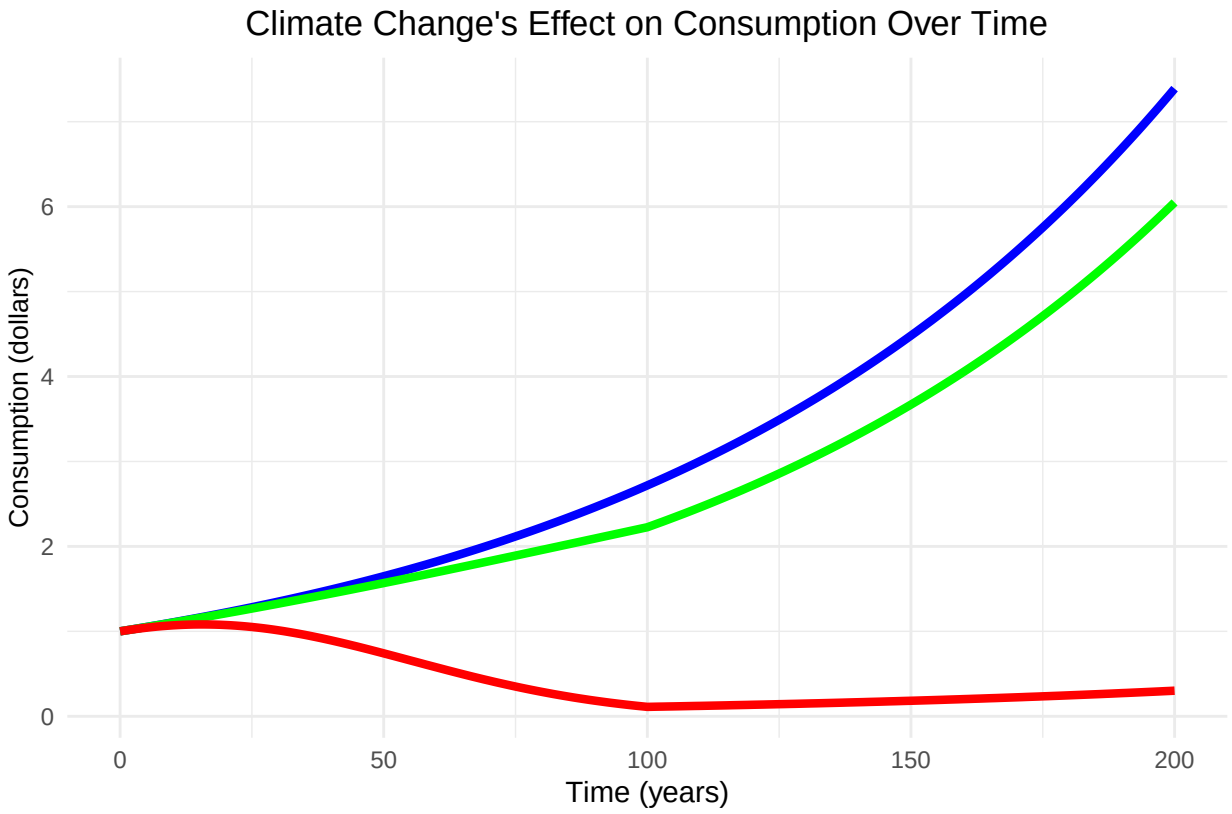

Figure 2

Plot 1b

Figure 2 (above) plots economic activity (consumption) change over time for three possible climate scenarios. In order from bottom to top we have consumption changes over time for: extreme climate change (red), modest climate change (green), and no climate change (blue).

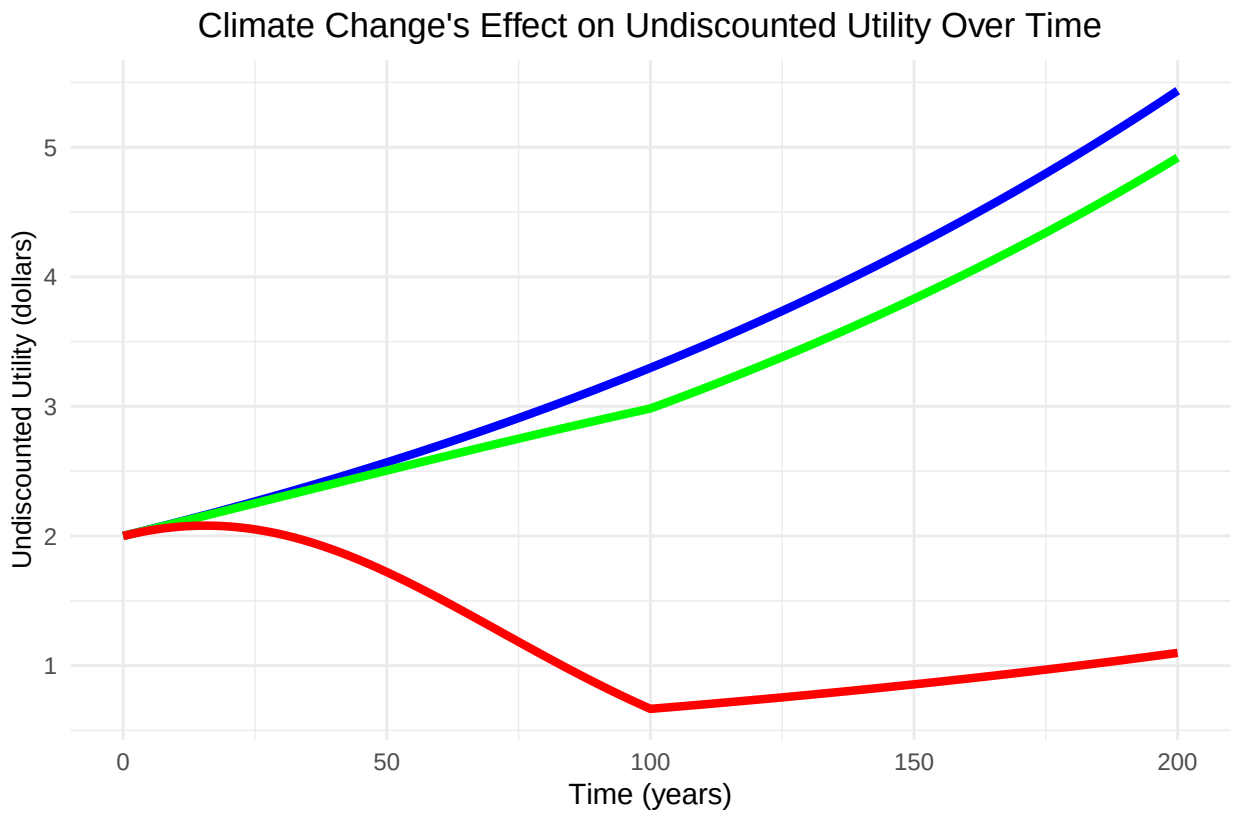

Figure 3

Figure 3 (above) plots estimated changes in undiscounted societal utility over time for three possible climate scenarios. In order from bottom to top we have utility over time for: extreme climate change (red), modest climate change (green), and no climate change (blue).

Question 2a

$T = 4.4$

The present value of the utility over the next 200 years with a warming of 4.4 degrees is 198.66. The present value of the utility over the next 200 years in the case of no warming is 255.27.

Percentage Loss (L)

To determine the present value of the utility under these scenarios, we summed the discounted utility over 200 years for each scenario. The present value (i.e. discounted) utility over the next 200 years without climate change is estimated to be $255.27. With an increase in temperature of 4.4 degrees over the next 200 years is estimated to be $198.66. There is a 22.177% loss in utility under a 4.4 degree warming regime relative to the 0 degree warming regime.

Question 2b

Next, we conducted a sensitivity analysis of the percentage loss in present value (L) for T, g, n, and B.

Sensitivity to T

Percentage Loss (L) for T Sensitivy Analysis

Sensitivity of B

Percentage Loss (L) for B Sensitivy Analysis

Sensitivity of g

Percentage Loss (L) for g Sensitivy Analysis

Sensitivity of n

Percentage Loss (L) for n Sensitivy Analysis

Our calculation of L in 2a is not overly sensitive to different changes in specific parameters. With a 10% increase in T, g, n, and B, L increases by 3.62%, 0.4%, 2.581%, and 1.762%, respectively, compared to the original L we calculated. Given this information, it is safe to assume that our climate-economy model is fairly robust to possible modeling errors in our estimates of those parameters.

Question 2c

Givens: Vnot = p_4_4 Vsubt = utility(C) for T = 0 = utility_df_T_0 d = 0.005 n = 0.5 g = 0.01 B = 0.05

Answer = line 80is, approx 40% (39.5)

The maximum fractional value of consumption society would be willing to endure every year to completely prevent climate change (from a 4.4 degree increase) is equal to approximately 40% of consumption every year. We determined this by creating a vector showing present values under the no warming model for a variety of thetas and determining which theta produced a present value nearly the same as the present value under 4.4 degrees of warming.

Question 2d

Before solving for theta star we needed to create a dataframe for utility values over time at T = 4 (utility_df_T_4) and T = 6 (utility_df_T_6). Then we need to determine the present value under 2 degree, 4 degree, and 6 degree warming scenarios (pv_2, pv_4, pv_6).

0.025 = 1/40 = 2.5%

Under uncertainty, the maximum fractional value of consumption society would be willing to endure every year to completely prevent climate change is equal to approximately 38%. To determine this, we calculated the present value under uncertainty, which we determined to be 201.34. Then, we determined which value for theta would return a present value of 201.34 under zero warming conditions.