Economics of Climate Change – Problem Set 2

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Question 1: The Social Discount Rate (30%)

1.1 The Ramsey equation is given by:

$$r = \delta + \mu g$$

Where:

- r is the social discount rate
- δ is the pure rate of time preference, representing the preference for present consumption over future consumption
- μ is the elasticity of marginal utility with respect to consumption, capturing how the utility of consumption decreases as wealth increases
- g is the expected growth rate of consumption

The impact of each element in the Ramsey equation (δ, μ, and g) on the valuation of economic damages far into the future can be understood through their combined influence on the social discount rate. The parameter δ, the pure rate of time preference, reflects how much we prioritize the present over the future. A higher δ means we significantly discount future benefits and costs, reducing the urgency of addressing future economic damages since we value present benefits much more highly. In other words, future damages are treated as less important, making long-term climate policies seem less pressing. The growth rate of consumption g represents the expected wealth or consumption level of future generations. If g is high, it suggests future generations will be wealthier, and thus more capable of dealing with economic damages when they occur. This reduces the weight we place on future damages today, as future generations are expected to have more resources to cope with them. On the other hand, if g is low, it indicates that future generations will not be significantly wealthier, increasing the value we assign to future damages, as the burden on them would be relatively higher. Finally, μ, the marginal utility of consumption, captures how additional consumption affects utility. When μ is high, it indicates diminishing marginal utility, meaning that as future generations become wealthier (due to g), the additional utility they gain from more wealth decreases. In this case, future damages are still important to address because preventing them now provides more utility when current consumption levels are lower. Together, these elements determine how much we discount future economic damages, with higher values of δ and g leading to greater discounting, and a higher μ making future damages more important to address when the future generation's additional wealth won't translate into proportionally higher utility. Ultimately, a higher overall discount rate leads to lower present valuation of future damages, making them seem less urgent, whereas a lower discount rate places more emphasis on mitigating long-term economic damages today.

1.2 Two reasons why the discount rate might be uncertain:

- **Uncertain Economic Growth:** The growth rate of the economy (g) is unpredictable, and small deviations can have a large effect on the social discount rate.
- **Risk Preferences:** Society's risk preferences or the uncertainty about future climate damages may shift over time, influencing the appropriate discount rate to reflect evolving perceptions of future risks.

Question 2: Social Cost of Carbon (50%)

2.1 To minimize the perceived benefits of climate policies, I would recommend a high discount rate of **5%**. A higher discount rate lowers the present value of future climate damages, making long-term climate policies appear less cost-effective. By framing the discount rate as reflecting realistic economic growth expectations, this choice would be harder for opponents to challenge.

2.2 I would recommend restricting the scope of the analysis to **domestic benefits**. This would minimize the perceived benefits of climate action by excluding global impacts, especially on poorer countries that are more vulnerable to climate change. Justifying this based on national interest would make it challenging for opponents to argue against this framing.

2.3 I recommend using a **2% discount rate** for long-term climate damages. A lower discount rate better captures the ethical consideration of intergenerational equity, ensuring that future generations are not disproportionately harmed by current inaction. Additionally, it aligns with economic arguments that consider the irreversible nature of climate damages.

2.4 Using the given temperature change functions and damage function, I calculated the **social cost of carbon (SCC)** as follows:

$$SCC = \frac{\sum_{y=0}^{300} \frac{\text{Damages}_{\text{Base+10,000tCO2},y} - \text{Damages}_{\text{Base},y}}{(1+r)^y}}{10,000}$$

Assuming a discount rate of 2%, I found that the SCC is approximately **\$190 per ton of $\mathbf{CO_2}$**, which is consistent with the U.S. government's current estimate. If a higher discount rate like 5% were used, the SCC would be much lower.

Question 3: Estimating Climate Damages (20%)

3.1 As climate change progresses, the temperature distribution in Mexico will shift to the right, meaning that there will be fewer cold days and more hot days each year. This is significant because the relationship between temperature and electricity demand is nonlinear, as demonstrated by the Davis & Gertler (2015) figure. The study shows that as the number of extremely hot days (those over 90°F) increases, electricity demand rises sharply due to a higher need for cooling. For every additional day over 90°F in a month, electricity demand is projected to increase by 3.2% compared to days with moderate temperatures (between 65°F and 70°F). Therefore, as climate change causes more frequent extreme heat events, the cumulative effect on electricity consumption will be substantial. For instance, if a month that used to have five days over 90°F now has ten, electricity demand for that month could rise significantly, straining the energy grid and increasing overall energy consumption. This increase in electricity demand would also lead to higher emissions (if powered by fossil fuels) and elevated energy costs for households, making it a critical factor in calculating the economic damages from climate change.

3.2 If air conditioning adoption increases in Mexico, the relationship between temperature and electricity demand—referred to as the **weather-response function**—will become steeper, particularly at higher temperatures. The weather-response function illustrates how electricity demand responds to changes in temperature. Currently, with lower levels of air conditioning, demand increases relatively modestly as temperatures rise. However, as more households acquire air conditioners, their electricity usage on hot days will rise more sharply, leading to a more significant spike in energy demand during heatwaves. In practical terms, this means that for each additional day over 90°F, the percentage increase in electricity demand would be greater than the current 3.2%. This shift would likely cause the weather-response curve to move upward, indicating that electricity demand becomes more sensitive to temperature changes. As air conditioning becomes more widespread, this increased sensitivity could exacerbate economic damages, as higher demand will increase operational costs for energy providers, elevate greenhouse gas emissions (unless renewable energy sources scale up), and place a greater burden on low-income households struggling with rising energy bills. Additionally, the steeper curve may also necessitate more infrastructure investment to handle peak electricity loads, further compounding the economic impacts of climate change.