ESM 204 HW 3:
Distributional consequences of climate policy

Spring, 2022

Last year, the Biden Administration assembled an Inter-agency Working Group (IWG) tasked with updating the United States Government's Social Cost of Carbon (SCC), which has not been comprehensively updated since 2010. The Administration has also called on government agencies to address environmental justice, racism, and equity concerns when considering policies designed to mitigate climate change.

While the Interagency Working Group develops a new SCC, the Biden Administration's "interim" value is $51 per metric ton of CO_2. The electricity sector is the second largest source of greenhouse gas emissions in the U.S. (after transportation). In this homework, you will consider the distributional consequences of imposing a household electricity tax based on the SCC to address the climate change problem.

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

Use the following set of facts:

- Consumers can be separated into two income groups: "high" and "low." The data set provides price (in $) and quantity (in kWh) estimates of demand per month for the two groups. Run linear regressions (with an intercept) to estimate the demand curves for "high" and "low" income consumers.
- Initially, there is no tax on electricity consumption.
- The current electricity price (without any taxes) is $.10 per kWh.
- The marginal cost of producing a kWh of electricity is linear and has a price-intercept of 0.

1. One kWh of electricity emits 0.85 pounds of CO_2. Assuming that the interim SCC correctly reflects the total social cost of one metric ton of CO_2, what is the marginal externality cost per kwH of electricity?
2. What is the aggregate monthly demand curve for electricity? What is the supply curve for electricity? What is the "benefit" to consumers under the status quo? What is the "benefit" to producers under the status quo? What is the environmental cost under the status quo?
3. How is the current consumer benefit divided between "high" and "low" income consumers?
4. Derive the optimal electricity tax (in cents per kWh) using the interim SCC. Noting that recent research has shown the poor face a disproportionate share of the impacts from climate change, assume that the climate externality is borne entirely by the "low" income group. What would be the effects of this tax on:
   (a) The amount of electricity produced and consumed
   (b) The price of electricity
   (c) Overall welfare of "high" income consumers
   (d) Overall welfare of "low" income consumers

(e) Power suppliers (i.e., electricity producers)

(f) Total environmental damage

(g) Total tax revenue generated

5. Now, assume that all revenue from the electricity tax will be redistributed to the consumers in proportion to their pre-tax consumption. For example, if 80% of the electricity was consumed by "high" income consumers, then they get 80% of the tax revenue. Additionally, consider the fact that current scientific evidence suggests the true SCC may be much higher than \$51. For a range of SCC values (\$51, \$75, \$100, \$125, and \$150 per metric ton of CO_2), calculate the effects of an SCC-based electricity tax on:

   (a) Overall welfare of "high" income consumers

   (b) Overall welfare of "low" income consumers

   (c) Electricity producers

6. Suppose the "high" income group has access to expensive home solar generation. This lowers the electricity demand curve for the "high" income group by half (vertically). Under this new demand:

   (a) What is total electricity consumption?

   (b) What is the total environmental externality?

   (c) What value of the electricity tax makes the total environmental damage the same as the damage when solar panels are available to the high income group?