ESM 204: Homework #1

(Due before class on April 17, 2023)

This homework has 3 parts. Part 1 asks you to do some basic tasks in R. If you are well-versed in R, this may only take a few minutes. If you are new to R, this may take a few hours, but the investment will be worth it in the rest of this course and beyond. Part 2 asks you to solve some basic policy questions using math. Part 3 asks you to use R to solve similar policy questions, but that cannot be solved easily without a computer.

1. Basics of R
    a. Launch R Studio and start a new R script. Write a computer program that counts from 1 to 10 by 0.5 increments. Print out the results.
    b. Write a function. Your function should have three inputs (X, a, and b) and one output (Y). The function should calculate Y = a*X + b. Call your function for the values X=5, b=10, a=3. What value of Y did you get? Confirm algebraically that it is correct.
    c. Build a dataframe. Your dataframe is going to call your function from above. We are going to fix a=3 and b=10, and we would like the dataframe to evaluate the function for integer values of X between 0 and 10. The columns of your dataframe should be: a, b, X, and Y. Print the resulting dataframe.
    d. Plot using your dataframe. Use ggplot to plot Y (vertical axis) against X (horizontal axis) from your dataframe.
    e. Find the intersection of two curves. Use the function fzero (from the pracma package) or uniroot (from the stats package) to find where two curves cross. The two curves are: (1) Y = a1*X + b1 and (2) Y = a2*X + b2. For any values of a1, b1, a2, and b2, we want to know the value of X and Y where these functions cross. Follow these steps:
        i. Write a function called F1 that takes X, a1, and b1 as inputs and delivers Y=a1*X + b1 as the output. This is almost exactly the same as in part (b) above.
        ii. Write a different function called F2 that takes X, a2, and b2 as inputs and delivers Y=a2*X + b2 as the output.
        iii. Write a third function that takes the following inputs: X, a1, b1, a2, and b2. This new function will call F1 and F2. The output is Z=F1-F2 (in other words, for any value of X, Z is the difference between the two functions.
        iv. Use fzero to find X* and Y* for the following values of the parameters: a1=-2, b1=100, a2=3, b2=0.
    f. Use algebra to confirm that your answer to (e) is correct.

2. Food Bank Markets:
    a. Recall the NPR story, where food banks around the country can buy and sell surplus food in a new kind of market. Consider the supply and demand for peanut butter (the story indicated that it is particularly valuable in this market). In this market there are food banks who have surplus peanut butter and food banks that want more peanut butter. The currency is “credits” (not “dollars”). The demand curve for peanut butter is given by P = 400 - .05Q (where P has units “credits per jar” and Q has units “jars” of peanut butter). The supply of peanut butter is P = 20 + .05Q. What do you predict would be the equilibrium price and

quantity of peanut butter that would be traded? How would you measure the benefit of the new market to food banks that buy peanut butter? How would you measure the benefit of the new market to food banks that sell peanut butter?

   b. Suppose there is also an externality of the trade in peanut butter (reflecting the idea of "food miles"). Each jar of peanut butter that is transacted imposes an externality that is the equivalent of 50 credits. For example, if 20 jars are sold from one food bank to another, then there is a climate cost equivalent to 1000 credits. Do you think this new information should change the amount of trade by food banks? Can you design a change to the food bank market that would perfectly account for this externality? What would be the new equilibrium price and quantity.

3. Use R to solve more complicated supply and demand problems[1]
   a. Old cars are often fuel inefficient. The supply of inefficient old cars is given by: $P = 120 + 0.3Q^{1.3}$ (where P is \$/car and Q is the quantity of cars). The state of California offers a "cash for clunker" program, where they will pay \$1000 for any inefficient old car. Answer the following questions:
      i. Use R to determine how many cars will be sold back to the state under this program.
      ii. Use R to calculate the elasticity of supply of inefficient cars.
      iii. What are benefits of this policy to owners of old cars?
      iv. What is the cost of this program to taxpayers?
   b. Suppose the marginal benefit of removing old cars (environmental, health, etc) is given by: $TB = 1500 – .04Q^{1.2}$ (where Q is the number of cars bought back under the program).
      i. Use R to find the socially optimal number of cars to remove.
      ii. Use R to find the optimal "cash for clunkers" subsidy (which may differ from the current subsidy of \$1000).

[1] Tip: Think carefully about what you want R to do for you. Then try to write an R script that will do it.