Homework 1
Ross Summer Connection 2022
Due: Wednesday July 27th @ 11:59pm

Question 1: Pat and Kris are roommates. They spend time making pizza and brewing root beer. Pat takes 4 hours to brew a gallon of root beer and 2 hours to make a pizza. Kris takes 6 hours to brew a gallon of root beer and 4 hours to make a pizza.

a) Assume there are 12 hours available for production. Construct a table representing the maximum amount of root beer and pizza that each person could produce with their time.
b) Assuming constant opportunity cost, construct a table describing how much of the other good each person would have to give up to get another unit of one good.
c) Who has the absolute advantage in making pizza? In root beer? (Note: absolute advantage means who can make most of each thing given total time, while comparative advantage means who has the give up the least of the other thing to make another unit of the first!)
d) Who has the comparative advantage in making pizza? In root beer?
e) If Pat and Kris trade foods with each other, who will trade away pizza in exchange for root beer? (Hint: economic agents with a comparative advantage in the production of some good will specialize in that good and sell it in exchange for the other good.)
f) The price of pizza can be expressed in terms of gallons of root beer. What is the highest price at which pizza can be traded that makes both people better off? What is the lowest? (Hint: think about which prices must hold for Pat and Kris to be willing to trade.)

Question 2: What is the opportunity cost of a banana in terms of a coconut if a banana costs $2 and a coconut costs $5? What is the opportunity cost of coconuts in terms of bananas? (Assume you can buy and sell fractions of a fruit!)

Question 3: Roger's Carpet Cleaning Business faces the following total costs and total benefits associated with cleaning carpets. Answer the following questions using the information given.

a) In two new columns, find marginal cost and marginal benefit. What is the optimal quantity?
b) In a new column, find total profits. What is the optimal quantity?
c) Plot marginal cost and marginal benefit on a graph. What is the optimal quantity?

Quantity of Carpets	Total Cost	Total Benefit
0	0	0
1	20	60
2	42	110
3	68	150
4	100	180

Question 4: April is a promising young scientist who needs to decide how much time to spend analyzing data with her microscope. Her *total benefit* from spending t hours on the scope is given by $TB(t) = At$ while her *marginal cost* is $MC(t) = t^2 + B$, where $A > B > 0$ are constants.

a) Find the optimal time t^* spent on the microscope, and show your answer graphically.
b) What happens to the optimal solution when A gets bigger? Describe why this mathematical result is equivalent to an increase in April's productivity.

Question 5: Suppose that there are two countries, with 70 people in the poor (P) country and 30 people in the rich (R) country. Labor markets are competitive in both countries, so workers are paid according to their marginal products. Thus, wages are given by

$$w_P = MP_P(L) \coloneqq 7 - 0.07L$$
$$w_R = MP_R(L) \coloneqq 10 - 0.03L$$

a) Explain what the following statement means and give an example: the marginal product of labor in production is (often) diminishing, or getting smaller, with additional workers.
b) How do you know that both of these countries satisfy diminishing marginal products?
c) In a graph with w_P on the vertical axis and L on the horizontal axis, plot the poor country's labor demand curve. Assuming full employment, find total output. (Hint: Trapezoids!)
d) Assuming full employment, find total world out. (Hint: repeat c for the rich country.)
e) Now assume rich country citizens have read Clemens (2011) and reflected on the state of the currently segregated world. They decide to allow 20 poor country citizens to migrate. Repeat steps c and d, again assuming full employment.
f) Compute the percent increase in output. (And sing it from the rooftops!)
g) Replicate Figure 1 in Clemens (2011) to the best of your ability.
h) In Haxhiu (2020), I show that emigration can actually *improve* the productivity of non-migrants back home through increased education financed by remittances. Suppose that after those 20 poor citizens leave, the labor demand curve changes to

$$w_P^{NEW} = 7.5 - 0.07L$$

Explain why this mathematical result is equivalent to a positive externality from migration!

i) Compute the percent increase in output, considering this positive externality, and compare it to your answer in part f.
j) Suppose the migrants face discrimination in the rich country, and only receive half of the posted wage. How would you represent this change mathematically in the model, and how would it change our conclusions?

Question 6 (EXTRA CREDIT): Recall that in LEC1 we introduced marginal analysis by studying the optimal schooling decision given total benefit and cost functions. As some of you have already noted, it is unrealistic to think that we know all the functions: TB, TC, MB, MC. In this problem, we will see how causal inference can be used to learn about certain aspects of marginal benefits!

a) Let $Y_i \geq 0$ denote hourly earnings of individual i (aka outcome). Let $D_i \in \{0,1\}$ denote whether enrolled in college. We can write earnings as a function of enrollment status: $Y_i(1)$ and $Y_i(0)$, which are called potential outcomes. Write down the ATE in terms of these potential outcomes and explain what it measures.
b) If you know whether someone is enrolled in college, write down actual hourly earnings as a function of potential outcomes and enrollment status.
c) Write down actual earnings from part b in terms of the individual treatment effect τ_i.
d) Suppose that even without the college education, those who eventually went on to enroll in college would have higher earnings. Describe what this means for the selection bias term $SB \coloneqq E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]$.
e) Would a simple comparison of those enrolled versus not enrolled in college

$$E[Y_i|D_i = 1] - E[Y_i|D_i = 0]$$

be a biased estimate of the ATE (under scenario in part c). If so, is it biased up or down?