ECON 111: Fall 2021
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Practice Problems

1. Dave, George, Robin and Jerry are comedians. They all decide to produce a show and must allocate time to produce skits and standup routines. The table below shows how long it takes each comedian to produce each skit and each standup routine. They each decide to dedicate one hour to the task. Each of them can produce any linear combination of skits and standup routines provided they don't run out of time.

	Time required to make one:	
	Skit	**Standup Routine**
Dave	12 mins	15 mins
George	20 mins	6 mins
Robin	15 mins	10 mins
Jerry	15 mins	12 mins

(a) Sketch the individual PPF's of each comedian for the hour that they have to produce skits and standup routines.

(b) What is the opportunity cost to each comedian of producing a standup routine?

(c) Who has the comparative advantage in producing skits?

(d) Sketch the Joint PPF for the comedians given the hour that they have.

(e) Suppose that the group decides to produce 11 skits and 13 standup routines for one show. Is this efficient? Is there one comedian producing both skits and standup routines, if so who?

Let us now consider prices. We're interested in determining the price of one skit in terms of standup routines.

(f) At what prices would Dave and George be willing to trade at? Who should specialize in skits and standup routines?

(g) Now find the prices at which George and Robin would be willing to trade skits and standup routines. How do these prices relate to the ones you found in part (f)?

(h) Suppose now all comedians agree on a price of $\frac{5}{4}$ standup routines for one skit. Given this price, who would choose to specialize in skits?

2. Suppose that the market for off campus student housing in Amherst is perfectly competitive. There are only three different buildings that supply off campus housing to undergraduates. All of the apartments are identical. Building 1 has 200 apartments, building 2 has 300 apartments and building 3 has 500 apartments. This supply is fixed and does not depend on market forces. The market demand for apartments is linear and described by the following equation:

$$P = 1500 - \frac{Q_D}{2}$$

(a) Graph the market supply and demand curves for apartments. (Hint: For the supply curve, does quantity vary at all with price?)

(b) What is the equilibrium price and quantity of off-campus student apartments in Amherst?

(c) What is the (renter) consumer surplus and the landlord (producer) surplus? What is total surplus?

The Amherst town council thinks that they could make money by taxing off campus student apartments. The council passes a law that states that student renters of off campus apartments must pay \$100 per month.

(d) In the new equilibrium (with the \$100 fee) how much do renters spend on their apartment per month? How much do landlords collect each month? What is the occupancy (i.e. the quantity of apartments filled)?

(e) Now what is the new (renter) consumer surplus? What is the (landlord) producer surplus? How much money does the government collect from the fee?

(f) Is there any deadweight loss that results from the tax? Why or why not? (Hint, what is special about this market? How is it different from most of the supply and demand models we have studied thus far?)

There is a new candidate for mayor in Amherst. The candidate suggests that the charging students a \$100 per month fee is unfair and students are too poor for this, and that the greedy landlords should bear the burden of taxation. The candidate plans to eliminate any taxes paid by the students. Instead, candidate's plan states that the landlord must obtain a permit to rent an apartment. The cost of the permit is paid by the landlord. It would be \$100 per month.

(g) Would the mayoral candidate's new plan change how much consumers (renters) pay for apartments (relative to your answer from part f)? Would it change how much producers (landlords) receive in rent for the apartment (also relative to your answer from part f)? Would it increase the Amherst city government's revenues?

3. Consider the market for lumber in the US. Suppose that the market supply and demand curves are given, respectively, as follows;

$$Q_s = \frac{P}{4} - 25$$
$$Q_d = 325 - P$$

where price is in thousands of dollars (per million board feet) and quantity is in millions of board feet

(a) Compute the equilibrium price and quantity.

(b) Compute producer and consumer surplus at the equilibrium.

(c) What is the price elasticity of demand at the equilibrium point? What about supply?

Suppose now that there an additional social cost associated with producing lumber which encompasses losses in biodiversity due to habitat destruction and reductions in the amount of oxygen produced as a by-product of photosynthesis. The additional marginal cost to society per million board feet is estimated to be \$75,000 per million board feet of lumber.

(d) Sketch the marginal social cost curve alongside the supply and demand curves. What is the socially efficient quantity of lumber? How does it compare to the market quantity you found in part (a)?

(e) Sketch the region corresponding to deadweight loss in this setting. (Hint: Remember that you want to compare the losses associated with the inefficient market quantity as compared to the socially efficient quantity. These losses are described by the marginal social cost and marginal social benefit curves).

(f) You are a policymaker interested in social efficiency. What tax would you propose to achieve the socially efficient quantity as a market outcome?

(g) For the tax that you suggested in part (f), shade the region corresponding to tax revenue in your figure. How much revenue is raised?

(h) Given your answers to part (c), which side of the market do you expect to bear a higher incidence from the tax?

(i) Compute the incidences of the tax that you found in part (f).

4. You and your roommate share a small dorm. Every evening, your roommate invites their friends over to play a popular videogame. These gatherings can sometimes extend into the morning hours and cut into your sleep schedule. The costs to you and benefits to your roommate are described in the following table:

Number of Game Nights	Your Cost	Your Roommate's Benefit
1	$0	$30
2	2	40
3	5	46
4	9	51
5	15	53
6	25	53

For example, the total cost when your roommate has 3 game nights is $5, and your roommate's benefit from 3 game nights is $46.

(a) What is your marginal cost from the 3rd game night? What is your roommate's marginal benefit from the third game night?

(b) What is the socially efficient quantity of game nights? Recall that you want to compare marginal benefit and marginal cost of each game night.

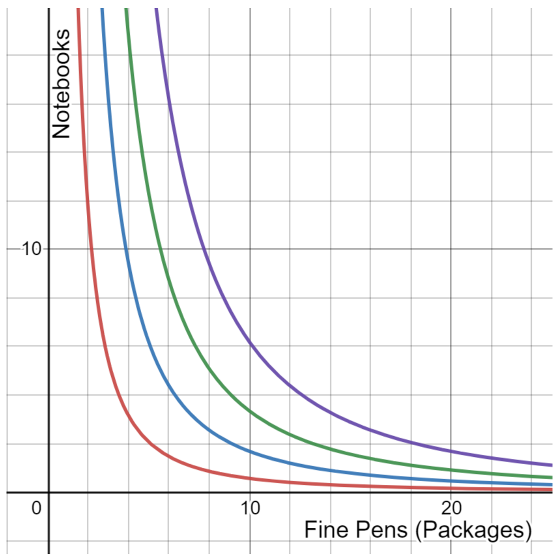
(c) Let's suppose that there are rules for quiet hours in the dorm, so that you have the right to a peaceful evening. How much would your roommate be willing to pay you to have their fifth game night? How much would you need to receive from them before you would consider taking their bribe for a fifth game night?

(d) Find a price that you can charge your roommate for game nights that ensures that the optimal quantity of game nights is reached.

(e) Now let us suppose that you have no right to a peaceful evening, and that your roommate has the right to invite guests over. How much would you be willing to pay your roommate so that they *won't* hold the fifth game night? How much would they need to receive from you before they're willing to cancel their fifth game night?

5. You use fine pens and notebooks for your studies each semester. After several years of attending school, you have a good feel for you preferences over pens and notebooks. This semester, you've allocated \$120 to purchase fine pens and notebooks. Suppose that notebooks cost \$8 a piece, and each package of fine pens costs \$10. The figure below shows some of your indifference curves for pens and notebooks.

   (a) In the figure below, sketch your budget set.



   (b) What is the slope of your budget set?

   (c) Mark the point(s) where your budget set intersects the blue indifference curve. For the point(s) that you found, how does your marginal rate of substitution compare to the slope of the budget set? How does your bang-per-buck of pens compare to your bang-per-buck of notebooks for the point(s) that you found?

   (d) At the consumption bundle which reaches the highest indifference curve, what is your marginal rate of substitution? How does your bang-per-buck of each good compare?

1. (a) The individual PPF's can be found by simply determining what combinations are feasible for each comedian. We know that they can use their time to produce either skits or routines at a constant opportunity cost, and so the PPF should be linear. The following figures show their PPF's:

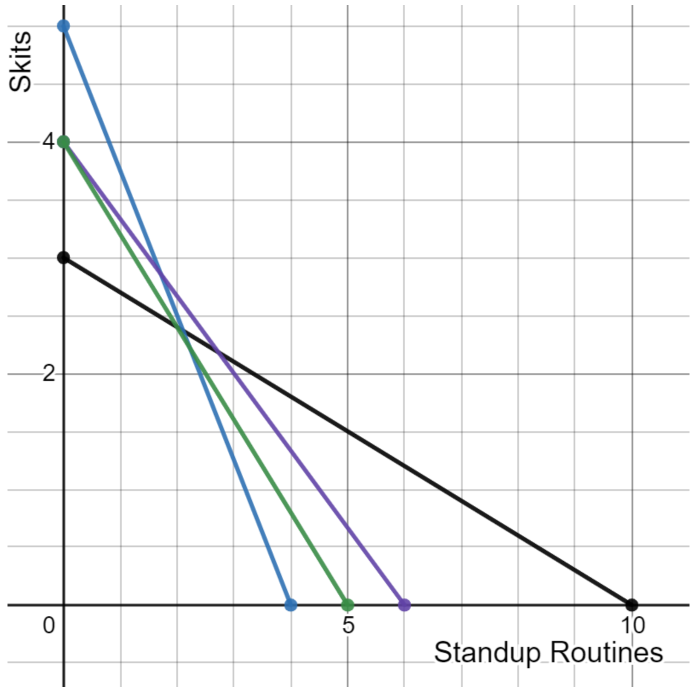


Figure 1: Dave (blue), George (black), Robin (purple) and Jerry (green)

(b) We're interested in the opportunity cost of a single standup routine for each comedian. In order to produce one standup routine, Dave must give up $\frac{5}{4}$ skits. Similarly, George's opportunity cost of a standup routine is $\frac{3}{10}$ of a skit. Robin's opportunity cost of a standup routine is $\frac{2}{3}$ of a skit. Finally, Jerry's opportunity cost of a standup routine is $\frac{4}{5}$ of a skit.

(c) The person with the lowest opportunity cost of a skit has the comparative advantage, since they give up the fewest standup routines per skit. In order to find who has the lowest opportunity cost of a skit, all we need to do is invert the opportunity costs for routines that we found in part (b). These opportunity costs are:

- Dave: $\frac{4}{5}$ standup routines
- George: $\frac{10}{3}$ standup routines
- Robin: $\frac{3}{2}$ standup routines
- Jerry: $\frac{5}{4}$ standup routines.

Hence, we see that Dave has the lowest opportunity cost of a skit, and so he has the comparative advantage in skits.

(d) Now, when sketching the PPF, it's helpful for us to order the opportunity costs of everybody. Let's order them according to the opportunity cost of a standup routine, so using the answers we had from part (b), we have

- George has the lowest opportunity cost of a standup routine
- Robin has the second lowest opportunity cost of a standup routine
- Jerry has the third lowest opportunity cost of a standup routine
- Dave has the highest opportunity cost of a standup routine

So let's start with everybody making skits, and ask who should be the first to start making standup routines? Well, George has the lowest opportunity cost of a standup routine, and so he should be the first to make standup routines. Once George is spending all of his time making standup routines, Robin should be the next one to start making standup routines. Jerry should then start once Robin is spending all of his time making standup routines, and finally Dave should be the last one to make standup routines. This gives us the following shape of the joint PPF: The point (10,13) is where George is making standup routines and

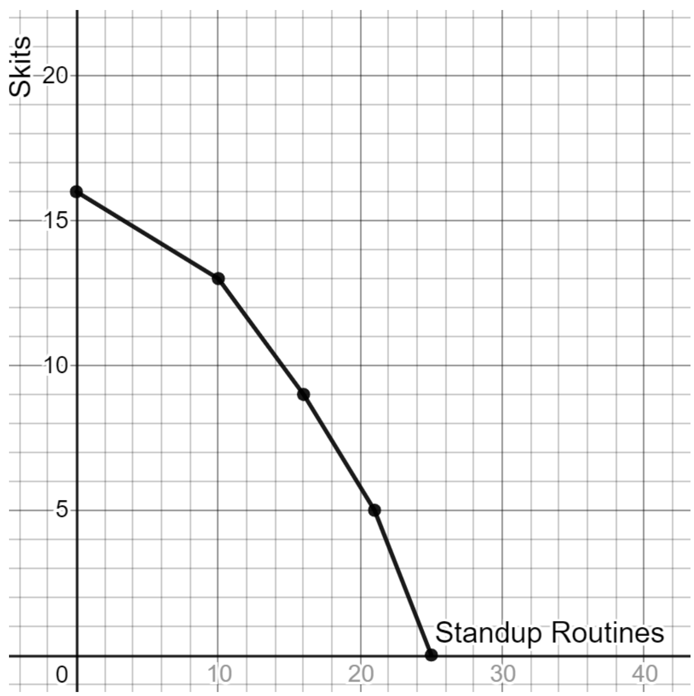


Figure 2: Joint PPF

all other comedians are making skits. The point (16,9) is where George and Robin are making standup routines while Dave and Jerry are making skits. Finally, the point (21,5) is where all comedians except for Dave are producing standup routines, while Dave is producing skits.

(e) We want the unit price of one skit in terms of standup routines. Let's first compare Dave and George. Between these two comedians, Dave has the comparative advantage in skits, while George has the comparative advantage in standup routines. So they should specialize in their respective comparative advantages in this instance, and determine which prices they can trade at.

Now, let's put ourselves in Dave's shoes. Dave has the comparative advantage in skits, and so if he's trading with George he should expect to be giving George skits and receiving standup routines from George. So we should ask: How many standup routines is Dave willing to trade off his skit for? Well, we know that Dave could use his own production technology and produce $\frac{4}{5}$ of a standup routine instead of the skit. Therefore if Dave is willing to trade his skit, he needs to receive at least what he could have otherwise made with a skit. That is, Dave wants to receive at least $\frac{4}{5}$ of a standup routine per skit.

Now, let's consider George. George is trading standup routines to Dave. How many standup routines is George willing to trade for a single skit? Well, George could use his own technology to produce a skit, but he gives up $\frac{10}{3}$ standup routines to produce it. Therefore, if George wants to receive skits at a better rate than he can make them on his own, he is willing to trade *at most* $\frac{10}{3}$ standup routines for one skit.

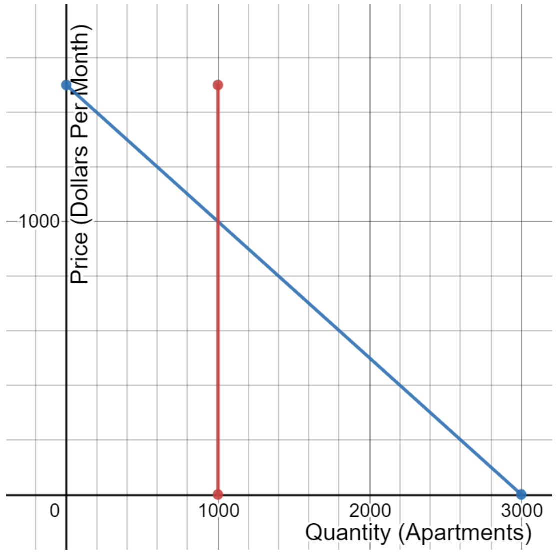
Therefore, the range of prices that Dave and George would be willing to trade at are $[\frac{4}{5}, \frac{10}{3}]$ standup routines per skit.

(f) For this problem, we already know that Robin has the comparative advantage in skits over George. We also already know that George is willing to trade at most $\frac{10}{3}$ standup routines for a single skit. So all we need to find is the amount of standup routines that Robin would need to receive in exchange for one of his skits. Using Robin's opportunity cost, we see that Robin could make $\frac{3}{2}$ standup routines in place of a skit, and so Robin needs to receive *at least* this many standup routines if he's willing to trade a skit.
Therefore, the set of prices at which Robin and George are willing to trade at are $[\frac{3}{2}, \frac{10}{3}]$ standup routines per skit. Comparing this to part (f), we see that Robin and George have fewer possible trade prices that Dave and George. This is due to the fact that Dave is willing to receive fewer standup routines per skit, because he has a lower opportunity cost than Robin.

(g) We have a specific trade price of $\frac{5}{4}$ standup routines per skit. Now, put yourself in each comedian's shoes and ask whether you should specialize in skits or standup routines. The answer is that you should specialize in skits if the trade price of a skit is higher than your opportunity cost of a skit. The reason is that you can now make skits and trade them off for a larger amount of standup routines than you could otherwise make yourself. This lines up with our intuition: The people with low opportunity costs for a skit should specialize in them at the trade price, because the price exceeds their opportunity cost.
Using the fact that you should specialize in skits if the trade price of a skit is higher than your opportunity cost, we see that we have the following specializations:

- Dave should specialize in skits, as the price $\frac{5}{4}$ routines per skit is higher than his opportunity cost of $\frac{4}{5}$ routines per skit.
- Jerry is indifferent between specializing in skits and specializing in standup routines. The trade price of a skit is exactly equal to his opportunity cost of a skit. So Jerry can specialize in either.
- Robin should specialize in standup routines, because the trade price is lower than his opportunity cost of a skit. He can now make 6 standup routines, and trade them off for $\frac{24}{5}$ skits, whereas he could only make 4 skits on his own.
- Similarly, George should clearly specialize in standup routines if Robin is. The price of a skit is lower than George's opportunity cost of a skit. If George specializes in standup routines, he can make 10 routines and trade them off for up to 8 skits, whereas he could only make 3 skits on his own.

2. (a) A sketch of supply and demand is given below:



(b) The equilibrium price is \$1000 per month and the quantity is 1000 apartments.

(c) The following figure sketches consumer and producer surplus:

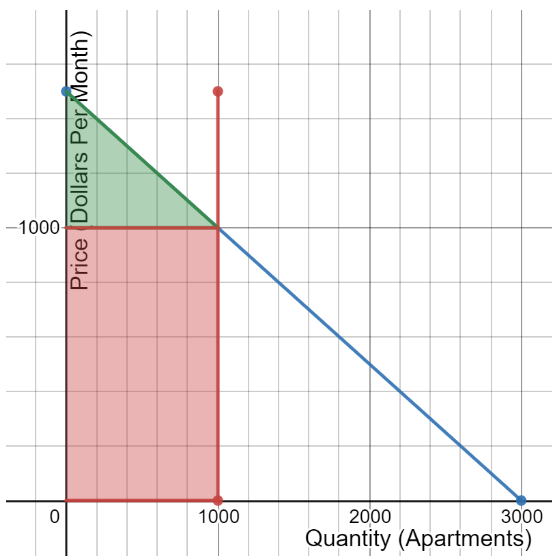


Figure 3: Consumer surplus (green) and producer surplus (red)

Consumer surplus is: $(1500 - 1000) \cdot \frac{1000}{2} = 250,000$
Producer surplus is: $1000 \cdot 1000 = 1,000,000$

(d) The new relationship between the pre-tax market price and quantity demanded can be found by considering the relationship between the total price that consumer pay and the quantity demanded. In particular, we have:

$$P_{market} + \tau = 1500 - \frac{Q_D}{2} \Rightarrow P_{market} = 1500 - \tau - \frac{Q_D}{2}$$

Substituting $\tau = 100$, we sketch this curve in the following figure: Now, looking at the previous sketch, the

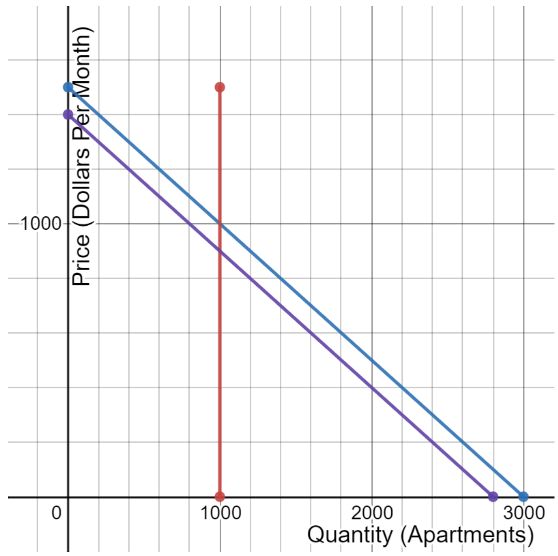


Figure 4: Relationship between pre-tax price and quantity demanded (purple)

pre-tax market price is \$900, and thus the total price that renters pay per month is still \$1000. On the other hand, landlords (producers) now receive only \$900 per apartment per month. The quantity is still 1000.

(e) The following figure sketches consumer surplus, producer surplus, and revenue.

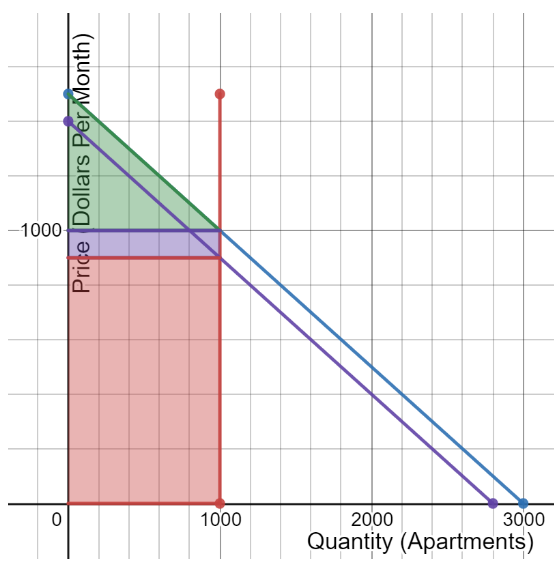


Figure 5: Consumer surplus (green), revenue (purple) and producer surplus (red)

Consumer surplus: $(1500 - 1000) \cdot \frac{1000}{2} = 250,000$
Producer surplus: $900 \cdot 1000 = 900,000$
Revenue: $100 \cdot 1000 = 100,000$

(f) Since the equilibrium quantity doesn't change after the tax, there is no deadweight loss. We're still at the efficient quantity of apartments. The only change is that we have transferred some producer surplus to the Amherst town council.

(g) The mayoral candidate's proposed policy wouldn't change anything. When we impose a tax on the producers, the fact that supply is perfectly inelastic means that the equilibrium quantity will not change (the supply curve shifts up). It's important to note that producers still need to receive at least \$100 from consumers in order for them to be willing to supply their apartments. See the following figure:

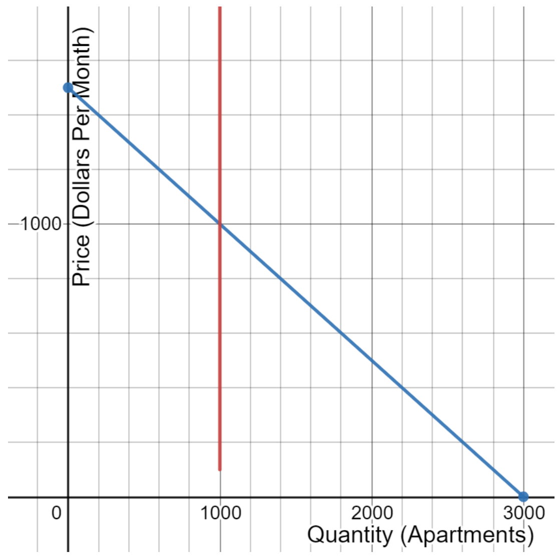
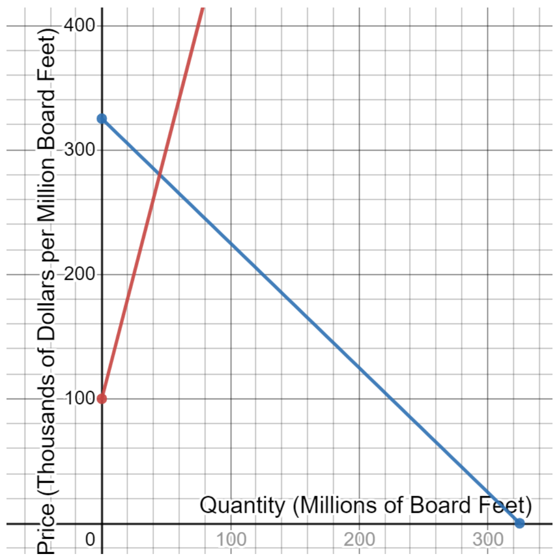


Figure 6: New supply

The equilibrium quantity remains the same. Similarly, the total price that consumers pay is still \$1000, the price that producers receive is still \$900, and the revenue collected is still $1000 \cdot 100 = 100,000$. Hence, the policy changes nothing.

3. (a) The following figure sketches the market supply and demand curves.



The equilibrium price is \$280 (thousands of dollars per million board feet) and the quantity is 45 (million board feet).

(b) The following figure sketches consumer and producer surplus:

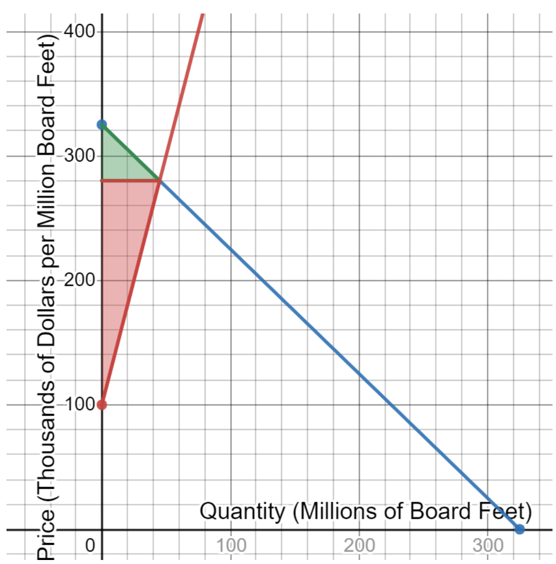


Figure 7: Consumer surplus (green) and producer surplus (red)

Consumer surplus is: $(325 - 280) \cdot \frac{45}{2} = \frac{2025}{2}$ (in thousands of dollars)
Producer surplus is: $(280 - 100) \cdot \frac{45}{2} = 4050$ (in thousands of dollars)

(c) The equations given in the problem conveniently express quantities as a function of price. Hence, given the equation:

$$Q_s = \frac{P}{4} - 25$$

we see that when we change the price by 1, the quantity supplied changes by $\frac{1}{4}$. We thus have that the price elasticity of supply at the equilibrium point is:

$$\epsilon_{p,s} = \frac{\Delta Q_s}{\Delta P}\frac{P}{Q} = \frac{1}{4}\frac{280}{45} = \frac{14}{9}$$

Now let's consider the demand equation given as:

$$Q_d = 325 - P$$

We see that when price changes by 1, the quantity demanded changes by 1 as well. Thus the price elasticity of demand is:

$$\epsilon_{p,d} = \frac{\Delta Q_d}{\Delta P}\frac{P}{Q} = (-1)\cdot\frac{280}{45} = -\frac{56}{9}$$

(d) The following figure sketches the marginal social cost curve alongside the original supply and demand curves: The marginal social cost curve can be found by solving the supply equation for price, and then adding an

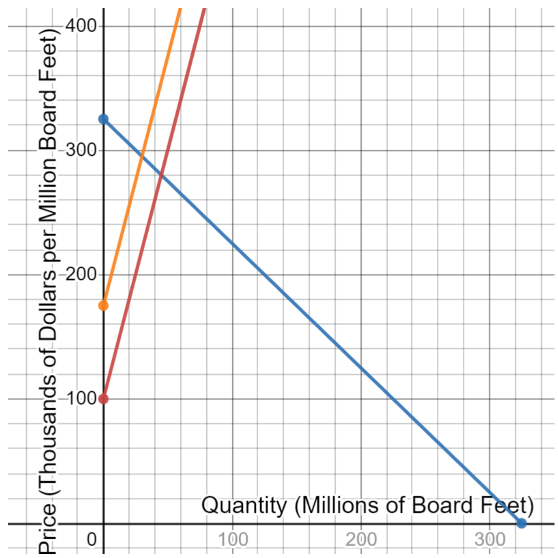


Figure 8: Marginal social cost (yellow), Supply (red) and Demand (blue).

additional 75 to the intercept. The reason is that the marginal social cost takes into account the marginal private cost (the supply curve) and then adds the additional marginal loss due to the externality (75). Inverting the supply equation, we can write it as:

$$Q_s = \frac{P}{4} - 25 \Rightarrow P = 4Q_s + 100$$

Now, the supply curve describes the marginal private cost of producing a given quantity of lumber. The marginal social cost is equal to the marginal private cost plus the externality, so the equation for the marginal social cost curve is:

$$MSC = 4Q_s + 175$$

Now to find where this curve intersects the demand curve (which in this case is the marginal social benefit curve), we have:

$$4Q + 175 = 325 - Q \Rightarrow Q = 30$$

So that the socially efficient quantity is less than the market externality (which lines up with our intuition regarding negative externalities). At the socially optimal quantity of 30, the marginal social cost is equal to the marginal social benefit (they both equal 295 at this point).

(e) In this case, the deadweight loss is a result of the fact that the market quantity is too high compared to the efficient benchmark. This leads to some transactions which are actually harmful to social surplus. Now, deadweight loss should compare the socially efficient quantity and the market quantity. More specifically, the deadweight loss should be a region between the marginal social cost and marginal social benefit curves (for deadweight loss, all that we care about is the loss in *social* surplus). In this problem, deadweight loss is sketched below:

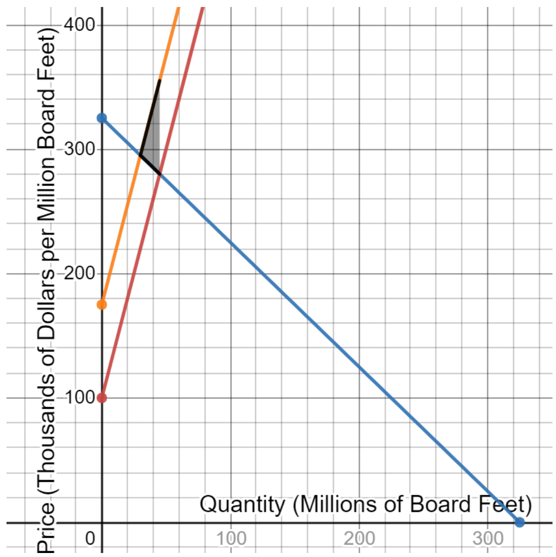


Figure 9: Deadweight loss (gray)

The deadweight loss here captures the fact that additional transactions beyond the socially efficient quantity are such that marginal social cost *is higher* than marginal social benefit, and so these transactions are actually harmful.

(f) In order to achieve the socially efficient quantity, we should impose a tax (on either side of the market) equal to the value of the negative externality. In this case, the optimal tax is $75,000 per million board feet of lumber. The following figure demonstrates a tax on the demand side that achieves the desired outcome (although we could have equivalently achieved the socially optimal quantity by taxing the demand side):

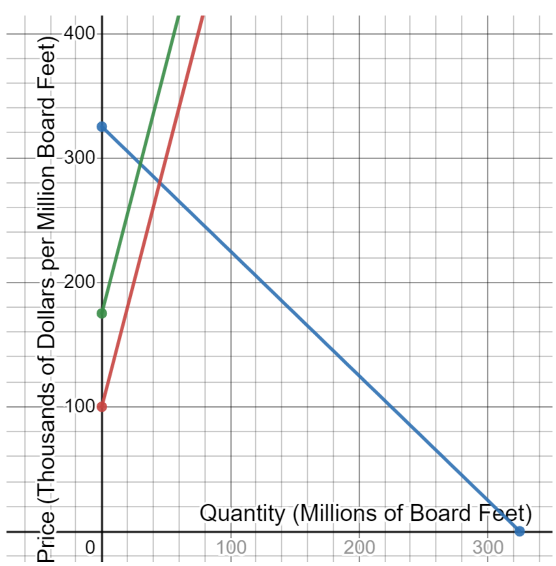


Figure 10: New relationship between (pre-tax) market price and quantity supplied (green)

Here, when we impose the appropriate tax on supply, the new curve is identical to the marginal social cost curve (that's the idea!)

(g) The following figure demonstrates the tax revenue using the previous figure from part (f): Remember, tax

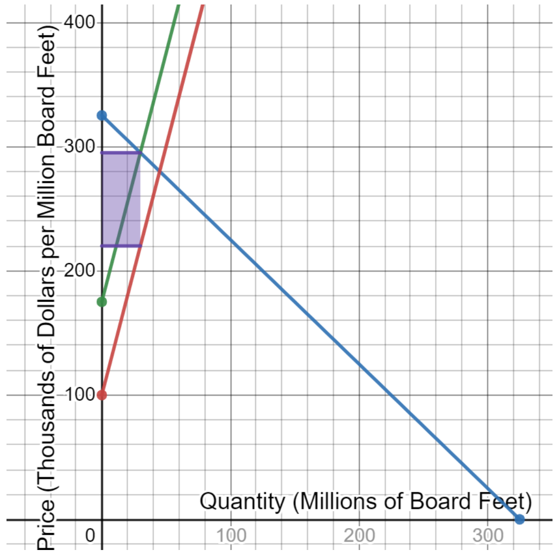


Figure 11: Tax revenue (purple)

revenue is given by:

$$R = \tau \cdot Q = 75 \cdot 30 = 2250$$

where this is in thousands of dollars.

(h) From part (c), we had the price elasticities of supply and demand as:

$$\epsilon_{p,s} = \frac{14}{9}$$
$$\epsilon_{p,d} = -\frac{56}{9}$$

We see that since the absolute value of the price elasticity of demand is much larger (4 times larger) than the price elasticity of supply, demand is more elastic. This means that we should expect the tax to burden the supply side of the market more (since supply is more inelastic).

(i) Recall that consumer incidence is the difference between the new total price that consumers pay (the after-tax total price) and the old total price that consumers pay (the old market price) . In this case, consumer incidence is:

$$CI = 295 - 280 = 15$$

Similarly, the producer incidence is the difference between the old amount that producers received per purchase (the old market price) and the new amount that producers receive per purchase (the new after-tax amount that they receive). In this case, the producer incidence is:

$$PI = 280 - (295 - 75) = 60$$

where here, the amount that producers receive after the tax is the new total price 295 minus the tax of 75. The following figure shows consumer and producer incidence in the graph:

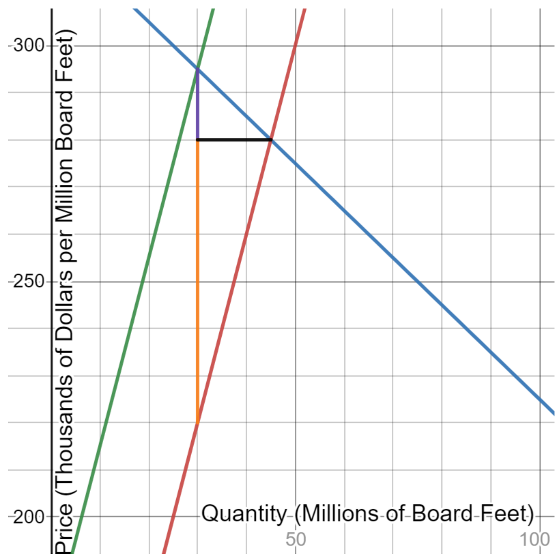


Figure 12: Consumer incidence (length of purple line) and producer incidence (length of yellow line)

4. (a) Your marginal cost of the 3rd game night is the difference between your total cost of the 3rd game night and your total cost of the 2nd game night. This is $5 - 2 = 3$. Similarly, your roommate's marginal benefit of the 3rd game night is the difference between their total benefit of the 3rd game night and their total benefit of the 2nd game night. This is $46 - 40 = 6$.

   (b) The socially efficient quantity of game nights is the quantity that maximizes the social surplus. In this case, social surplus is the difference between your roommate's total benefit and your total cost. The total surplus of each game night is:

   - 1st game night: 30 - 0 = 30
   - 2nd game night: 40 - 2 = 38
   - 3rd game night: 46 - 5 = 41
   - 4th game night: 51 - 9 = 42
   - 5th game night: 53 - 15 = 38
   - 6th game night: 53 - 25 = 28

   We see than that the quantity that maximizes total surplus is 4 game nights. Another way of finding this optimal quantity is to realize that, since marginal benefits are decreasing and marginal costs are increasing, the socially optimal quantity should be the *largest quantity such that marginal benefit is at least as large as marginal cost*. Comparing marginal costs and benefits of each game night will also demonstrate that the optimal quantity is 4.

   (c) Given that you have the right to a peaceful evening, your roommate needs to pay you in order to party. For the 5th game night, your roommate is willing to pay you at most \$2 in exchange for you allowing their guests over. On the other hand, you want to receive at least \$6 in order to allow the 5th game night. Hence, you can't reach a deal for the 5th game night.

   (d) We want to find a price that reaches 4 game nights, but doesn't allow for 5 game nights. Let's think about the possible prices that you can agree to for each game night:

   - 1st game night: you want at least \$0, and your roommmate is willing to pay at most \$30
   - 2nd game night: you want at least \$2, and your roommate is willing to pay at most \$10
   - 3rd game night: you want at least \$3, and your roommate is willing to pay at most \$6
   - 4th game night: you want at least \$4, and your roommate is willing to pay at most \$5
   - 5th game night: you want at least \$6, and your roommate is willing to pay at most \$2
   - 6th game night: you want at least \$10, and your roommate is willing to pay at most \$0

   For the first 4 game nights to occur, we need only consider a price that allows the 4th game night to happen (this is because marginal costs are increasing and marginal benefits are decreasing). In this case, any price between \$4 and \$5 will suffice. This allows the first 4 game nights to happen, and your roommate is not willing to pay for the 5th.

   (e) This is the reverse of part (c). Here, you need to pay your roommate in order to avoid game nights. In this case, you're willing to pay at most \$6 to avoid the 5th game night, and your roommate wants to receive at least \$2 in order to forego their gathering.

5. (a) The following figure shows a sketch of your budget set in this diagram:

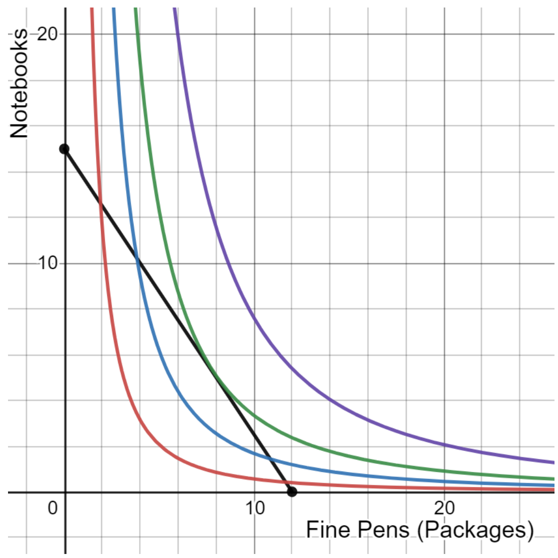


Figure 13: Your budget set (everything between the axes and the black curve)

(b) To determine the slope of your budget line, let's use the familiar rise-over-run. The height of your budget set is $\frac{W}{P_Y} = \frac{120}{8} = 15$. Similarly, the x-intercept of your budget set is $\frac{W}{P_X} = \frac{120}{10} = 12$. Thus, the slope of this line is:

$$\frac{0-15}{12-0} = -\frac{5}{4} = \frac{P_{pens}}{P_{notebooks}}$$

(c) The points are marked in the following figure:

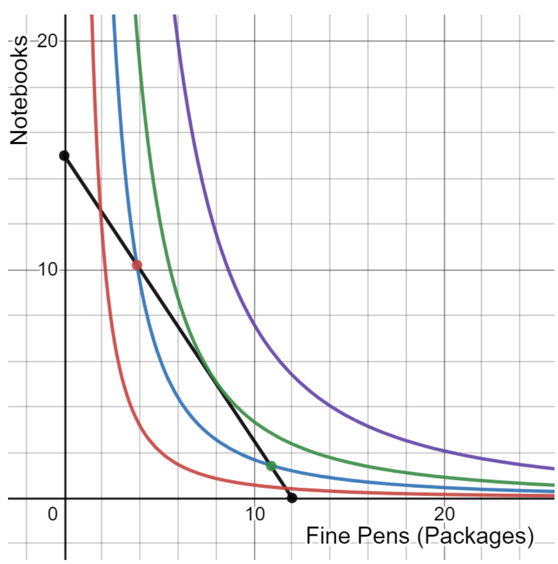


Figure 14: The red and green points mark where your budget set meets the blue indifference curve.

At the red point, you're consuming a lot of notebooks and relatively little fine pens. Here, your marginal utility per dollar of notebooks (bang-per-buck of notebooks) is lower than your marginal utility per dollar of fine pens. So you should substitute away from notebooks and purchase more fine pens.
The green point shows the opposite case. Here, your marginal utility per dollar of fine pens is lower than your marginal utility per dollar of notebooks.

(d) The consumption bundle which reaches the highest indifference curve is the bundle where your budget set intersects the green indifference curve. In this case, your bundget line is tangent to the green indifference curve, and hence the slope of your budget set is equal to the slope of this green indifference curve at the point that they intersect. This means that your marginal rate of substitution is equal to the price ratio:

$$\frac{MU_{pens}}{MU_{notebooks}} = \frac{P_{pens}}{P_{notebooks}}$$

at your optimal bundle. This equation can be rearranged to show that your marginal utility per dollar (bang-per-buck) of each good is equal:

$$\frac{MU_{pens}}{P_{pens}} = \frac{MU_{notebooks}}{P_{notebooks}}$$