APEC3001 **Problem Set 2 Answer Key** **Spring 2021**

Due Date: Thursday February 11, 2021

Your file upload must be submitted to Canvas by 10 pm to avoid late penalty

Note on collaboration: You may work collaboratively with other students in the class on this assignment but you must write up your own answers. Working together to figure out how to solve a problem is acceptable, copying someone else's answers is not acceptable and is an example of scholastic dishonesty. Copying or getting answers from someone outside the class, including from Internet sources, is not allowed.

1. (4 pts) Suppose the price of specialty workshop laptops is represented by $Q_S = 1000 + P$.
   a. (1 pt) If the demand for the laptops is $Q_D = 9000 - P - 0.05I$, where I is income. What are the current market equilibrium price and quantity if income is \$100,000?
   Solution:

$$Q_D = Q_S$$
$$9000 - P - 0.05I = 1000 + P$$
$$9000 - P - 0.05(100{,}000) = 1000 + P$$
$$4000 - P = 1000 + P$$
$$2P = 3000$$
$$P = 1500$$

$$Q_D = 4000 - P$$
$$Q_D = 4000 - 1500$$
$$Q_D = 2500$$

$$Q_S = 1000 + P$$
$$Q_S = 1000 + 1500$$
$$Q_S = 2500$$

$$\boldsymbol{P^* = \$1{,}500}$$
$$\boldsymbol{Q^* = 2{,}500\ laptops}$$

   b. (1 pt) Suppose that income falls to \$80,000. What is the new demand equation?
   Solution:

$$Q_D = 9000 - P - 0.05I$$
$$Q_D^{new} = 9000 - P - 0.05(80{,}000)$$
$$\boldsymbol{Q_D^{new} = 5000 - P}$$

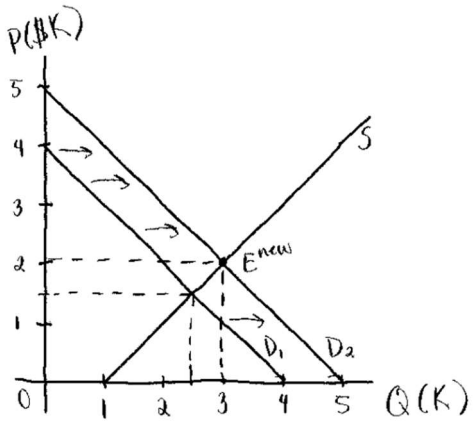
   c. (1 pt) What will be the new equilibrium price and quantity after the income decrease? Show in a graph after you do the calculations.
   Solution:

$$Q_D^{new} = Q_S$$
$$5000 - P = 1000 + P$$
$$2P = 4000$$
$$P = 2000$$

$$Q_D^{new} = 5000 - P$$
$$Q_D^{new} = 5000 - 2000$$
$$Q_D^{new} = 3000$$

$$Q_S = 1000 + P$$
$$Q_S = 1000 + 2000$$
$$Q_S = 3000$$

$$\boldsymbol{P_{new}^* = \$2,000}$$
$$\boldsymbol{Q_{new}^* = 3,000\ laptops}$$



d. (1 pt) Is the laptop workstation a normal or an inferior good? Explain. Show using a partial derivative.
Solution:
The laptop workstation is an inferior good. This is because the demand for these laptops increases as income decreases, which is true for inferior goods. The partial derivative of the demand curve with respect to income, shown below, is negative, confirming that demand decreases as income increases. This implies these laptops are inferior goods.

$$\boldsymbol{Q_D = 9000 - P - 0.05I}$$
$$\boldsymbol{\frac{\partial Q_D}{\partial I} = -0.05 < 0}$$

2. (3 pts) In the market for coffee, the elasticity of demand is estimated to be -0.6 and the elasticity of supply is estimated to be 1.2. If the government imposes a tax of $1 on each cup of coffee sold, what share of that tax will be paid by buyers and what share will be paid by sellers? Show your calculations.
Solution:

$$share\ borne\ by\ buyers = \frac{\epsilon_P^S}{\epsilon_P^S + |\epsilon_P^D|}$$
$$share\ borne\ by\ buyers = \frac{1.2}{1.2 + 0.6}$$
$$share\ borne\ by\ buyers \approx 0.67$$

$$share\ borne\ by\ sellers = \frac{|\epsilon_P^D|}{\epsilon_P^S + |\epsilon_P^D|}$$
$$share\ borne\ by\ sellers = \frac{0.6}{1.2 + 0.6}$$
$$share\ borne\ by\ sellers \approx 0.33$$

Buyers will pay 67% of the $1 tax for each cup of coffee purchased and sellers will pay 33% of the $1 tax for each cup of coffee sold.

3. (5 pts) The government of Kenya has decided that access to the Internet is essential in today's society and to bolster access, has proposed subsidizing the purchase of mobile devices. The inverse demand curve for mobile devices is given by $P=500 - 0.1Q_D$. The inverse supply curve of mobile devices is given by $P=200 + 0.1Q_S$.

   a. (1 pt) Solve for the equilibrium price and quantity in this market, and calculate consumer and producer surplus at that equilibrium.
   Solution:

$$P = P$$

Since the inverse supply and demand curves are only equal at the equilibrium quantity, Q^*, substitute Q_D & Q_S for Q^* in the respective curves:

$$500 - 0.1Q^* = 200 + 0.1Q^*$$
$$0.2Q^* = 300$$
$$Q^* = 1500$$

$$P = 500 - 0.1Q^*$$
$$P = 500 - 0.1(1500)$$
$$P = 350$$

$$P = 200 + 0.1Q^*$$
$$P = 200 + 0.1(1500)$$
$$P = 350$$

$$\boldsymbol{P^* = \$350}$$
$$\boldsymbol{Q^* = 1{,}500\ mobile\ devices}$$

Consumer surplus is given by:

$$CS = \frac{1}{2} * Q * (Demand\ Choke\ Price - Equilibrium\ Price)$$
$$CS = \frac{1}{2}(1500)(\$500 - \$350)$$
$$\boldsymbol{CS = \$112{,}500}$$

Producer surplus is given by:

$$PS = \frac{1}{2} * Q * (Equilibrium\ Price - Supply\ Choke\ Price)$$
$$PS = \frac{1}{2}(1500)(\$350 - \$200)$$
$$\boldsymbol{PS = \$112{,}500}$$

b. (1 pt) Suppose the government offers a subsidy of $100 per device to the sellers of mobile devices. What is the new inverse supply curve including this subsidy?
Solution:
A subsidy given to the seller means the seller receives the price the buyer pays plus the subsidy for each mobile device:

$$P_s = P_b + subsidy$$
$$P_s^{new} = P_b + 100$$

Substitute RHS of equation for P_s^{new} for P in the inverse supply curve:

$$P = 200 + 0.1Q_S$$
$$P_b + 100 = 200 + 0.1Q_S$$
$$P_b = 100 + 0.1Q_S$$

New inverse demand curve including the subsidy is:

$$\boldsymbol{P^{new} = 100 + 0.1Q_S}$$

c. (1 pt) How many mobile devices will be sold now that there is a subsidy of $100 per unit to sellers? What price will be paid by buyers? What price will be received by sellers?
Solution:

$$P = P^{new}$$

Since the inverse supply and demand curves are only equal at the equilibrium quantity, Q^*, substitute Q_D & Q_S for Q^* in the respective curves:

$$500 - 0.1Q^* = 100 + 0.1Q^*$$
$$0.2Q^* = 400$$
$$Q^* = 2000$$

$$P_b = 500 - 0.1Q^*$$
$$P_b = 500 - 0.1(2000)$$
$$P_b = 300$$

$$P_s = P_b + 100$$
$$P_s = 300 + 100$$
$$P_s = 400$$

$$\boldsymbol{Q^* = 2{,}000\ mobile\ devices}$$
$$\boldsymbol{P_b = \$300}$$
$$\boldsymbol{P_s = \$400}$$

d. (2 pts) What will the subsidy program cost the government? What will be the net effect of the subsidy on total surplus in society? Is there a deadweight loss?
Solution:
The government pays $100 for every mobile device sold, so the subsidy program will cost the government:

$$GE = \$100 * 2{,}000$$
$$\boldsymbol{GE = \$200{,}000}$$

Total surplus without the subsidy is:

$$TS = CS + PS$$

$$TS = \$112{,}500 + \$112{,}500$$
$$TS = \$225{,}000$$

Total surplus with the subsidy is:

$$TS^{sub} = CS^{sub} + PS^{sub} - GE$$
$$TS^{sub} = \frac{1}{2} * Q * (Demand\ Choke\ Price - Buyer\ Price) + \frac{1}{2} * Q * (Seller\ Price - Supply\ Choke\ Price) - GE$$
$$TS^{sub} = \frac{1}{2}(2000)(\$500 - \$300) + \frac{1}{2}(2000)(\$400 - \$200) - \$200{,}000$$
$$TS^{sub} = \$200{,}000 + \$200{,}000 - \$200{,}000$$
$$TS^{sub} = \$200{,}000$$

Net effect of subsidy on total surplus is:

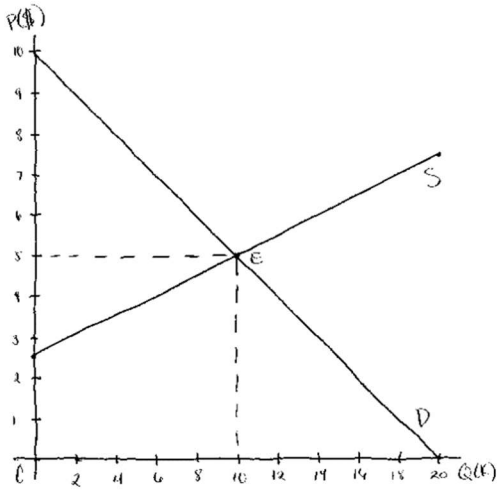
$$\Delta TS = TS^{sub} - TS$$
$$\Delta TS = \$200{,}000 - \$225{,}000$$
$$\boldsymbol{\Delta TS = -\$25{,}000}$$

There is a deadweight loss:

$$DWL = \frac{1}{2} * (Q^{sub} - Q^{*}) * (P_s - P_b)$$
$$DWL = \frac{1}{2} * (2000 - 1500) * (\$400 - \$300)$$
$$DWL = \frac{1}{2} * (500) * (\$100)$$
$$\boldsymbol{DWL = \$25{,}000}$$

4. (5 pts) The U.S. government has decided to limit the sale of cigarettes due to their negative health impacts. The demand curve for cigarettes is $Q_D = 20 - 2P$ and the supply curve for cigarettes is given by $Q_S = 4P - 10$. Quantity demanded and supplied are both measured in terms of thousands of packs per day. Price is per pack.

   a. (1 pt) Graph the supply and demand curves and find the equilibrium price and quantity in the market.
   Solution:



$$Q_D = Q_S$$
$$20 - 2P = 4P - 10$$

$$6P = 30$$
$$P = 5$$

$$Q_D = 20 - 2P$$
$$Q_D = 20 - 2(5)$$
$$Q_D = 10$$

$$Q_S = 4P - 10$$
$$Q_S = 4(5) - 10$$
$$Q_S = 10$$

$$\boldsymbol{P^* = \$5\ per\ pack}$$
$$\boldsymbol{Q^* = 10,000\ packs\ per\ day}$$

b. (1 pt) Now suppose the government limits the sales of cigarettes to 6, 000 packs in an effort to stop smoking. What is the new price in this market?

Solution:

At 6,000 packs, the price can be obtained using the inverse demand curve:

$$Q_D = 20 - 2P$$
$$2P = 20 - Q_D$$
$$P = 10 - 0.5Q_D$$

Set $Q_D = 6$, in the inverse demand curve:

$$P = 10 - 0.5(6)$$
$$\boldsymbol{P^{new} = \$7\ per\ pack}$$

c. (1 pt) How have consumer and producer surplus changed as a result of the quota (limiting sales)? What is the deadweight loss?

Solution:

Change in consumer surplus is given by:

$$\Delta CS = CS^{quota} - CS$$
$$\Delta CS = \frac{1}{2} * Q^{quota} * (Demand\ Choke\ Price - Quota\ Price) - \frac{1}{2} * Q^* * (Demand\ Choke\ Price - Equilibrium\ Price)$$
$$\Delta CS = \frac{1}{2}(6000)(\$10 - \$7) - \frac{1}{2}(10000)(\$10 - \$5)$$
$$\Delta CS = \$9000 - \$25000$$
$$\boldsymbol{\Delta CS = -\$16,000}$$

Change in producer surplus is given by:

$$\Delta PS = PS^{quota} - PS$$
$$\Delta PS = \frac{1}{2} * Q^{quota} * (Seller\ Price - Supply\ Choke\ Price) + Q^{quota} * (Quota\ price - Seller\ Price)$$
$$-\frac{1}{2} * Q^* * (Equilibrium\ Price - Supply\ Choke\ Price)$$
$$\Delta PS = \frac{1}{2}(6000)(\$4 - \$2.5) + 6000(\$7 - \$4) - \frac{1}{2}(10000)(\$5 - \$2.5)$$
$$\Delta PS = \$4500 + \$18000 - \$12500$$
$$\boldsymbol{\Delta PS = \$10,000}$$

Deadweight loss is given by:

$$DWL = \frac{1}{2} * (Q^* - Q^{quota}) * \left(P^{quota} - P_s^{quota}\right)$$
$$DWL = \frac{1}{2} * (10000 - 6000) * (\$7 - \$4)$$
$$DWL = \frac{1}{2} * (4000) * (\$3)$$
$$\boldsymbol{DWL = \$6,000}$$

d. (2 pts) If the government decided to impose a tax on producers for each pack of cigarettes sold instead of a quota, approximately what size tax would reduce equilibrium quantity in the market to 6,000? What are the advantages and disadvantages of a tax versus a quota? Explain.

Solution:

Set Q_D & Q_S equal to 6 in the respective demand and supply curves:

$$6 = 20 - 2P_b$$
$$6 = 4P_s - 10$$

A tax yields:

$$P_b = P_s + t$$

Substitute the RHS of the equation for P_b in the demand curve, and solve for t:

$$6 = 20 - 2(P_s + t)$$
$$6 = 20 - 2P_s - 2_t$$
$$2t = 14 - 2P_s$$
$$t = 7 - P_s$$

Use the supply curve to solve for P_s:

$$6 = 4P_s - 10$$
$$4P_s = 16$$
$$P_S = 4$$

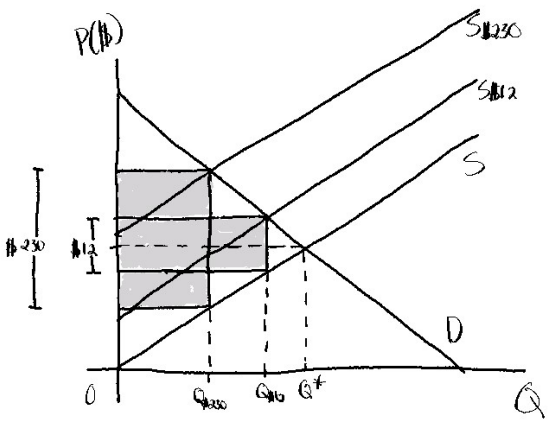
Now, solve for t, using $P_s = 4$:

$$t = 7 - 4$$
$$\boldsymbol{t = \$3\ per\ pack}$$

A tax of $3 per pack and a quota of 6,000 packs lead to the same decrease in consumer surplus and increase in deadweight loss, and thus both share those disadvantages. This is because tax results in changing the price the buyer pays to $7 per pack and the price the seller receives to $4 per pack (which is derived by finding the equilibrium prices and quantity under the tax). The areas of consumer surplus and deadweight loss are the same under the tax, as they were under the quota. The tax of $3 per pack now results in a decrease in producer surplus, and so also is a disadvantage to producers. However, the tax also results in revenue the government receives ($18,000), that can be used to benefit society, and thus is an advantage to society. This is because, instead of the change in surplus (less deadweight loss) given as revenue to producers, it is now revenue to the government. The quota of 6,000 packs instead results in an increase in producer surplus, because producers are collecting this extra revenue (less deadweight loss), which is obviously an advantage to producers.

5. (3 pts) The U.S. Senate is considering a bill that would tax the sale of laptop computers in order to fund a computer education program. The Congressional Budget Office (CBO) estimates that if it implements a low tax of $12 per laptop, revenue should be sufficient to exactly fund the program. The CBO also estimates that a high tax of $230 per laptop will exactly fund the program.

   a. (2 pts) How can a low tax and a high tax raise exactly enough money to fund the program? Illustrate your answer using a graph.
   Solution:
   The tax revenue is:
   $$Q^{tax} * tax$$
   An increase in the per-unit tax will decrease the number of laptops sold. **Under the two schemes, the taxation revenue would be the same if:**
   $$\boldsymbol{Q^{tax}_{\$12} * \$12 = Q^{tax}_{\$230} * \$230}$$
   In the graph below, this happens when both shaded rectangles have the same area.



   b. (1 pt) Suppose that you are an economic advisor to the Senate Finance Committee, tasked with analyzing the economic impact of the tax proposals. Which proposal do you recommend, and why?
   Solution:
   Since both proposals lead to the same government revenue is raised, I recommend the $12 per laptop tax proposal because the deadweight loss is smaller, which means there is a smaller lost to society under the $12 tax as opposed to the $230 tax.