Economics 500: Microeconomic Theory

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Problem Set #10 – Answers

1. Suppose there are 100 identical firms in a perfectly competitive industry. Each firm has a short-run total cost curve of the form

$$SRTC = (1/300)*q^3 + 0.2q^2 + 4q + 10$$

   a. Calculate the firm's short-run supply curve with q as a function of market price (P).

   SRMC=$q^2/100+0.4q+4$, setting SRMC=P

   P= $q^2/100+0.4q+4 \Rightarrow 100P=q^2+40q+400=(q+20)^2$

   Since q>0, $q=10\sqrt{P}-20$, (P>=4) (SR supply function)

   b. On the assumption that there are no interaction effects among costs of the firms in the industry, calculate the short-run industry supply curve.

   $Q_S=100q=100(10\sqrt{P}-20)=1000\sqrt{P}-2000$

   c. Suppose market demand is given by Q = -200P + 8,000. What will be the short-run equilibrium price-quantity combination?

   $Q_D=-200P+8000$, P<=40

   At SR equilibrium: $Q_S=Q_D \Rightarrow 1000\sqrt{P}-20=-200P+8000 \Rightarrow P^2-125P+2500=0$

   $\Rightarrow$ P=25 or P=100(impossible)

   Plug in the demand function:

   When P=25, $Q_D=-200*25+8000=3000=Q_S$.

2. Suppose there are 1,000 identical firms producing diamonds and the total cost curve for each firm is given by

$$SRTC = q^2 + wq$$

   where q is the firm's output level and w is the wage rate of diamond cutters.

   a. If w = 10, what will be the firm's short run supply curve? What is the industry's supply curve? How many diamonds will be produced at a price of 20 each? How many more diamonds would be produced at a price of 21?

   $w=10 \Rightarrow SRTC=q^2+10q \Rightarrow SRMC=2q+10$

   setting SRMC=P, $2q+10=P \Rightarrow q=P/2-5$ (firm's SR supply function)

   industry supply curve: $Q_S=1000q=500P-5000$

   When P=20, $Q_S=500*20-5000=5000$

   When P=21, $Q_S=500*21-5000=5500 \Rightarrow$ 500 more would be produced.

b. Suppose the wages of diamond cutters depends on the total quantity of diamonds produced and the form of this relationship is given by

$$W = 0.002Q$$

where Q represents total industry output, which is 1,000 times the output of the typical firm.

In this situation, show that the firm's marginal cost (and short run supply) curve depends on Q. What is the industry supply curve? How much will be produced at a price of 20? How much will be produced at a price of 21? What do you conclude about the shape of the short-run supply curve?

$w=0.002Q \Rightarrow SRTC=q^2+0.002Qq \Rightarrow SRMC=2q+0.002Q$ (we can see SRMC depends on Q)

setting SRMC=P

$2q+0.002Q=P \Rightarrow q=P/2-0.001Q$ (we can see SR supply curve depends on Q)

$=P/2-q \Rightarrow q=P/4$

The industry supply curve: $Q_S=1000q=500P-Q \Rightarrow Q=250P$

*When P=20, Q=250*20=5000*

*When P=21, Q=250*21=5250 ➔ 250 more diamonds would be produced.*

➔ The new SRSS curves are steeper.

3. A perfectly competitive market has 1,000 firms. In the very short run, each of the firms has a fixed supply of 100 units. The market demand is given by

$$Q = 160{,}000 - 10{,}000P$$

a. Calculate the equilibrium price in the very short run.

$Q_S=1000q_s=100{,}000$

At the equilibrium, $Q_S=Q_D \Rightarrow 160{,}000-10{,}000P=100{,}000 \Rightarrow P=6$

b. Calculate what the equilibrium price would be if one of the sellers decided to sell nothing or if one seller decided to sell 200 units.

If one of the sellers decided to sell nothing

$Q_S=999*q_s=99{,}900$

At the equilibrium, $Q_S=Q_D \Rightarrow 160{,}000-10{,}000P=99{,}900 \Rightarrow P=6.01$

If one seller decided to sell 200 units

$Q_S=999*q_s+200=100{,}100$

At the equilibrium, $Q_S=Q_D \Rightarrow 160{,}000-10{,}000P=100{,}100 \Rightarrow P=5.99$

c. At the original equilibrium point, calculate the elasticity of the industry demand curve and the elasticity of the demand curve ($e_{D,P} = \partial Q/\partial P * P/Q$) facing any one seller.

Industry demand curve: $Q_D=160{,}000-10{,}000P$

$\Rightarrow e_{D,P}=\partial Q/\partial P * P/Q=-10{,}000*P/Q$

When P=6, $Q_D=100{,}000$, $e_{D,P}=-10{,}000*6/100{,}000=-0.6$

For one seller, demand function:

$q_D=Q_D-999{,}100=160{,}000-10{,}000P-99{,}900=60{,}100-10{,}000P$

$\rightarrow e_{q,P}$=-10,000P/q

When $P=6$, $q_D=100 \rightarrow e_{q,P}$=-10,000*6/100=-600

Now suppose that in the short run, each firm has a supply curve that shows the quantity the firm will supply (q_i) as a function of market price. The specific form of this supply curve is given by

$$q_i = -200 + 50P$$

Using this short run supply response, answer questions (a) through (d) above.

a. $Q_S=1000q_i$=-200,000+50,000P,
   At the equilibrium, $Q_S=Q_D \rightarrow$-200,000+50,000P=160,000-10,000P $\rightarrow$P=6,
   $Q_D=Q_S$=100,000
b. *If one seller decided to sell nothing*
   $Q_S=999*q_i$=-199,800+49,950P
   At the equilibrium,
   $Q_S=Q_D \rightarrow$-199,800+49,950P=160,000-10,000P $\rightarrow$P=6.002
   If one seller decided to sell 200 units
   $Q_S=999*q_i+200$=-199,600+49,950P
   At the equilibrium,
   $Q_S=Q_D \rightarrow$-199,600+49,950P=160,000-10,000P $\rightarrow$P=5.998
c. *Industry demand curve:* Q_D=160,000-10,000P
   $e_{D,P}$=-10,000P/Q
   at the point: P=6, Q_D=100,000
   $e_{D,P}$=-10,000*6/100,000=-0.6
   for one seller, demand function
   $q_D=Q_D-Q_{Si}$=160,000-10,000P-(-199,800+49,950P)=359,800-59,950P
   $e_{D,P}$=-59,950P/Q
   at the point, P=0, q_D=-200+50.6=100
   $e_{q,P}$=59,950*6/100=-3597

4. Suppose the demand for Frisbees is given by

$$Q = 100 – 2P$$

and the supply by

$$Q = 20 + 6P$$

a. What will be the equilibrium price and quantities for Frisbees?
   $Q_D=Q_S \rightarrow$100-2P=20+6P $\rightarrow$P=10, $Q_D=Q_S$=80
b. How would your answers to part (a) change if the supply curve were instead

$$Q = 70 + P$$

   What do you conclude by comparing these two cases?
   At the equilibrium:
   $Q_D=Q_S \rightarrow$100-2P=70+6P $\rightarrow$P=10, $Q_D=Q_S$=80
   $\rightarrow$*Conclusion: Different supply curves do not imply different equilibrium.*

5. Suppose that the demand for broccoli is given by

$$Q = 1{,}000 - 5P$$

Where Q is quantity per year measured in hundreds of bushels and P is price in dollars per hundred bushels. The long-run supply curve for broccoli is given by

$$Q = 4P - 80$$

a. Show that the equilibrium quantity here is Q = 400. At this output, what is the equilibrium price? How much in total is spent on broccoli? What is consumer surplus at this equilibrium? What is producer surplus at this equilibrium?

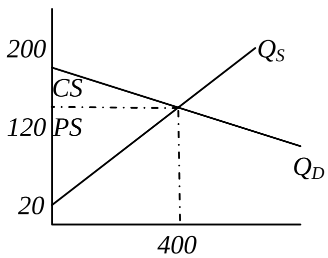
At equilibrium:

$Q_D=Q_S$ ➔ $1000-5P=4P-80$ ➔ $P=120$, $Q_D=Q_S=400$

*Total spending=PQ=120*400=48,000*

CS=1/2(200-120)400=16,000

PS=1/2(120-20)400=20,000



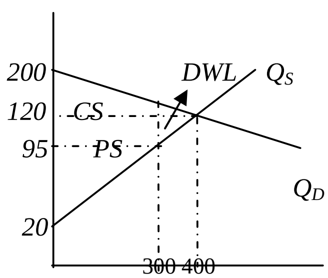
b. How much in total consumer and producer surplus would be lost if Q = 300 instead of Q = 400?

When Q=300, along Q_S, P=95

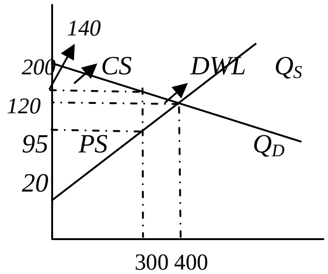
along Q_S, P=95

along QD, P=140

➔ *DWL=1/2(140-95)(400-300)=2250*



c. Show how the allocation between suppliers and demanders of the loss of total consumer and producer surplus described in part (b) depends on the price at which broccoli is sold. How would the loss be shared if P = 140? How about if P = 95?



From the graph, we can see the allocation of DWL between CS and PS depends on the price level.

When P=140,

*CS=1/2(200-140)*300=9000*

*PS=1/2(95-20)*300+(140-95)*300=2475.*

Producers gain 4750, consumers lose 7000. The The difference (2250) is the deadweight loss.

When P=95,

CS=9000+13500=22500, PS=11250

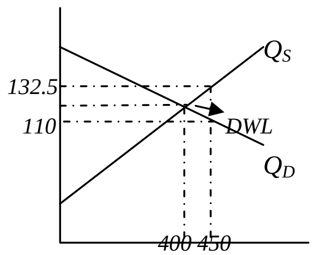
Consumers gain 6500, producers lose 8750. Difference is again the deadweight loss, 2250.

d. What would be the total loss of consumer and producer surplus if Q = 450 rather than Q = 400? Show that the size of this total loss also is independent of the price at which the broccoli is sold.

When Q=450, along Q_D, P=110, consumes only want to pay 110/unit.

along Q_S, P=132.5,

Total Loss of CS and PS=1/2(132.5-110)(450-400)=562.5



This total loss is independent of price, which can fall between 110 and 132.5.

e. Suppose the demand for broccoli shifted outward to

$$Q = 1{,}270 - 5P$$

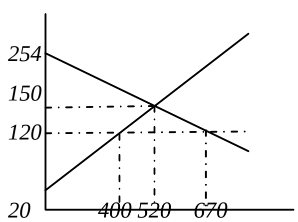
What would be the new equilibrium price and quantity in this market?

New equilibrium, Q_D=Q_S ➔1270-5P=4P-80 ➔P=150, Q_S=Q_D=520.

f. What would be the new levels of consumer and producer surplus in this market?

*CS=1/2(254-150)*520=27,040, PS=1/2(150-20)*520=33,800*

Total surplus=CS+PS=27040+33800=60840.



g. Suppose the government had prevented the price of broccoli from rising from its equilibrium of before. Describe how the consumer and producer surplus measures would be reallocated or lost entirely.

Price ceiling P=120, the market demand>supply, the firm will produce only 400 units, at this output level consumers would like to pay $246/unit.

*The PS=1/2(120-20)*400=20000, CS=1/2(174-120)+(254-120)*400=37600*

So we can see the consumers are better off, because of getting more surplus, the producers are more worse off because of losing surplus.

So we can see that some part of producer surplus does not transfer to consumer, that is DWL=1/2(174-120)(520-400)=3240.