14.01 Fall 2010

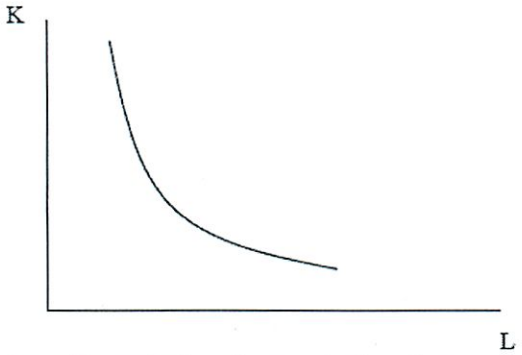
Problem Set 4

Due in class on Octobers 15th

1. For each of the following production functions, sketch a representative isoquant. Calculate the marginal product for each input, and indicate whether each marginal product is diminishing, constant, or increasing. Also calculate the marginal rate of technical substitution for each function. Also indicate whether the function exhibits constant, increasing, or diminishing returns to scale.

a) $F(L,K) = LK^3$

This production function is of the Cobb-Douglas form. Isoquants: $K = (Q/L)^{1/3}$ look approximately as follows:



Let's first calculate the marginal products and check whether they are diminishing, constant or increasing.

$$MP_L = \frac{\partial F}{\partial L} = K^3 \qquad \frac{\partial^2 F}{\partial L^2} = 0$$ Therefore, constant.

$$MP_k = \frac{\partial F}{\partial K} = 3LK^2 \qquad \frac{\partial^2 F}{\partial K^2} = 6LK > 0$$ Therefore, increasing.

For the MRTS we get,

$$MRTS = \frac{MP_L}{MP_K} = \frac{K^3}{3LK^2} = \frac{1}{3}\frac{K}{L}$$

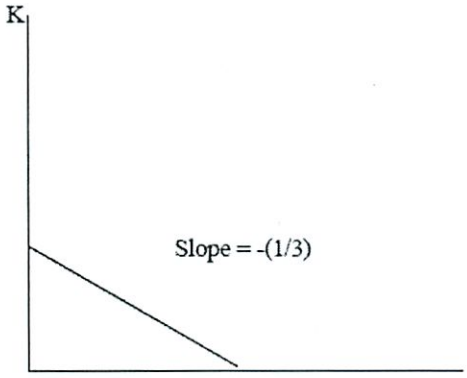
Checking for returns to scale (we are scaling up all inputs by a factor $t>1$)

$F(tK,tL) = tL(tK)^3 = t^4LK^3 = t^4F(K,L)$.

So, this production function exhibits increasing returns to scale.

b) $F(L,K) = L + 3K$

This is a perfect substitutes production function. Isoquants are linear with a slope equal to the negative of the constant MRTS which is 1/3 here. Isoquant: $K = Q/3 - (1/3)L$.



Marginal products are constant for both inputs.

$$MP_L = \frac{\partial F}{\partial L} = 1 \qquad \frac{\partial^2 F}{\partial L^2} = 0 \text{ Therefore, constant.}$$

$$MP_K = \frac{\partial F}{\partial K} = 3 \qquad \frac{\partial^2 F}{\partial K^2} = 0 \text{ Therefore, constant.}$$

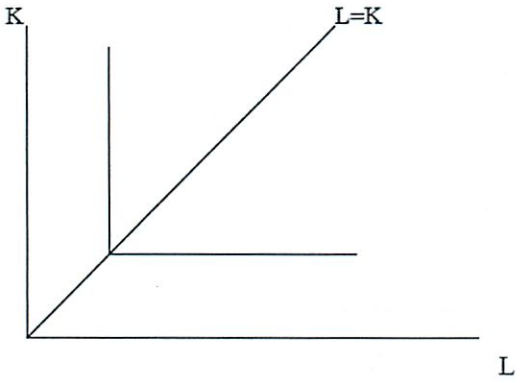
For the MRTS we get,

$$MRTS = \frac{MP_L}{MP_K} = \frac{1}{3}$$

We verify constant returns to scale: $F(tK,tL) = tL+3tK = t(L+3K) = tF(K,L)$.

c) $F(L,K) = [Min\{L,K\}]^{1/3}$

This is a perfect complements production function. Isoquants are L-shaped (with the kink a L=K).



Marginal products for both inputs:

$$MP_L = \frac{\partial F}{\partial L} = 0 \text{ if } L \geq K$$
$$= \frac{1}{3}L^{-2/3} \text{ if } L < K$$

$$\frac{\partial^2 F}{\partial L^2} = 0 \text{ if } L \geq K$$
$$= -\frac{2}{9}L^{-5/3} \text{ if } L < K$$

$$MP_K = \frac{\partial F}{\partial K} = 0 \text{ if } L \leq K$$
$$= \frac{1}{3}K^{-2/3} \text{ if } L > K$$

$$\frac{\partial^2 F}{\partial K^2} = 0 \text{ if } L \leq K$$
$$= -\frac{2}{9}K^{-5/3} \text{ if } L > K$$

For the MRTS we get,

$$MRTS = \frac{MP_L}{MP_K} = 0 \text{ if } L > K$$
$$= \infty \text{ if } L < K$$

(MRTS not defined on the kink points, where K=L)

This production function exhibits decreasing returns to scale (note $t > 1$)

$F(tL, tK) = [min\{tL, tK\}]^{\frac{1}{3}} = [tmin\{L, K\}]^{\frac{1}{3}} = t^{\frac{1}{3}}[min\{L, K\}]^{\frac{1}{3}} < tF(K, L)$

2. Consider the production function $f(l, k) = 2l^{\frac{1}{4}}k^{\frac{1}{4}}$.

(a) (15 points) Find the associated (long-run) total, average, and marginal cost curves.

(b) (6 points) Sketch the total, average, and marginal cost curves.

(a) Minimize $wL+rK$ s.t. $2L^{1/4}K^{1/4} = Q$
K, L

Setting up the Lagrangian and solving for the first order conditions yields the "conditional" input demand curves for K and L.

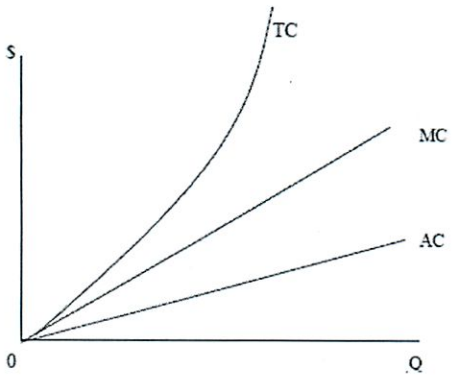
$$L^*(r,w,Q) = \frac{Q^2 r^{1/2}}{4w^{1/2}}$$

$$K^*(r,w,Q) = \frac{Q^2 w^{1/2}}{4r^{1/2}}$$

$$TC^*(r,w,Q) = \frac{Q^2 w^{1/2} r^{1/2}}{2}$$

$$AC^*(r,w,Q) = \frac{Q^2 w^{1/2} r^{1/2}}{2Q} = \frac{Q w^{1/2} r^{1/2}}{2}$$

$$MC^*(r,w,Q) = \frac{\partial TC}{\partial Q} = \frac{2Q w^{1/2} r^{1/2}}{2} = Q w^{1/2} r^{1/2}$$



3. Suppose the process of producing corn on a farm is described by the function

$$q = 8K^{\frac{1}{2}}(L-40)^{\frac{2}{3}}$$

where q is the number of units of corn produced, K the number of machine hours used, and L is the number of person-hours of labor. In addition to capital and labor, the farmer needs to pay a \$15 transportation fee to deliver corn to downtown. So the total cost can be written as:

$$TC = 15q + rK + wL$$

where wage rates is w and the rental rate of machines is r.

(a) (8 points) Suppose in the short run, the machine hours rented are fixed at $K = 8$, and its rental rate $r = 64$, and wage rate $w = 16$. Derive the short run total costs and average costs as a function of output level (q).

When K=8, the short run production function is

$$q = 16(L - 40)^{\frac{2}{3}}$$

this is

$$L = 40 + (\frac{q}{16})^{\frac{3}{2}}$$

the short run cost function is,

$$\begin{aligned} TC_{SR} &= 15q + 512 + w(40 + (\frac{q}{16})^{\frac{3}{2}}) \\ &= 1152 + 15q + 16(\frac{q}{16})^{\frac{3}{2}} \end{aligned}$$

and

$$AC_{SR} = \frac{TC_{SR}}{q} = \frac{1162}{q} + 15 + (\frac{q}{16})^{\frac{1}{2}}$$

(b) (6 points) Suppose the farm wants to produce 64 units of corn, i.e., $q = 64$, based on the answer to (a), what's the total short run cost?

The short run cost is $TC_{SR} = 1152 + 15q + 16\left(\frac{q}{16}\right)^{\frac{3}{2}} = 2240$.

(c) (10 points) In the long run, the farm can change its capital level. By minimizing cost subject to the production function, derive the cost-minization demands for K and L as a function of output (q), wage rates (w) and rental rates of machines (r).

The marginal product for K is $MP_K = \frac{8}{3}K^{\frac{-2}{3}}(L - 40)^{\frac{2}{3}}$
for L $MP_L = \frac{16}{3}K^{\frac{1}{3}}(L - 40)^{\frac{-1}{3}}$
by setting marginal rate of technical substitution equal to the input price ratio,

$$MRTS = \frac{MP_K}{MP_L} = \frac{r}{w}$$

we have $\frac{(L-40)}{2K} = \frac{r}{w}$

This means $L - 40 = \frac{2rK}{w}$.
Substituting the above equations for K and L into the production function $q = 8K^{\frac{1}{3}}(L-40)^{\frac{2}{3}}$ yields solutions for K and L: $q = 8K^{\frac{1}{3}}\left(\frac{2rK}{w}\right)^{\frac{2}{3}}$ so $q = 8K\left(\frac{2r}{w}\right)^{\frac{2}{3}}$

this implies $L = 40 + \frac{q}{8}\left(\frac{2r}{w}\right)^{\frac{1}{3}}$ and $K = \frac{q}{8}\left(\frac{w}{2r}\right)^{\frac{2}{3}}$

4. You run a cost-minimizing firm with production function $f(l, k) = [min\{l, k\}]^{\frac{1}{3}}$, where l is labor and k is capital. Assume that you are a price-taker in the input markets: you pay w for each unit of labor you hire

and r for each unit of capital (where w and r are set exogenously), and face no costs other than those from labor and capital.

(a) (15 points) Assuming that you can freely choose both labor and capital (i.e., the "long-run problem"), derive expressions for your cost-minimizing conditional input demands, $l_*(r, w, Q)$ and $k_*(r, w, Q)$. Confirm that the conditional input demand functions are "homogeneous of degree zero" in w and r; that is

$$l_*(tr, tw, Q) = l_*(r, w, Q) \text{and}$$
$$k_*(tr, tw, Q) = k_*(r, w, Q)$$
$$\text{for all } t > 0.$$

$F(L, K) = \{minL, k\}^{\frac{1}{3}}$ is a perfect complements production function, so we know that we will always be producing at $L = K$. Using this, $Q = F(L, K) = \{minL, k\}^{\frac{1}{3}} = \{minL, L\}^{\frac{1}{3}} = L^{\frac{1}{3}} \Longrightarrow L^* = Q^3 and K^* = Q^3$.
That is, $L^*(r, w, Q) = K^*(r, w, Q) = Q^3$ are independent of the input prices r and w. In particular, we verify homogeneity of degree zero: $L^*(tr, tw, Q) = Q^3 = L^*(r, w, Q)$ and same for $K^*(r, w, Q)$.

(b) (8 points) What will happen to your conditional demand for labor if there is an increase in the wage rate, assuming that r and Q remain the same? Explain in one sentence why your answer makes intuitive sense.

As can be seen both in the picture and by plugging into the formulas, since $L^*(r, w, Q) = K^*(r, w, Q) = Q^3$ are independent of the prices r and w, there will be no change in the inputs for a change in prices (given the perfect complement production function, producers cannot substitute away from labor when its price w increases).

(c) (5 points) Use your answers from (a) to write down an expression for your total cost function $TC(r, w, Q)$. Is this function "homogeneous of degree one" in w and r; that is does $TC(tr, tw, Q) = tTC(r, w, Q)$?

The total cost function $TC(r, w, Q)$ states how much it costs to produce quantity Q, when prices are r and w (and the producer behaves optimally). We have:

$$TC(r, w, Q) = wL^*(r, w, Q) + rK^*(r, w, Q) = wQ^3 + rQ^3 = (r + w)Q^3$$

$TC(r, w, Q)$ is indeed homogenous of degree one:

$$TC(tr, tw, Q) = (tr + tw)Q^3 = t \cdot (r + w)Q^3 = t \cdot TC(r, w, Q).$$

Lecture 11

10/17

Perfect Competition

$C = 10 + .5q^2$

$P = MC$

will produce $P = q$ ← amt to produce

but also need to think about firm's shut down condition

if $p = 3$

Then q would $= 3$

but $\pi = 3 \cdot 3 - (10 + .5q^2(3))$

$= -5.5$

But if shut down

$\pi = 0 - 10$

$= -10$

So it will stay in biz in short run

↳ so as long as $pq \geq VC$

revenue

$P \geq \frac{VC}{q}$

$\boxed{P \geq AVC}$

(2) $VC = .5 + q^2$

$= .5 + p^2$ since $q = p$

$AVC = .5 + p$

So by definition ~~$p \geq AVC$~~ of at firm it will never go out of business since $p \geq AVC$

Short run

Step 1 $p = MC \rightarrow q^*$

Step 2 $p \geq AVC$

figure ~~10~~ 11-1

- supply curve is the MC ~~cost~~ curve here above $p \geq AVC$
- Short run perfect competition
- for long run check the shutdown condition
  - must always check

But we are interested also interested in ~~the~~ market/industry supply curve

Steps short run equilibrium

1) Cost fn → pick capital/fixed $ amt
2) Get Firm's supply curve $p = MC$
3) Add up the firm's supply curve for market curve

figure 11-2

(3) Notes very choppy

The more producers in the market the more elastic the supply is

4) Intercesect Market supply w/ market demand to get p

Market supply $Q_S = 5q = 5p$

$Q_D = 30 - p$

Set = $30 - p = 5p$

$p = 5$ ← equalibrium price

So at that price

$Q_D = 25$

5) Each firm then decides how much to produce

- each firm produces $p = q = 5 = 5$
- since 5 firms
- Bingo Magic of the Market

What do you need to find SR equalibrium

Q function

D "

firms - since no entry/exit
- can derive in long run

(4) Long Run

- Can figure out how many firms in the market
- no one can lose $
  - no shutdown condition since firm goes away
- if you make - profits you leave

- Entry + exit
  - if in market can make profit → firms enter
    making losses → " leave
  - till all firms make 0 profit
    (again perfect competition - which exists no where)

- figure 11-3
  - market for PCs 1990

(1) Entry drives price to Average cost
to point of MC = AC

Firms will produce as efficently as possible
Bottom of LRAC
will be driven out of biz if you are not cost minizing

Of course in reality no pefecth competive price

LR Supply upward sloping in reality
1. entry + exit not free → barriers
   - even in long run

(4)(5) ↳ large capital investment in sunk cost

↳ can exist as long as they don't make too large profit

↳ med school slots are limited

- occupational licensing

2. Patent

3. Thuggary

4. Firms differ

↳ Firms are not

- each has different cost minimizing production level

11-7 figure - capacity constraints

5. Input prices rise as market expands

11-8 figure

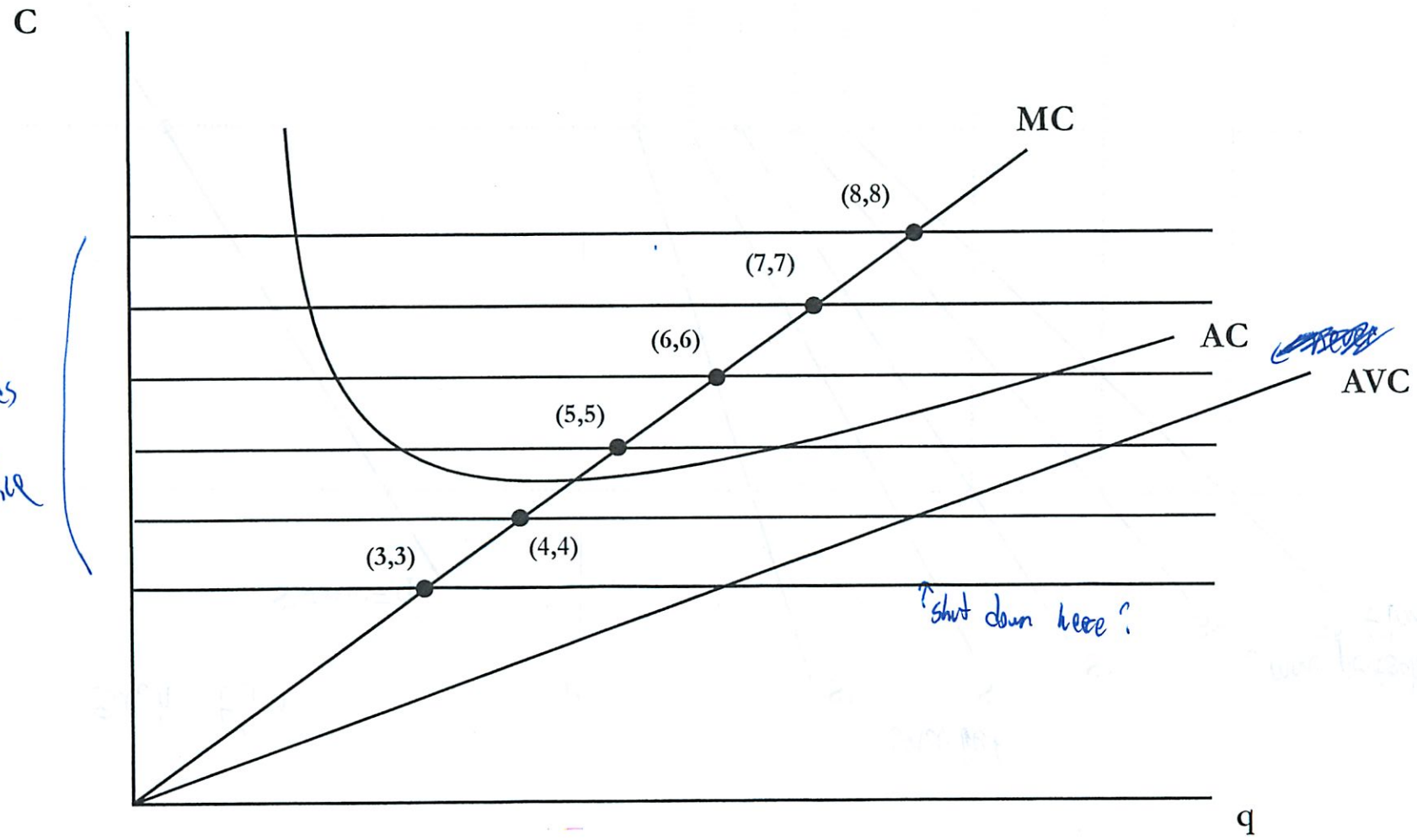
11-9 figure

So LR supply curve is not flat

That is why supply curve is upward sloping

10/18

Figure 11-1: The firm's supply decision

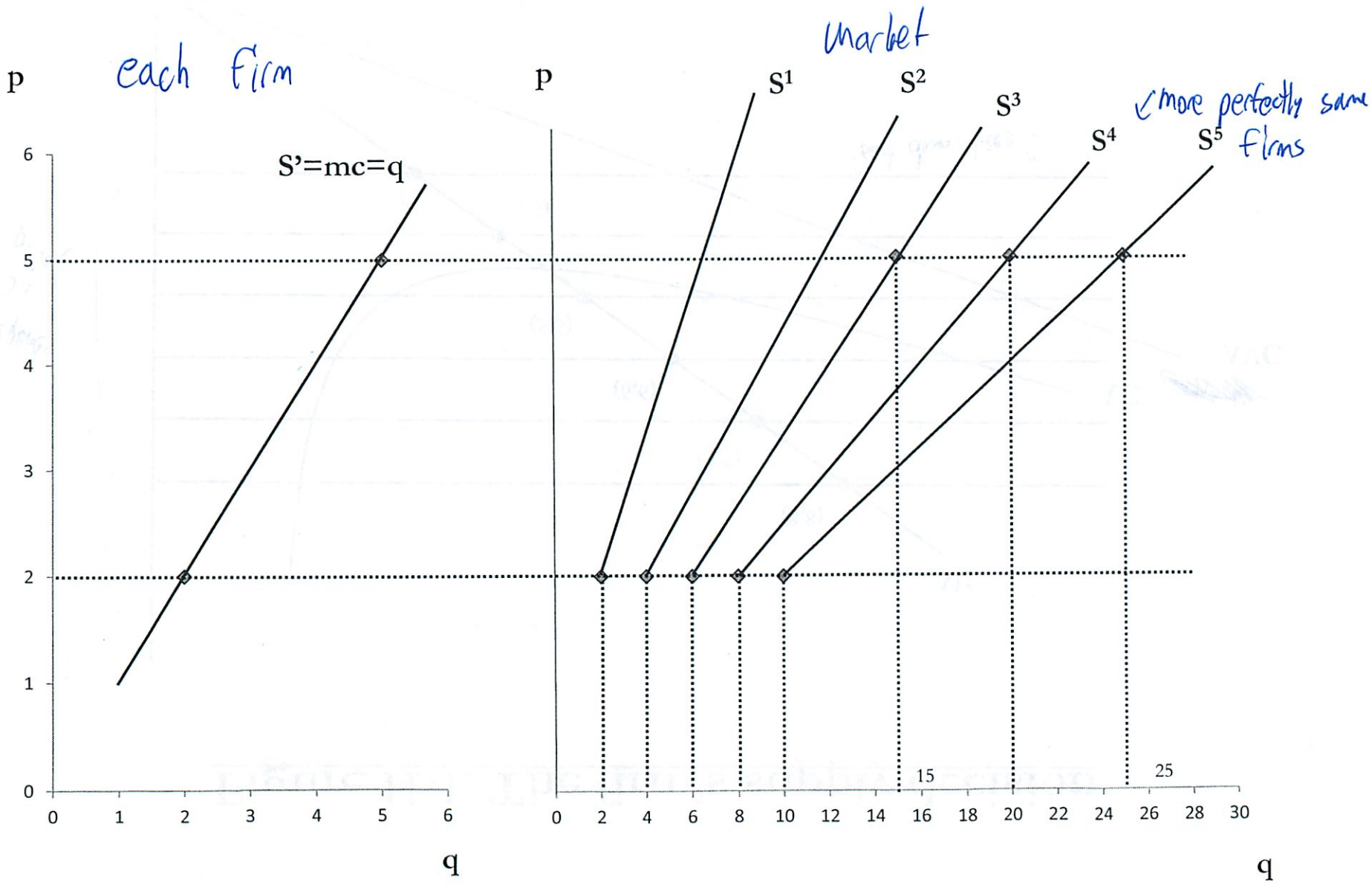


Lecture 11

depends on price

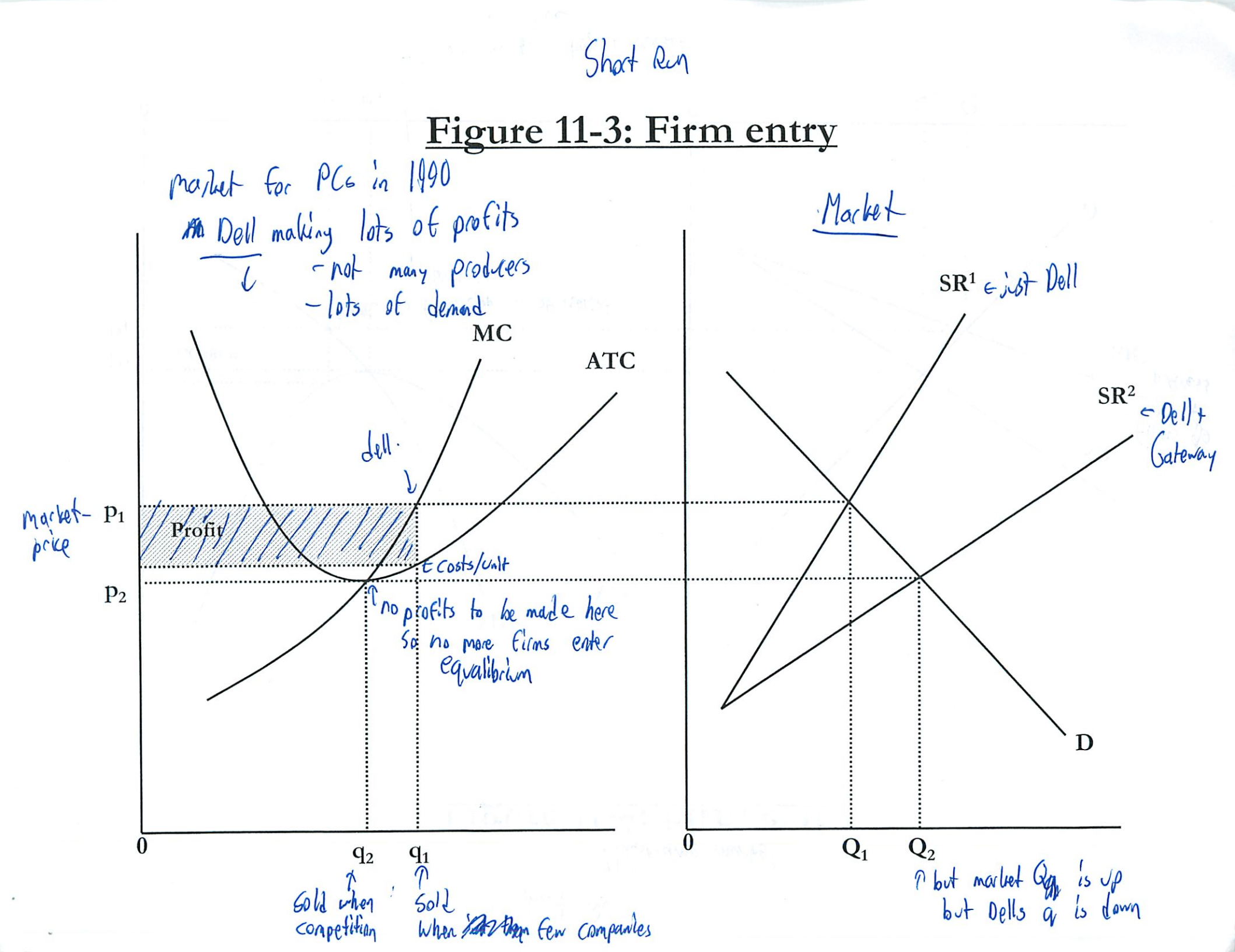
? shut down here ?

Figure 11-2: Short-run market supply curve



Short Run

Figure 11-3: Firm entry



Short Run

Mainframe market

Figure 11-4: Firm exit

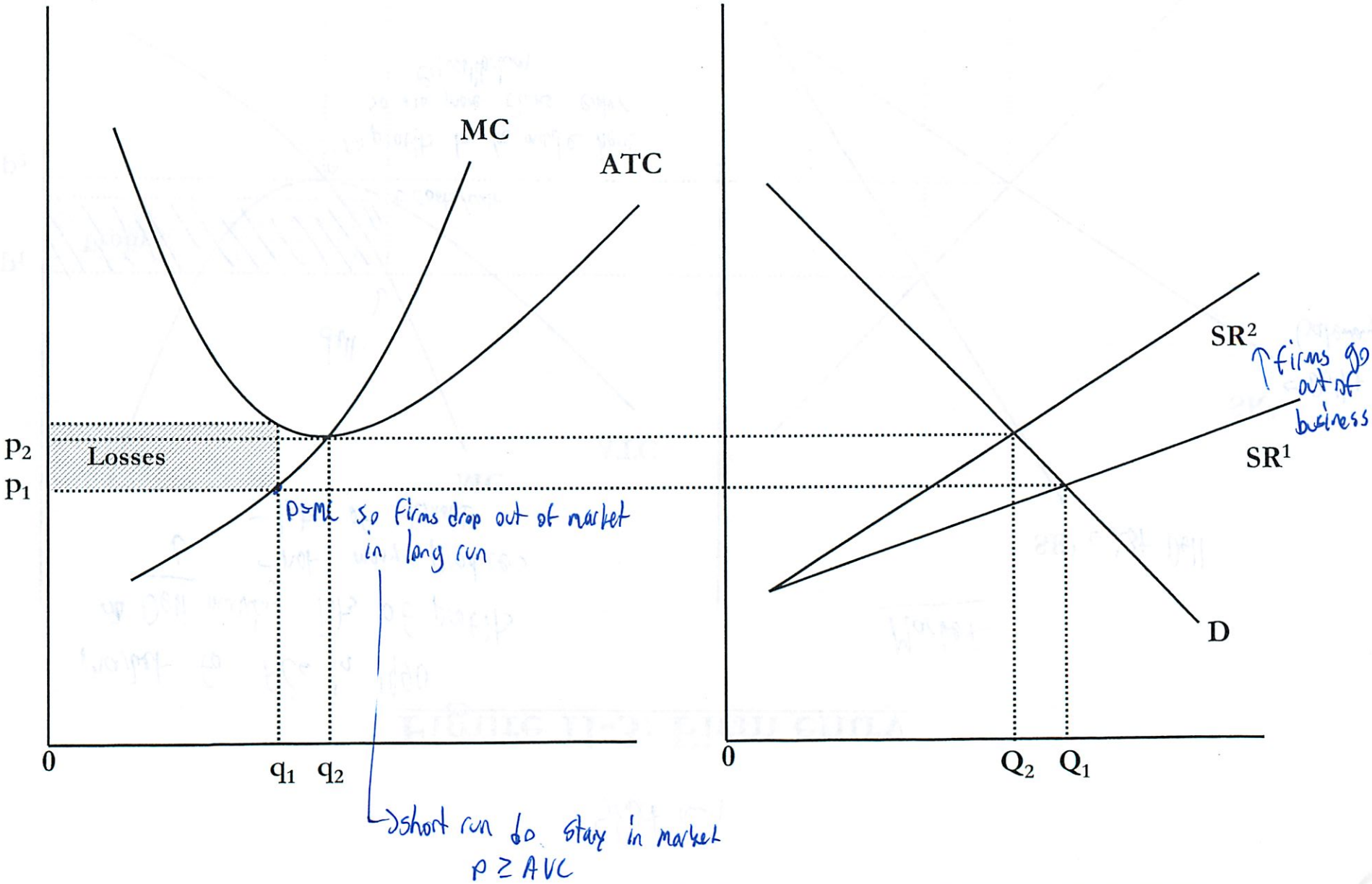
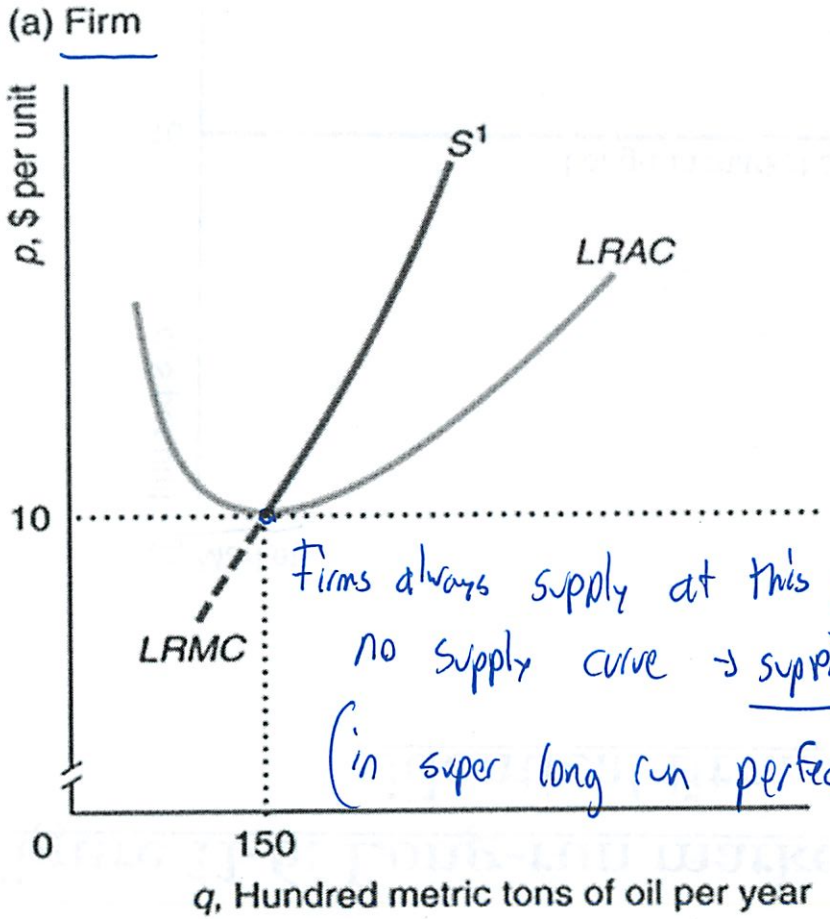


Figure 11-5: Long-run firm supply with identical firms



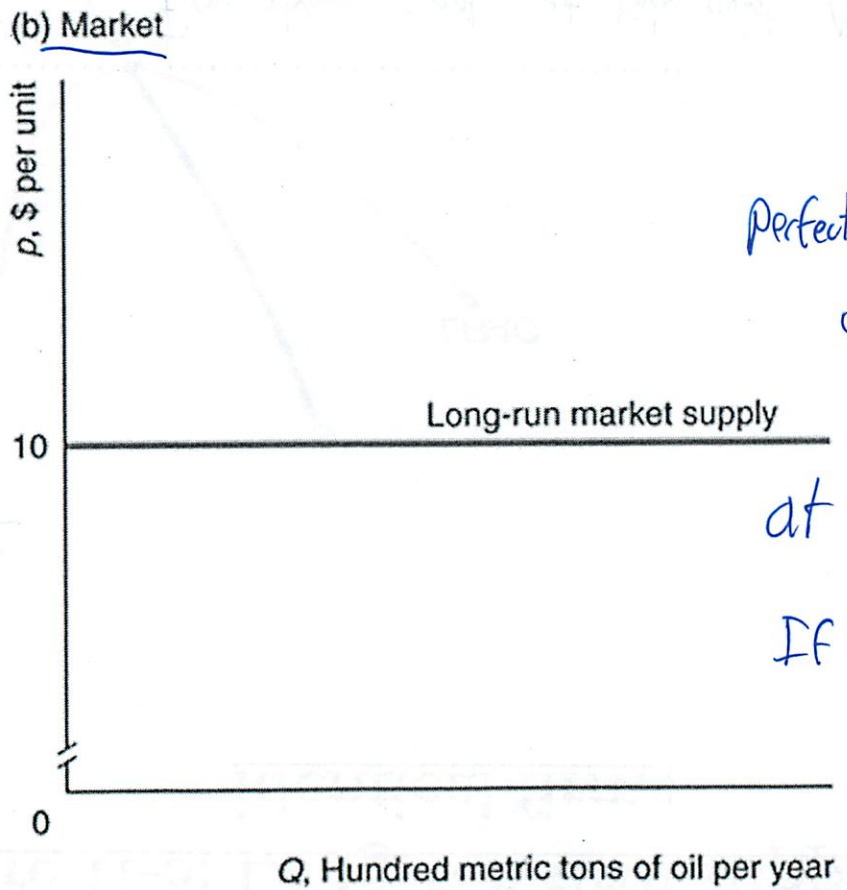
Firms always supply at this point MC=AC

no supply curve → supply point

(in super long run perfectly competitive)

- don't need to know about market demand
- just MC=AC ← point of cost minimization → *lowest pt on LRAC *

Figure 11-6: Long-run market supply with identical firms



Perfectly elastic
demand curve for firm
Supply " " market

at the cost minimizing point

If price ↑, firms enter, drives prices ↓

If prices ↓, firms leave, drives prices ↑

Figure 11-7: International LR market supply curve for cotton

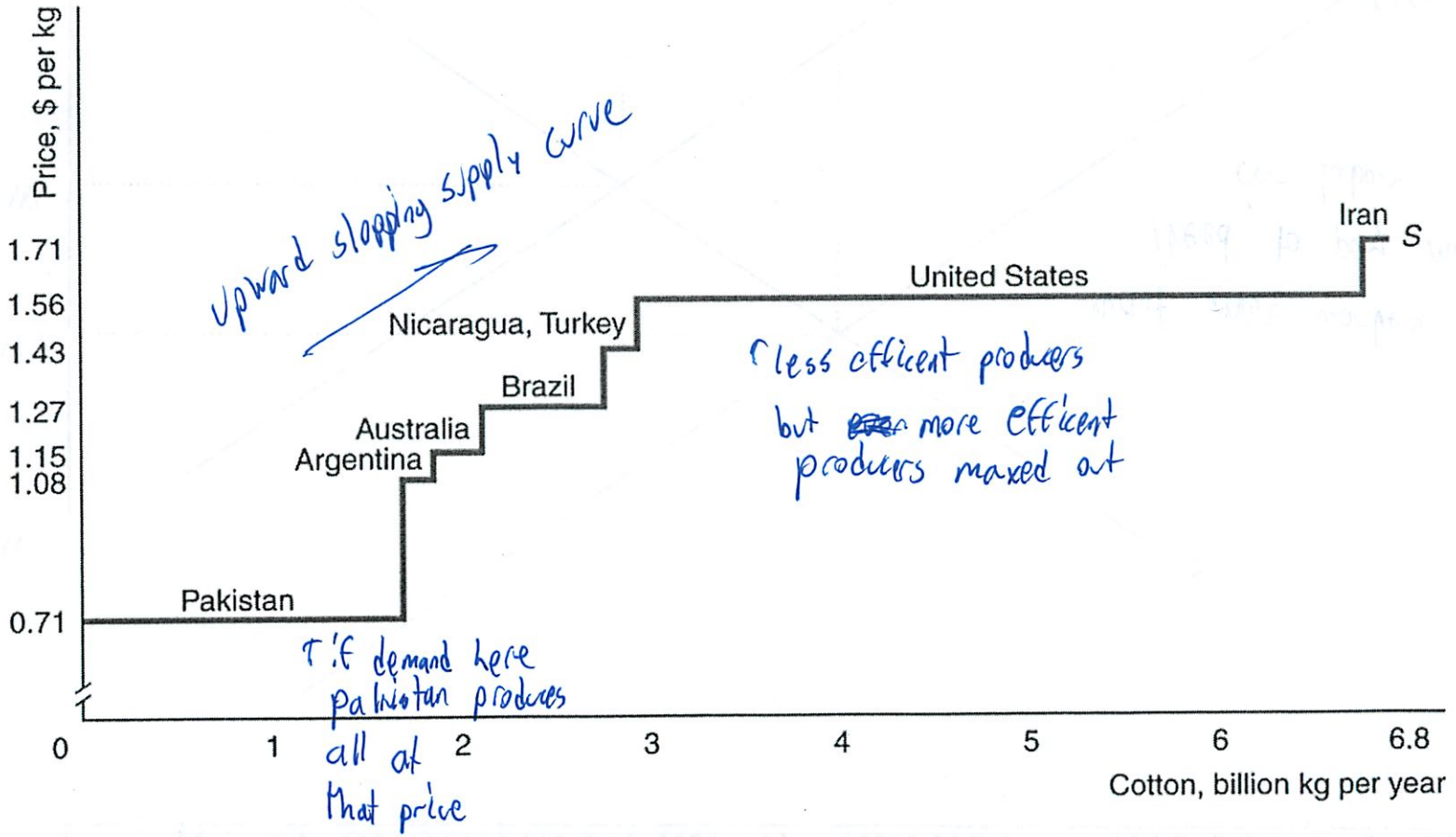


Figure 11-8: Shifts in labor market in the long-run

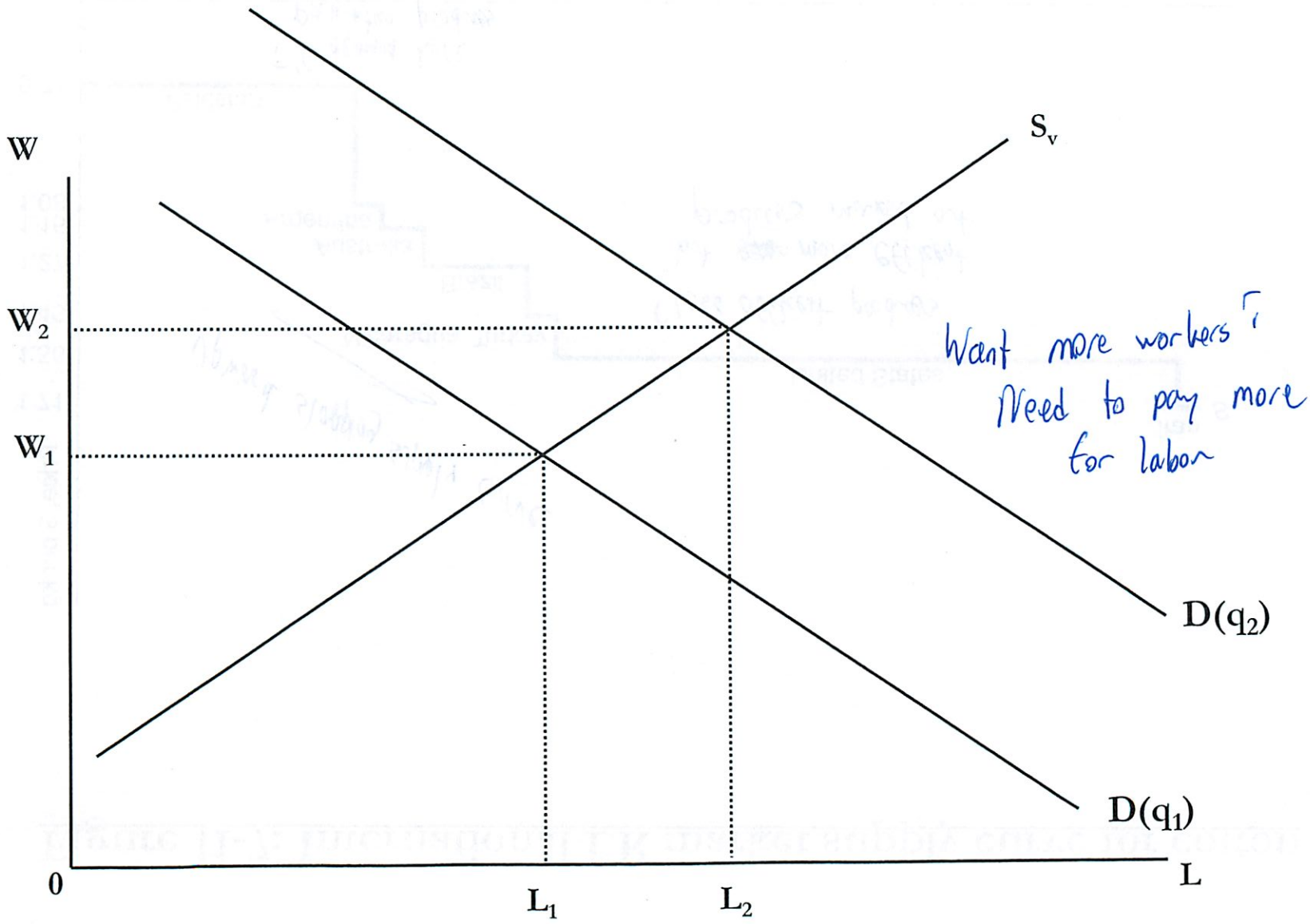
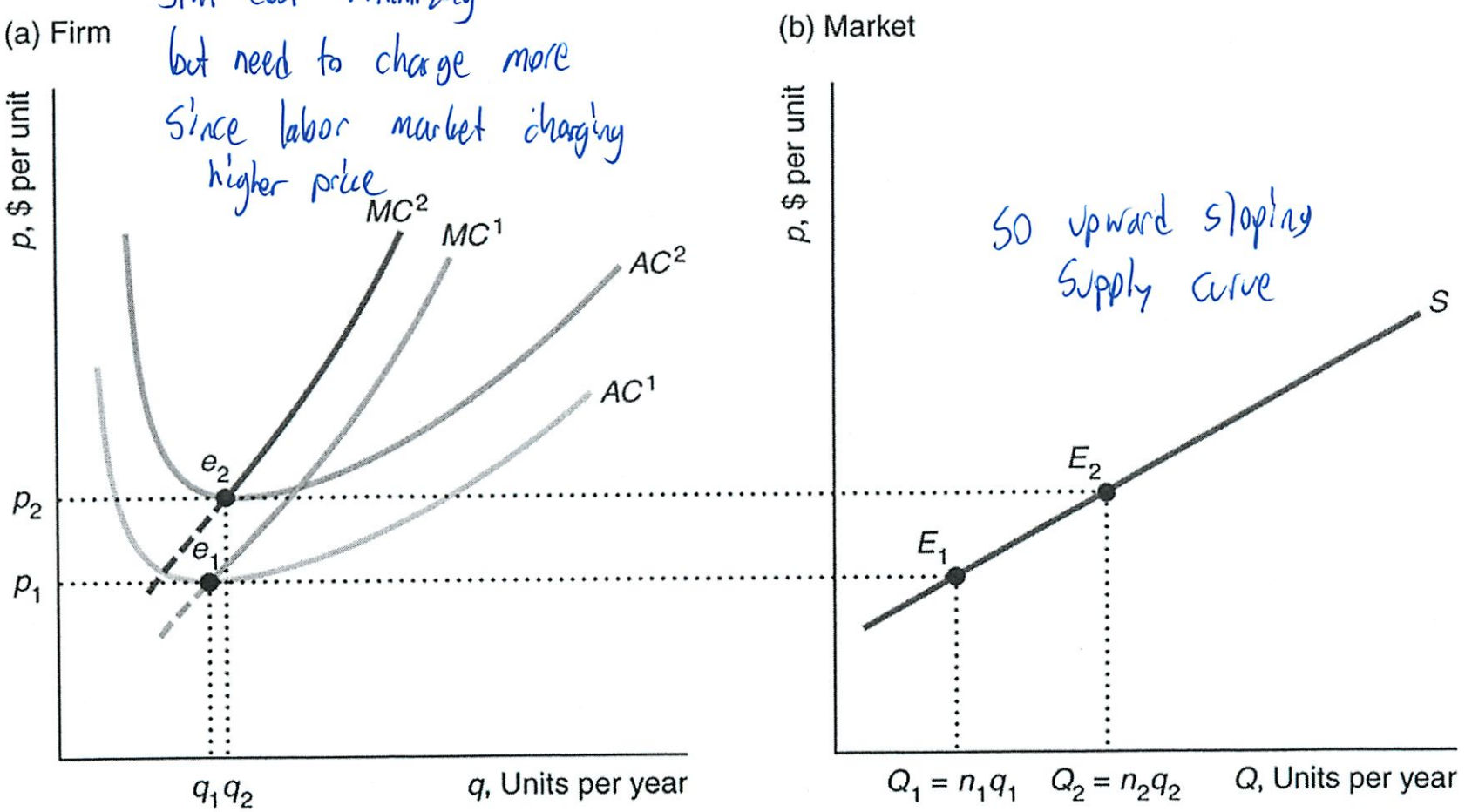


Figure 11-9: Long-run market supply in an increasing cost market



Still cost minimizing but need to charge more since labor market charging higher price

So upward sloping supply curve

Lecture 12

10/20

Do firms behave rationally?

CEO pay
- are they worth it?
- hard to say that today

Agency problem
- we had talked about sole proprietorships
- Owners + managers the same
- but most production in US is done by integrations
  - seperate Owners + control/managers
- managers want to make their lives easier
  - ↳ may not be profit maximizing
- Owners don't know this → imperfect info
- set up an intermediary → board of directors
  - ↳ but hard to oversee - boards usually not that good
  - or manager picks his friends
- need to align incentives
  - ↳ Stock options are Ownership stake
    - ↳ cost ~~ed~~ half as much as pure stock
    - worthless if stock price goes ↓
    - can buy stocks at today's price in a few years
- figure 12-1

(2)

-2 Unintended consequences

1. -excessive gambling - worker only wants stock price to go up

if it goes down, he does not care by how much

lets say 10% chance 100% ↑ (doubling value)

90% " 20% ↓

Expected value of gamble = P(win) · $(win) + P(lose) $(lose)

$.1 \cdot 100 + .9 \cdot -20$

$= -8\%$

expected to lose $

but for person on options

$.1 \cdot 100 + .9 \cdot 0$

10% ↑

he can win or walk away

2. Who structures these things

- Cheating
- backdating
- over state profits + cash in options

A lot of the 1990s was false wealth

But econ is the dismal science - hard to balance incentives

Large single owners more successful than small diffused owners

(3)

Normative economics

↳ no longer positive → the study of the way things are

↳ but the way it should be

Welfare economics → well being

↳ not $ to poor ~~people~~ people (here)

but utility is ordinal

↳ actual # meaningless

so measure welfare in $

↳ Corps → profits

↳ people → Compensating variation

↳ How much would you pay to avoid that situation?

How much would you pay for concert tickets?

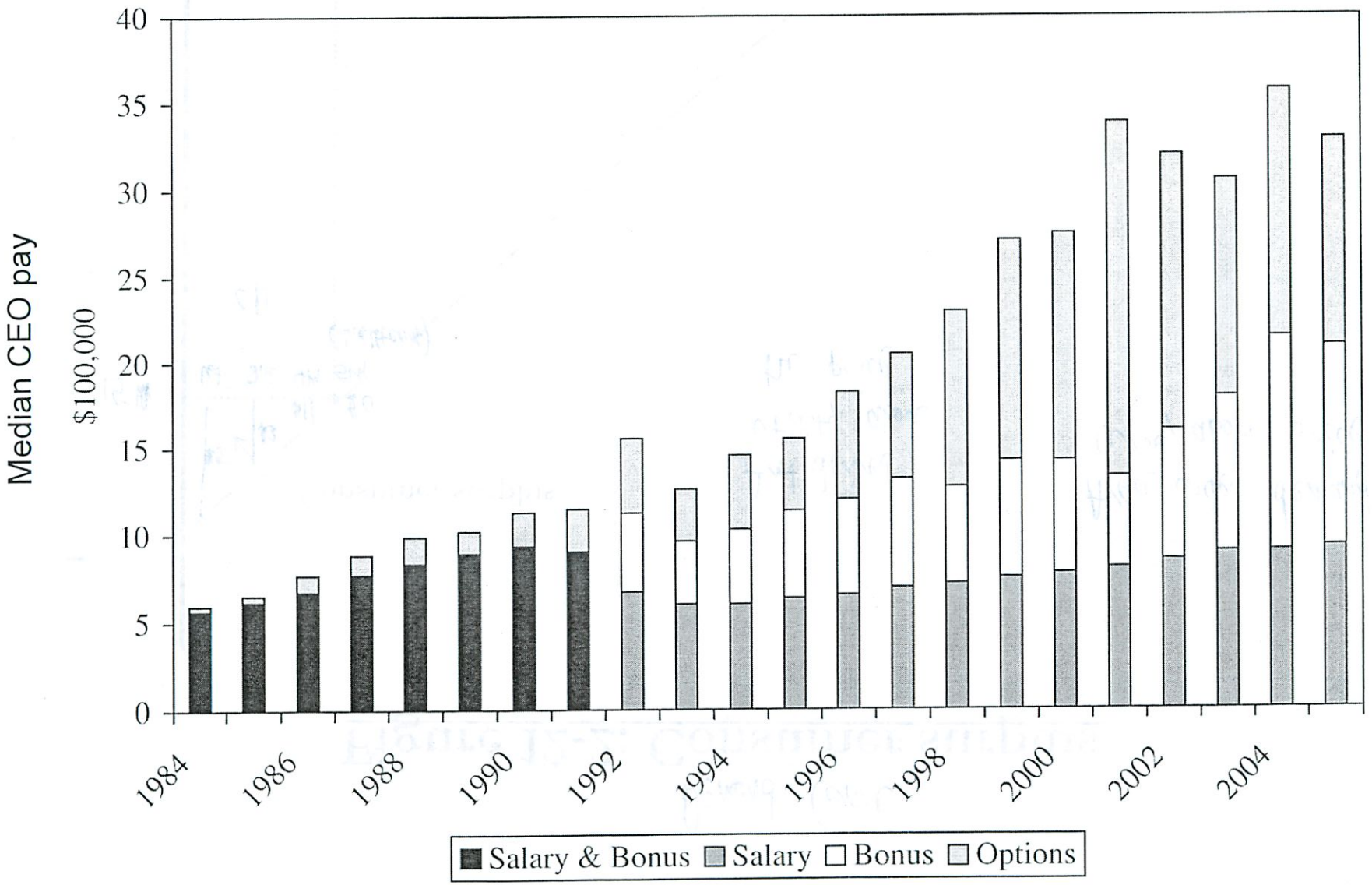
Consumer surplus - benefits consumers get above what they paid for a good/service

$0 → when I pay what I am willing to pay

look at demand curve → figure 12-2

diminishing marginal utility drives this

Figure 12-1: CEO compensation

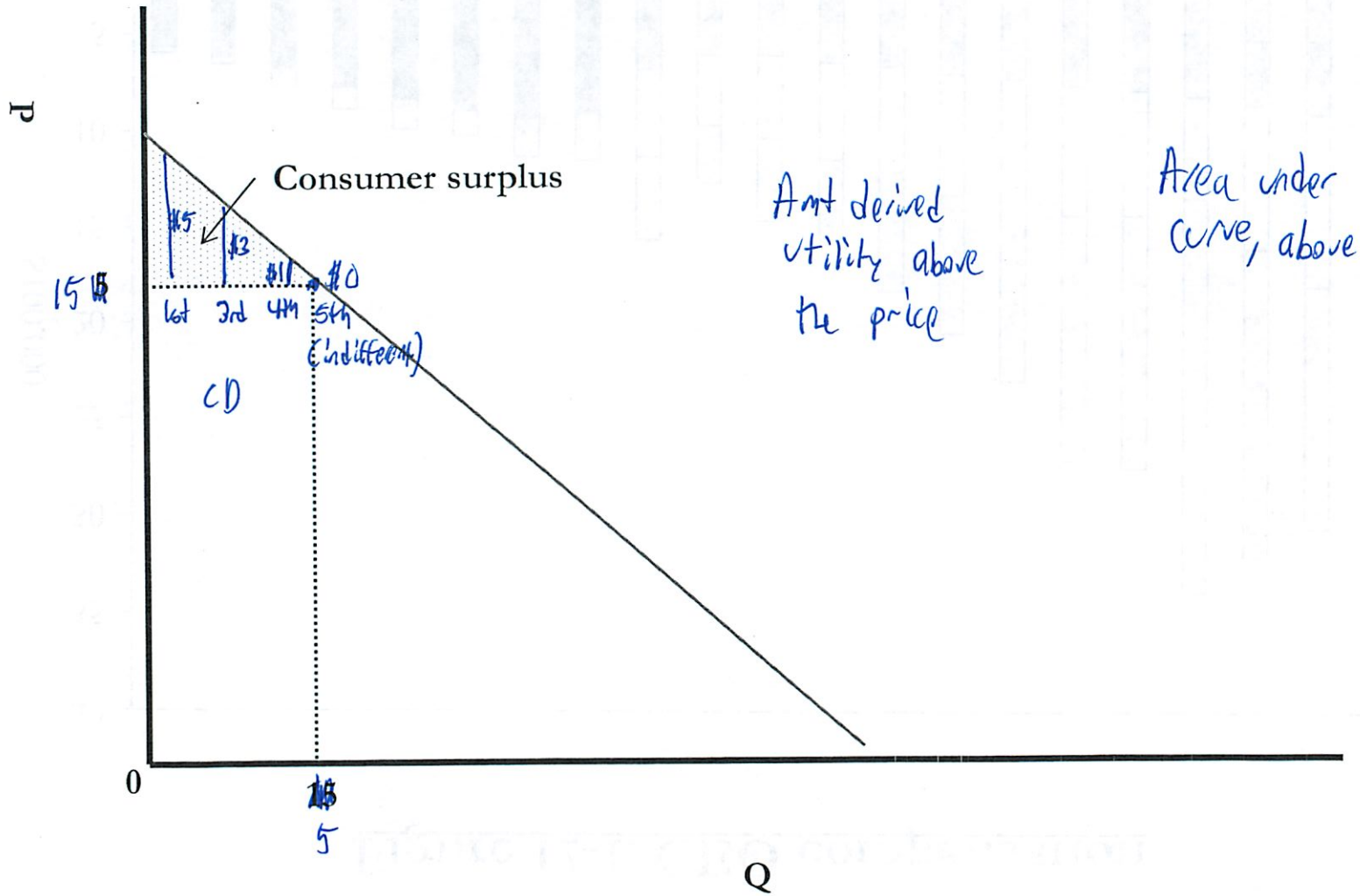


Lecture 12

10/20

Demand Curve

Figure 12-2: Consumer surplus



Amt derived utility above the price

Area under demand curve, above price

Michael Plasmeier

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14.01 Fall 2010

Problem Set 5

Due in class on October 22

1. (24 points) You manage a factory that produces cans of peanut butter. The current market price is \$10/can, and you know the following about your costs:

$MC(5) = 10, ATC(5) = 6$
$MC(4) = 4, ATC(4) = 4$

a. (8 points) A case of food poisoning breaks out due to your peanut butter, and you lose a lawsuit against your company. As punishment Judge Judy decides to take away all of your profits and considers the following two options to be equivalent:

i. Pay a lump sum in the amount of your profits
ii. Imposing a tax of $\$[P - ATC(q^*)]$ /can since that is your current profit per can, where q*is the profit maximizing output before the lawsuit.
Explain briefly why she is right or wrong.

b. (8 points) Judge Judy gives you the option of choosing either plan. Which plan would you choose? Provide intuition. Hint: a clear diagram may be helpful.

c. (8 points) In the following year, you finally pay off the court ordered amount and everything returns to normal. However, an employee tells you that at current levels of production, actual costs are double what you initially thought. After carefully looking at the cost information, you decide to continue producing the exact same amount. Could you still be maximizing profits?

2. (32 points) Assume downward sloping or flat demand and a U-shaped LRAC curve. In each of the following situations, determine graphically and/or verbally:

a) (2 points for each of (i)-(viii)) Does the firm have the cost-minimizing amount of capital given its output level? If not, should the firm increase or decrease its amount of capital given its output?

b) (2 points for each of (i)-(viii)) Does the firm have the profit maximizing level of output given its amount of capital? If not, should the firm increase or decrease its level or output, given its capital?
If the situation is impossible, state why.

i) $SRAC > LRAC, SRMC > LRMC, MR = SRMC$
ii) $SRAC > LRAC, SRMC < LRMC, MR = SRMC$
iii) $SRAC < LRAC, SRMC > LRMC, MR = SRMC$
iv) $SRAC > LRAC, SRMC > LRMC, MR > SRMC$
v) $SRAC > LRAC, SRMC < LRMC, MR > SRMC$
vi) $SRAC = LRAC, SRMC = LRMC, MR > SRMC$
vii) $SRAC = LRAC, SRMC > LRMC, MR = SRMC$

viii) $SRAC = LRAC, SRMC = LRMC, MR = SRMC$

3. (6 Points) Suppose, in the short-run, output of widgets is supplied by 100 identical competitive firms, each having a cost function:

$$c_s(y) = \frac{1}{3}y^3 + 2$$

The demand for widgets is given by:

$$y_d(p) = 6400/p^{\frac{1}{2}}$$

(a) (3 points) Obtain the short-run industry supply function for widgets.

(b) (3 points) Obtain the short-run equilibrium price of widgets, and the output of widgets supplied by each firm.

4. (22 Points) Sebastian owns a coffee factory in Argentina. His production function is:

$$F(K, L) = (K-1)^{\frac{1}{4}}L^{\frac{1}{4}}$$

Consider the cost of capital to be r and the wage to be w. Both inputs are variable, and Sebastian faces no fixed costs.

a) (2 points) What is the MRTS of labor for capital?

b) (5 points) What are Sebastians input demands, conditional on the quantity (q) he wants to produce? [Hint: Treat w and r as parameters.]

c) (3 points) Show that Sebastians long run cost function is $C(q) = r + 2(wr)^{\frac{1}{2}}q^2$.

d) (5 points) What is the supply function of Sebastians firm?

Consider now that $r = 4, w = 1$ and that the market demand for coffee is $Q_d = 20 - P$. There are 7 other companies operating in this market, all with cost structures identical to Sebastians company.

e) (6 points) What is the aggregate supply in this market?

f) (6 points) Calculate the equilibrium price, aggregate quantity sold, quantity sold by each firm and economic profit of each firm?

g) (5 points) Can this be a long-run equilibrium? Why? How will the supply side of the market adjust in the long-run?

h) (6 points) What is going to be the price in the long-run? How many firms will be present in this market in the long-run? How much will each firm produce?

Michael Plasmeier 14.01 P-Set 5 10/21

1. Peanut Butter Factory

Market price #10

$MC(5) = 10$ $ATC(5) = 6$

$MC(4) = 4$ $ATC(4) = 4$

a) Judge Judy (really ?!?) gives you 2 options

i) Pay a lump sum = to profits

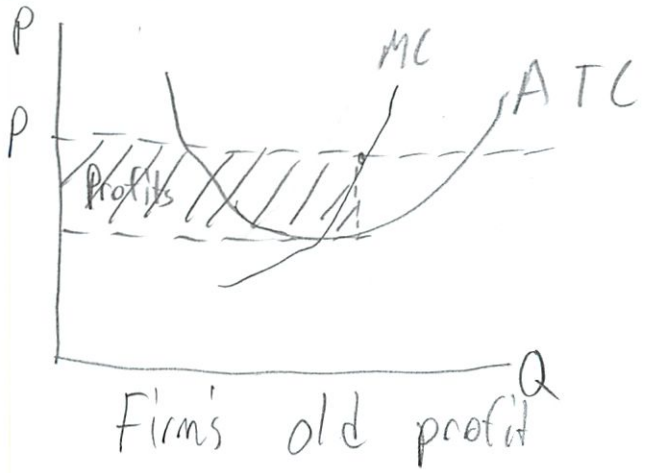
ii) Impose a tax of $P - ATC(Q^*)$ ← previous profit maximizing output

Are the 2 options the same?

No. Option 1 is far better, because first in long run competitive economies there are no profit. Second option 2 would raise the cost of production above competive market price and the firm would sell 0 units, causing it to lose its fixed costs as well as profits, since revenue would be 0. It would be forced to leave the industry. The first option would be much better, at least it could break even and try to make at least an accounting poofit next year

(2)

b Answered above.



Firm's old profit

Long Run Market Supply

Firm under option ii

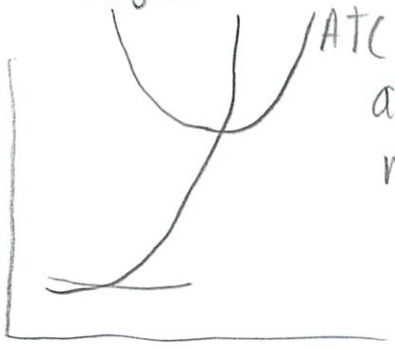
← would prefer to sell no products in long run

c) ATC(5) = 12

ATC(4) = 8 ← If costs double, the same amount is not necessarily still profit maximizing (1)

The ATC curve ↑

and the marginal cost curve is steeper.



but still intersects at same q - which (1) may be profit maximizing but may not be profitable

(3)

Also need to check shut down condition

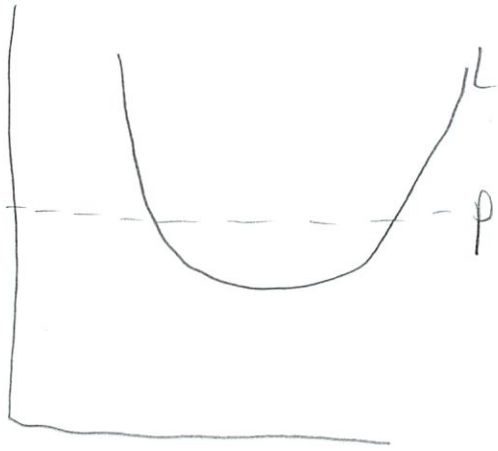
$P < AVC$.

Does not appear to be reached here

2. Assume a downward sloping or flat demand curve

U shaped LRAC

a) Does the firm have the cost minimizing amt of capital given its output curve. Should it increase capital levels given its output?



↳ flat demand curve for a particular firm's product since totally elastic

b) Does the firm have profit maximizing level of output given its amt of capital ↑. Should it ↑ ↓ amt of capital?

So more capital would ↓LRAC
less " " ↑SRAC

Output want MR = MC

4

i) SRAC > LRAC , SRMC > LRMC , MR = SRMC

↑ capital is important to the business

↑ adding capital does ↓ cost of producing good, no change in k

↑ producing proper amt of goods in short run

ii) SRAC > LRAC , SRMC < LRMC , MR = SRMC

↑ capital important to business

↑ adding capital increases cost, perhaps cut back on k

↑ producing proper output

decreasing capital in ~~short~~ run — ✓

iii) SRAC < LRAC , SRMC > LRMC , MR = SRMC

↑ costs will go up in future, perhaps shut down or produce more in LR, less k

↑ adding capital ↓ cost of producing good, no change in k

↑ producing proper SR output

X-4 impossible

iv) SRAC > LRAC , SRMC > LRMC , MR > SRMC

↑ capital is important to biz

↑ adding capital decreases cost ✓ good ~~+~~ no change

↑ could increase SR output ✓

v) SRAC > LRAC , SRMC = LRMC , MR > SRMC

↑ capital important to biz

↑ adding production, k does not ↓ MC Constant econ of scale

increase production ← at constant econ of scale ✓

(5)

vi) SRAC = LRAC , SRMC = LRMC , MR > SRMC

↑ capital does nothing to make production cheaper

↑ constant econ of scale

↑ could increase production

Capital increase

−1

vii) SRAC = LRAC , SRMC > LRMC , MR = SRMC

↑ capital does nothing to make production cheaper

↑ adding capital does ↓ marginal cost

↑ proper output

how does this reconcile?

I think this is impossible ✓

If LRMC < SRMC than SRAC ≠ LRAC

Slopes do not = so lines are not identical

viii) SRAC = LRAC , SRMC = LRMC , MR = SRMC

↑ adding capital does not help - Constant returns to scale

↑ ↑ proper level of output ✓

(6)

3. Suppose widget cost function each firm

$C_s(y) = \frac{1}{3}y^3 + 2$ 100 producers

Demand for widgets

$Y_d(p) = \frac{6400}{p^{1/2}}$

a) Short run industry supply function for widgets

Sum the quantities of each firm

$100\left(\frac{1}{3}y^3 + 2\right)$

b) Obtain the short run equilibrium price of widgets and output of widgets from each firm

Firm produces at MR = MC

$\frac{1}{100} \cdot p \cdot \frac{6400}{p^{1/2}} = \frac{1}{3}y^3 + 2$

$\frac{1}{100}p \cdot \frac{6400}{p^{1/2}} = \frac{1}{3}\left(\frac{6400}{p^{1/2}}\right)^3 + 2$

Solve for p

$p = 36.953$ and TI took 2 min - likely wrong

Get MR

$R = p \cdot \frac{6400}{p^{1/2}}$ 1/100 is 1/100 for each firm

$\frac{1}{100}p \cdot \frac{6400}{p^{1/2}}$

$MR = \frac{\partial R}{\partial p} = \frac{3200}{\sqrt{p}} = \frac{32}{\sqrt{p}}$

6

$MC = \frac{1}{3} \cdot 3y^2 + 0$

$MC = y^2$

$y = \frac{1}{100} \cdot \frac{6400}{p^{1/2}}$

$\frac{32}{\sqrt{p}} = \left(\frac{64}{\sqrt{p}}\right)^2$

solve for p

$p = 16384$ still wrong

$MC = y^2 \cdot$ ~~# items~~

cost per item
$C(y)$

Or do we need $P(y)$

Want $p = MC$

$\uparrow$ *$p \leq MR$ for firm.

$y = \frac{6400}{\sqrt{p}}$

$y\sqrt{p} = 6400$

$\sqrt{p} = \frac{6400}{y}$

$p = \frac{40960000}{y^2}$

(8)

$$\frac{40\,960\,000}{Y^2} = Y^2$$

solve for Y^2

$$40\,960\,000 = Y^4$$

$\boxed{Y = 142}$ market demand

$$142 = \frac{6400}{\sqrt{P}}$$

$$142\sqrt{P} = 6400$$

$$\sqrt{P} = 45$$

$P = 2031$ ← still not reasonable

Cost ~~$= \frac{1}{3}(142)^3 + 2$~~

Cost ~~$= 954431$~~ ← not reasonable

Well each produces 1.42

$= \frac{1}{3}(1.42)^3 + 2$

$= 2.95$ firm cost

this problem does not add up!

Or is the price → just keep as P

$P = MC$

$P = y^2$ ← each firm

$Y = \sqrt{P}$ ←

market

$Y = 100\sqrt{P}$

(9)

b) Obtain SR =librium

$$100\sqrt{p} = \frac{6400}{\sqrt{p}}$$

Solve for p

$p = 64$ ✓

$Y_{D_{market}} = \frac{6400}{\sqrt{64}} = 800$

$Y_{S_{Market}} = 100\sqrt{64} = 800$

$Y_{S_{firm}} = \sqrt{64} = 8$

$Y_{profit_{Firm}}$ $8 - 8 = 0$ Long run break even ✓

So what did I do wrong at first?
confusing total revenue
assuming p must be function of y
* Calculate price produces will charge, then see what demand is *

(10)

4. Sebastian owns a coffee factory (Review from last week)

$$F(k;L) = Q = (k-1)^{1/4} L^{1/4}$$

Cost capital $= r$
Wage $= \ell$

All inputs variable
No fixed cost

a) MRTS Labor for capital

$$MP_L = \frac{\partial F}{\partial L} = \frac{1}{4} L^{-3/4} (k-1)^{1/4} = \frac{(k-1)^{1/4}}{4 L^{3/4}}$$

$$MP_k = \frac{\partial F}{\partial k} = \frac{1 \; L^{1/4}}{4 (k-1)^{3/4}}$$

$$MRTS = \frac{MP_L}{MP_k} = \frac{\frac{(k-1)^{1/4}}{4 L^{3/4}}}{\frac{L^{1/4}}{4 (k-1)^{3/4}}}$$

$$= \frac{(k-1)^{1/4}}{4 L^{3/4}} \cdot \frac{4 (k-1)^{3/4}}{L^{1/4}}$$

$$= \frac{(k-1)^{1/4} (k-1)^{3/4}}{L^{3/4} \cdot L^{1/4}} = \frac{k-1}{L}$$

(11)

b) What are his input demands - conditional on q

Treat w and r as parameters

isoquant

slope $= \frac{K-1}{L}$

So $q = 5$

$K = 0 \quad L = X$
$K = 1 \quad L = X$
$K = 2 \quad L = 625$
$K = 3 \quad L = 312.5$
$K = 4 \quad L = 208$
$K = 5 \quad L = 156$
$K = 6 \quad L = 125$
$K = 7 \quad L = 104$
$K = 8 \quad L = 89$
⋮ etc

Want $K(Q)$ and $L(Q)$

$Q = (K-1)^{1/4} L^{1/4}$

$\frac{Q}{L^{1/4}} = (K-1)^{1/4}$

$\frac{Q^4}{L} = K-1$

(12)

$$k = \frac{Q^4}{L} + 1$$

$$Q = (k-1)^{1/4} L^{1/4}$$

$$\frac{Q}{(k-1)^{1/4}} = L^{1/4}$$

$$L = \frac{Q^4}{k-1}$$

With cost (need to include r, w)

$$C = Lr + kr$$

But what does qv want? His isoquant? Isocost?

Want the optimal pt at each q (isocost = isoquant)

$$MRTS = \frac{MP_L}{MP_K} = \frac{w}{r}$$

$$\frac{k-1}{L} = \frac{w}{r}$$

$$\frac{\frac{(k-1)^{1/4}}{4L^{3/4}}}{w} = \frac{\frac{L^{1/4}}{4(k-1)^{3/4}}}{r}$$

$$k - 1 = \frac{wL}{r}$$

$$k = \frac{wL}{r} + 1$$

$$\frac{(k-1)r}{w} = L$$

$$L = \frac{(k-1)r}{w}$$

think that's right now

in 14.01 just putting # together

(13)

Combine both L, k's from isoquant iso cost to find optimal w/ cost of factors

$$Q^4 = (k-1)\,L$$

$$Q^4 = \frac{w}{r} L^2$$

$$Q^4 = (k-1)^2 \frac{r}{w}$$

see back for math

$$L = \sqrt{\frac{r}{w}}\, q^2 \qquad k = \sqrt{\frac{w}{r}}\, q^2 + 1$$

c) Show long run cost function

$$C = wL + rk = w\left(\sqrt{\frac{r}{w}}\, Q^2\right) + r\left(\sqrt{\frac{w}{r}}\, Q^2 + 1\right)$$

$$= \sqrt{rw}\, Q^2 + \sqrt{rw}\, Q^2 + r$$

$$= 2\sqrt{rw}\, Q^2 + r$$

d) What is the supply function of his firm?

$Q_S = ?$

$MR = MC = P$

Since perfectly competitive

$$\begin{cases} P = MC & P < MC \\ P = AVC = AC & P > MC \end{cases}$$

$$Q^4 = (k-1)^2 \frac{r}{w}$$

$\wedge 1/2 \quad \wedge 1/2 \quad \wedge 1/2$

$$Q^2 = (k-1)\sqrt{\frac{r}{w}}$$

$$Q^2 = k\sqrt{\frac{r}{w}} - \sqrt{\frac{r}{w}}$$

$$k\sqrt{\frac{r}{w}} = Q^2 - \sqrt{\frac{r}{w}}$$

$\cdot\sqrt{\frac{w}{r}} \quad \cdot\sqrt{\frac{w}{r}} \quad \cdot\sqrt{\frac{w}{r}}$

$$k = Q^2\sqrt{\frac{w}{r}} + 1$$

$$Q^4 = \frac{w}{r}L^2$$

$\wedge 1/2 \quad \wedge 1/2 \quad \wedge 1/2$

$$Q^2 = \sqrt{\frac{w}{r}}\,L$$

$$L = \frac{Q^2}{\sqrt{\frac{w}{r}}}$$

$$L = Q^2 \cdot \sqrt{\frac{r}{w}}$$

(14)

$$MC = \frac{\partial C}{\partial Q} = 2q\,2(wr)^{1/2}$$

$$\begin{cases} 0 & p > AC \\ p = 4q\sqrt{wr} & p < MC \\ p = \dfrac{r + 2\sqrt{wr}\,q^2}{q} & MC < p < AC \end{cases}$$

over →

e) $r = 4$, $w = 1$

$Q_d = 20 - p$

7 firms

Aggregate supply long run

- must consider firms dropping out
- none do here

$$Q_{Market} = 7\left(\frac{p}{4\sqrt{wr}}\right)$$

$$= \frac{7p}{8}$$

f) equilibrium

$$20 - p = \frac{7}{8}p$$

$$p = ?$$

$$p = 10.66\overline{6}$$

Want in terms of q

$$q = \begin{cases} 0 & p > AC \\ \frac{p}{4\sqrt{wr}} & p < MC \\ \dots & MC < p < AC \\ 2 & \end{cases}$$

$$qp = r + 2\sqrt{wr}\,q^2$$

$$qp - 2\sqrt{wr}\,q^2 = r$$

$$-2\sqrt{wr}\,q^2 + qp - r = 0$$

solve for p

w, r constants

(15)

market $\begin{cases} Q_D = 20 - 10.667 = 9.33 \text{ widgets} \\ Q_S = \frac{7}{8}(10.667) = 9.33 \text{ widgets} \end{cases}$

$Q_{S\,firm} = \frac{1}{7} \cdot 9.33 = \frac{4}{3}$ widget

Profit of firm

$R = \frac{4}{3} \cdot 10.667 = 14.22$

$C = r + 2(wr)^{1/2} q^2$

$4 + 2\sqrt{4 \cdot 1} \cdot \left(\frac{4}{3}\right)^2$

$= 11.11$

Cool how # work out

Profit = \$14.22 − \$11.11 = \$3.11

g) Firms will want to enter the industry because there are profits to be made, even only selling $\frac{4}{3}$ products. Firms will enter the industry until long run profits are 0

$\frac{1}{n} \cdot 9.33 \cdot 10.667 - 4 + 4\left(\frac{1}{n} \cdot 9.33\right)^2 = 0$

$n = 4.20$ Firms

4.97 4.87 ✓

Remember firms can't change demand, price

20 firms kinda weird - all making .4b a product

(16) kinda did this already

h) What will price be in the long run?

No - will change! Induced demand

$$\frac{1}{n} \cdot Q \cdot P - 4 + 4\left(\frac{1}{n} \cdot Q\right)^3 = 0$$

$$20 - P = n\frac{P}{4\sqrt{wr}} = \frac{nP}{8}$$

Solve for $P(n, w, r)$

Get Q

$$20 - P = \frac{nP}{8}$$

$$160 - 8P = nP$$

$$160 = nP + 8P$$

$$160 = P(n+8)$$

$$P = \frac{160}{n+8}$$

$$Q = 20 - P$$

$$= 20 - \frac{160}{n+8}$$

$$\frac{1}{n} \cdot \left(20 - \frac{160}{n+8}\right) \cdot \frac{160}{n+8} - 4 + 4\left(\frac{1}{n} \cdot \left(20 - \frac{160}{n+8}\right)\right)^2 = 0$$

$n = 1.76$ firms

? no profits in industry

-6

check solution

(17)

$$P = \frac{160}{n+8} = \frac{160}{1.76+8} = 16.39$$

$$Q = 20 - P$$

$$= 3.60$$

again really cool how # work out
make sure ⇔ know what every step is + can do

14.01 Fall 2010

Problem Set 5

Due in class on October 22

1. You manage a factory that produces cans of peanut butter. The current market price $10/can, and you know the following about your costs:
MC(5) = 10, ATC(5) = 6
MC(4) = 4, ATC(4) = 4

a. A case of food poisoning breaks out due to your peanut butter, and you lose a lawsuit against your company. As punishment Judge Judy decides to take away all of your profits and considers the following two options to be equivalent:
i. Pay a lump sum in the amount of your profits
ii. Imposing a tax of $ [P -ATC (q*)] /can since that is your current profit per can, wher q*is the profit maximizing output before the lawsuit.

Explain briefly why she is right or wrong.
You maximize profits where p =mc, and since p= 10 =mc (5) you would set q=5. π/q = (p -atc) = (10 -6) = 4. The tax would be $4/can.*

Judge Judy is wrong because the tax will shift your marginal cost curve up by 4, while the lump sum does not change the marginal cost curve. Since the profit maximizing firm sets p=mc, a tax will cause you to reduce your output and your average total cost at thi new output will be lower than $ATC_t(5) = 6+4 = 10$.

b. Judge Judy gives you the option of choosing either plan. Which plan would you choose? Provide intuition. Hint: a clear diagram may be helpful.

The lump sum transfer will result in a $\pi = 0$.
With the tax, $mc_t(4) = 8$ and since $p= 10 > 8$, this implies that the optimal q_t is such tha $4 < q_t < 5$. We also know that $8 < atc_t(q_t) < 10$ since average total cost also shifts up by This implies $\pi_t = q_t (p - atc_t) > 0$.
Intuition: since we know that mc (4) =atc (4), the average total cost is minimized at q = both with and without the tax. By imposing a $4/can tax, the firm reduces its quantity from 5 to q_t, which decreases average total cost. (p -atc) or the profit/can increases, so that the firm is still making positive profits despite the $4/can tax.
You would prefer to have the tax plan.

c. In the following year, you finally pay off the court ordered amount and everything returns to normal. However, an employee tells you that at current levels of production, actual costs are double what you initially thought. After carefully looking at the cost information, you decide to continue producing the exact same amount. Could you still l maximizing profits?

Yes, the increase in costs could be completely due to fixed costs. This would not affect your behavior in any way in the short run. However in the long run, since $\pi = q (p - atc)$ 5 (10 -12) = -10 < 0, you would exit in the long run.

2. Assume downward sloping or flat demand and a U-shaped LRAC curve. In each of the following situations, determine graphically and/or verbally:

a) Does the firm have the cost-minimizing amount of capital given its output level? If not, should the firm increase or decrease its amount of capital given its output?

b) Does the firm have the profit maximizing level of output given its amount of capital? If not, should the firm increase or decrease its level or output, given its capital?
If the situation is impossible, state why.

i) $SRAC > LRAC, SRMC > LRMC, MR = SRMC$

ii) $SRAC > LRAC, SRMC < LRMC, MR = SRMC$

iii) $SRAC < LRAC, SRMC > LRMC, MR = SRMC$

iv) $SRAC > LRAC, SRMC > LRMC, MR > SRMC$

v) $SRAC > LRAC, SRMC < LRMC, MR > SRMC$

vi) $SRAC = LRAC, SRMC = LRMC, MR > SRMC$

vii) $SRAC = LRAC, SRMC > LRMC, MR = SRMC$

viii) $SRAC = LRAC, SRMC = LRMC, MR = SRMC$

First, it is to be understood that capital input is here regarded as the fixed costs—fixed in the short run, that is. The two questions for each case come down to your judgment in the short term and long term.

i) $SRAC > LRAC, SRMC > LRMC, MR = SRMC$ $MR = SRMC$ shows that the firm is at an output level that maximizes the profit, given its capital in the short term. However, because $SRMC > LRMC$ and $SRAC > LRAC$, the amount of capital is not optimized to minimize costs at the present output level. The firm should increase its capital input in the long run so as to move cost curves to the right.

ii) $SRAC > LRAC, SRMC < LRMC, MR = SRMC$ Similar to above in the short run. But now $SRMC < LRMC$, which means that the cost curves are to the left of optimum. Capital input must be decreased in the long run to shift costs to the left.

iii) $SRAC < LRAC, SRMC > LRMC, MR = SRMC$ Impossible: $SRAC$ is always greater than $LRAC$.

iv) $SRAC > LRAC, SRMC > LRMC, MR > SRMC$ The output is not optimized even in the short run, because $MR > SRMC$. The output should be increased to maximize profit in the short run. Long run decision regarding capital is the same as i).

v) $SRAC > LRAC, SRMC < LRMC, MR > SRMC$ The output is not optimized even in the short run, because $MR > SRMC$. The output should be increased to maximize profit in the short run. Long run decision regarding capital is the same as ii). Graphically, this means that SRAC curve should move to the left along LRAC, to which it runs tangent at optimum output level.
(Note: Please give full credit if the student interprets the question as asking whether output is optimal not holding capital fixed and answers that the optimal capital investment is ambiguous.)

vi)$SRAC = LRAC, SRMC = LRMC, MR > SRMC$ $SRAC = LRAC$ means that the capital input is most appropriate for the given output level in the long run. However, since $MR > SRMC$, the given output

level is lower than it should be to maximize profit, so y needs to be increased in the short run to $y*$, causing $SRAC* > LRAC*$, and $SRMC* > LRMC*$. This means that $SRAC$ curve must shift to the right to reestablish the equilibrium between $SRAC$ and $LRAC$. So an injection of capital is required in the long run, and output will be increased.

vii) $SRAC = LRAC, SRMC > LRMC, MR = SRMC$ Impossible. Where $SRAC = LRAC$ and $MR = SRMC$, $SRMC$ must equal $LRMC$.

viii) $SRAC = LRAC, SRMC = LRMC, MR = SRMC$ The company reaches the optimum level in both long run and short run.

3. Suppose, in the short-run, output of widgets is supplied by 100 identical competitive firms, each having a cost function:

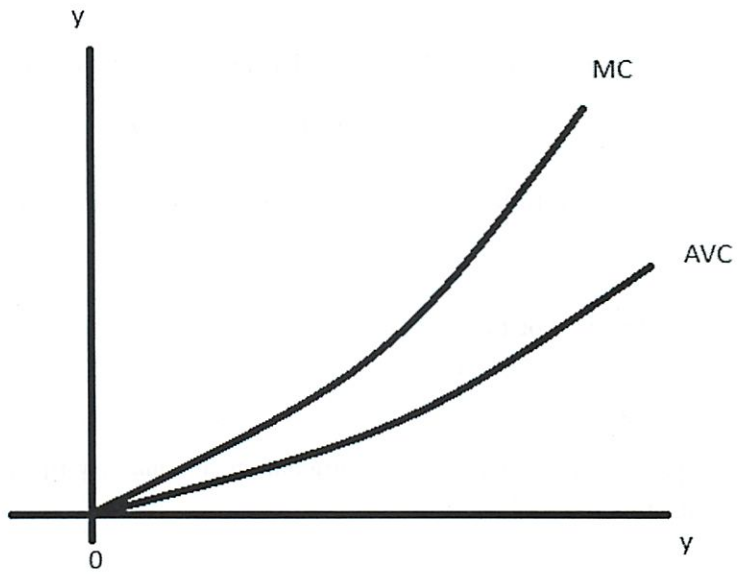
$$c_s(y) = \frac{1}{3}y^3 + 2$$

The demand for widgets is given by:

$$y_d(p) = 6400/p^{\frac{1}{2}}$$

(a) Obtain the short-run industry supply function for widgets.

Since $P = MC = y^2$, the supply function of each firm is given by $y = p^{\frac{1}{2}}$. In the figure below, $MC = y^2$ and


y
MC
AVC
0
y

The industry supply function is $y^s(p) = 100y_i^s(p) = 100p^{\frac{1}{2}}$.
(b) Obtain the short-run equilibrium price of widgets, and the output of widgets supplied by each firm.

$Y^s = Y^d \Longrightarrow 100p^{\frac{1}{2}} = \frac{6400}{p^{\frac{1}{2}}} \Longrightarrow p = 64$. Hence $y^* = 100 \cdot 8 = 800$ and $y_i = 8$. Finally, p*=64.

3. Sebastian owns a coffee factory in Argentina. His production function is:

$$F(K, L) = (K-1)^{\frac{1}{4}} L^{\frac{1}{4}}$$

Consider the cost of capital to be r and the wage to be w. Both inputs are variable, and Sebastian faces no fixed costs.

a) What is the MRTS of labor for capital?

$MRTS = MP_L/MP_K = (K-1)/L$

b) What are Sebastians input demands, conditional on the quantity (q) he wants to produce? [Hint: Treat w and r as parameters.]

Optimality Conditions:
$\frac{K-1}{L} = \frac{w}{r}$
$q = (K-1)^{1/4} L^{1/4}$
Lead to Conditional Demand Functions:
$L^d = (\frac{r}{w})^{1/2} q^2$
$K^d = (\frac{w}{r})^{1/2} q^2 + 1$

c) Show that Sebastians long run cost function is $C(q) = r + 2(wr)^{\frac{1}{2}} q^2$.
$C(q) = wL^d + rK^d = w(r/w)^{1/2} q^2 + r[(w/r)^{1/2} q^2 + 1] = r + 2(wr)^{1/2} q^2$

d) What is the supply function of Sebastians firm?
The inverse supply function for a firm is given by1: $P = MC(q)$, for any q such that $P \geq MinAC(q)$

$P = MinAC$, when $MC = AC$ $4(wr)^{1/2} q = r/q + 2(wr)^{1/2} q$ $q = (r/w)^{1/4}/2^{1/2}$
Therefore, the inverse supply function is $P = 4(wr)^{1/2} q$, for all $q \geq (r/w)^{1/4}/2^{1/2}$.

When $q = (r/w)^{1/4}/2^{1/2}$, $P = 2^{3/2}(wr^3)^{1/4}$, and therefore,Sebatian's supply function is:
$q = P/[4(wr)^{1/2}]$, when $P \geq 2^{3/2}(wr^3)^{1/4}$
$q = 0$, otherwise

Consider now that $r = 4, w = 1$ and that the market demand for coffee is $Q_d = 20 - P$. There are 7 other companies operating in this market, all with cost structures identical to Sebastian's company.

e) What is the aggregate supply in this market?

As shown in (c), $C(q) = r + 2(wr)^{1/2}q^2$ Therefore, $MC = 4(wr)^{1/2}q = 8q$

$MC = 8q$
Inverse Supply of one firm: $P = MC = 8q$, for any q such that $P \geq MinAC$

At $MinAC, MC = AC$
$8q = 4/q + 4q$
$q = 1$
$MinAC = 8$
Inverse Supply of one firm: $P = 8q$, for $q \geq 1$
Supply of one firm: $q = P/8$, for $P \geq 8$ $q = 0$, otherwise
Aggregate Supply: $Q^s = 8 * (P/8) = P$, for $P \geq 8$ $Q^s = 0$, otherwise

f) Calculate the equilibrium price, aggregate quantity sold, quantity sold by each firm and economic profit of each firm?
$Q^s = Q^d$

$P = 20P$
$P = 10$
$Q = 10$
$q = 10/8 = 5/4$
Economic Profit of one firm $= 10 * 5/444 * (5/4)^2 = 2.25$

g) Can this be a long-run equilibrium? Why? How will the supply side of the market adjust in the long-run?
No, because the economic profits of the firms in this market will attract the entry of other firms, until the economic profits are driven to 0.

h) What is going to be the price in the long-run? How many firms will be present in this market in the long-run? How much will each firm produce? In the long run we must have $P = MinAC = 8$

When $P = 8, Q_d = 208 = 12$
As $q = 1$, for $AC = MinAC = 8$, we will need to have 12 firms in this market in the long run, each producing $q = 1$.

Recitation

10/22

PS5 due
P66 out due 10/29

1. Cost minimization (Pset 5 # 2)
2. Competive firm profit maxinization
   - SR =libriun (PS 5 #1+3)
   - LR =libriun (P55 #4)

Deriving Supply Curves

- SR vs LR
  - SR: only some factors variable; no free entry + exit
  - LR: Can vary all costs of production; Free to enter + exit
- firms exist to maximize profits

$$\pi = TR - TC$$

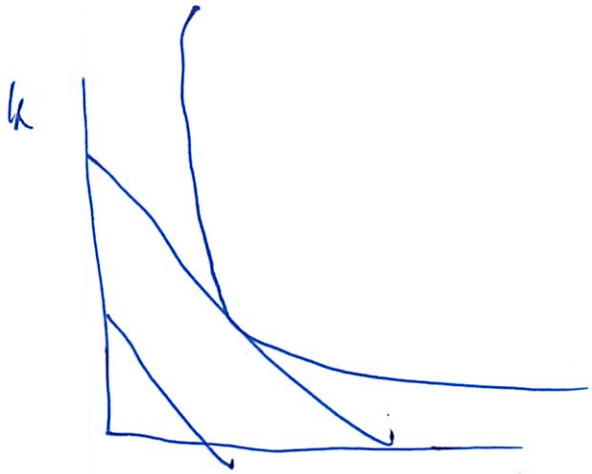
minimize costs by adjusting q and mix of k, L

$$Q = f(L,k)$$

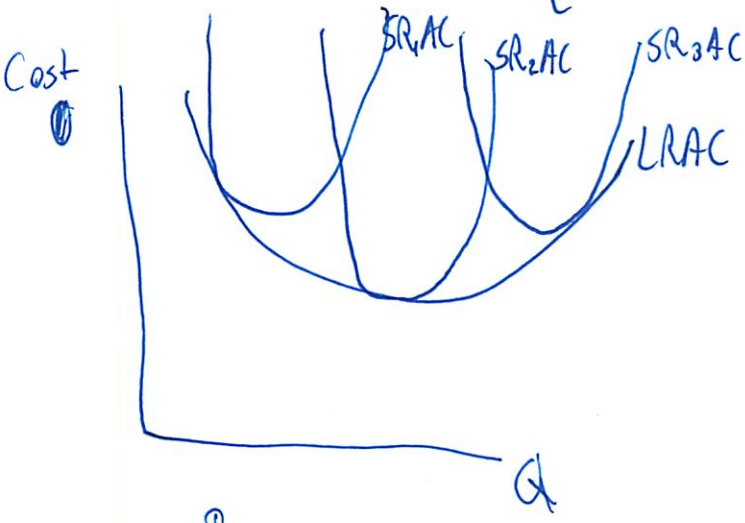
$$C = r \cdot k + w \cdot L$$

- short run
  - firm can not vary k
  - SR costs k fixed, L varries
- long run
  - all inputs variable

(2)



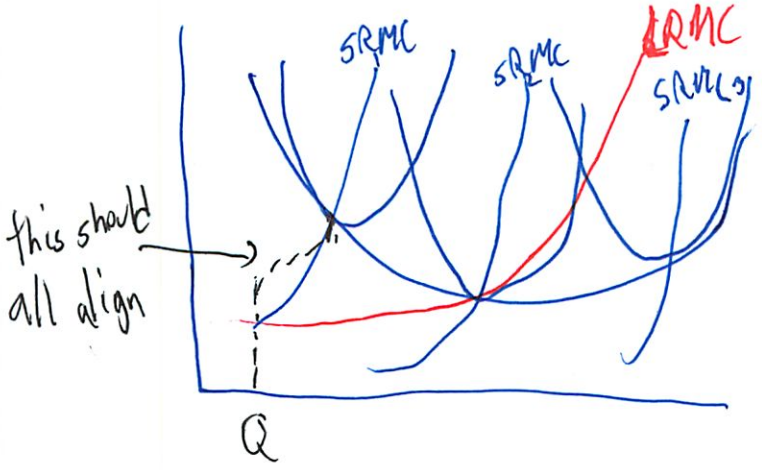
Slope Isoquant = Slope Isocost



Sl, 2, 3 = different plant sizes

↑ TA claims that each represents a diff firm in SR
I think it represents the diff. size plants the firm could build in LR

Will choose output where SRAC = LRAC



$$\frac{d\left(\frac{SRC}{Q}\right)}{dQ} = \overbrace{\frac{d}{dQ}\frac{SRC \cdot Q - SRC}{Q^2}}^{SRMC}$$

$$\frac{d\left(\frac{LRC}{Q}\right)}{dQ} = \overbrace{\frac{d}{dQ}\frac{LRC \cdot Q - LRC}{Q^2}}^{LRMC}$$

③

$$SRMC \cdot Q - SRC = LRMC \cdot Q - LRC$$

$$SRMC - \frac{SRC}{Q} = LRMC - \frac{LRC}{Q}$$

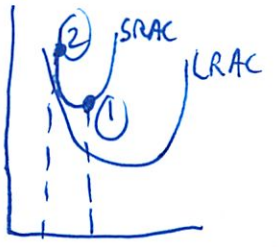
LRAC is continuous since could have any size plant - take the limit ....

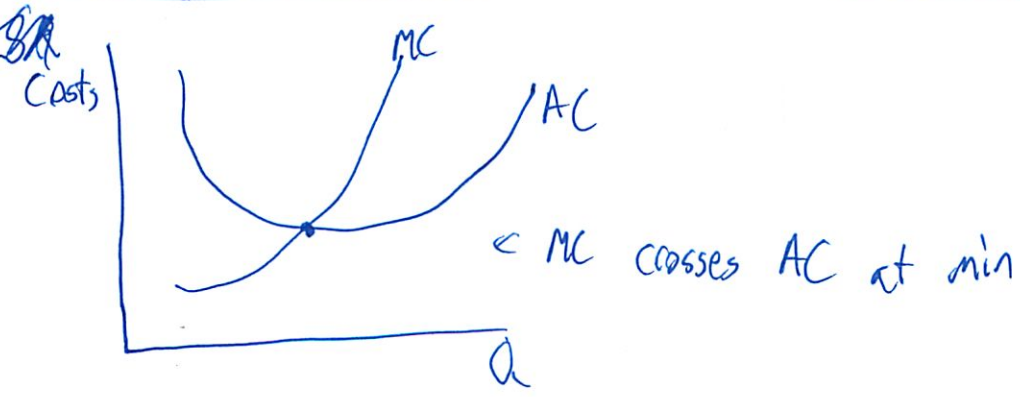
PS 5 #2

- not covered in class + not in textbook
- SRAC = LRAC → SRMC = LRMC
  if, then

① - if SRMC > LRMC → increase capital to another plant

② - if SRMC < LRMC →
SRAC < LRAC → decrease capital to LRC
impossible

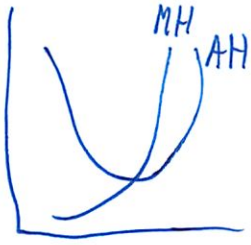


- 

< MC crosses AC at min

(4)

Suppose had room w/ students
- have a bunch of tall students
- have line outside room of short → tall students
  ↳ MC
- so avg height in room ↓
- till get to taller students in line when Avg height ↗



Picking Output Q to maximize profit

How much output to produce to maximize profits?

Set derivative = 0 so MR = MC

$$\frac{d\Pi}{dQ} = \frac{d}{dQ} TR - \frac{d}{dQ} TC$$

$$= 0 \quad \text{at optimal output level}$$

$$= MR - MC = 0$$

$$MR = MC$$

if $MR > MC$ → produce more } until

$TR = P \cdot Q$

(5)

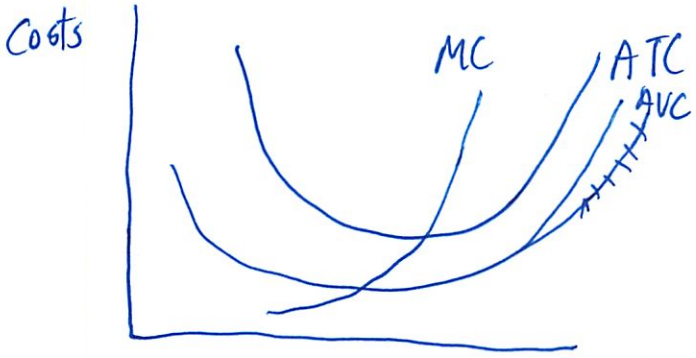
Dealing w/ perfectly competitive firms

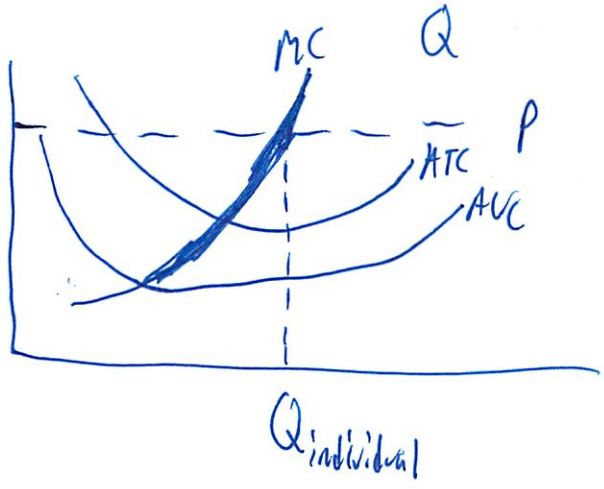
- price takers
- P is fixed

So MR = P

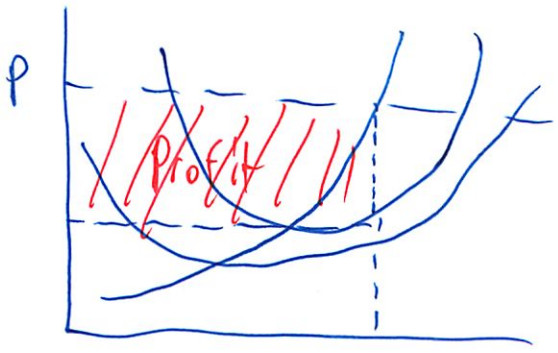
For a perfectly competitive firm

P = MC

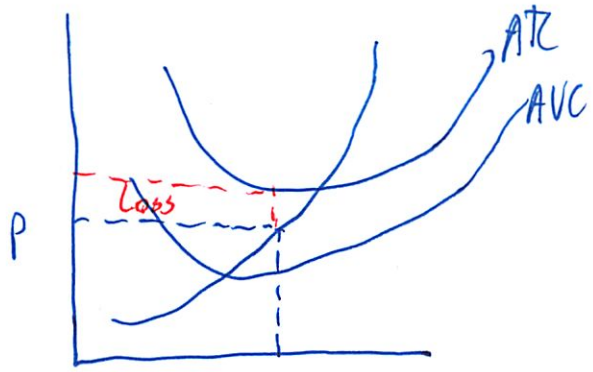




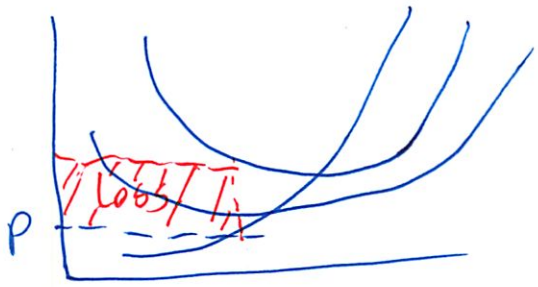
individual firms supply curve is just MC cost except at P < MC



(6)

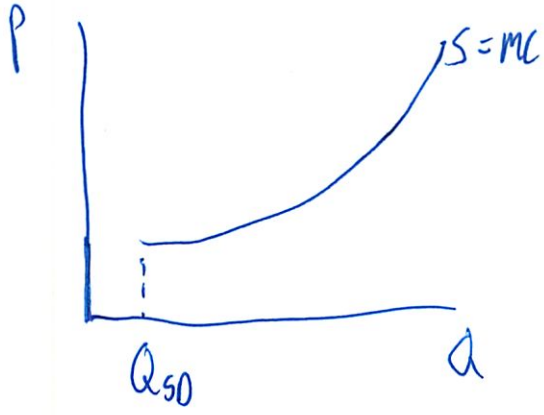


firm making a loss but will stay in biz - fixed cost



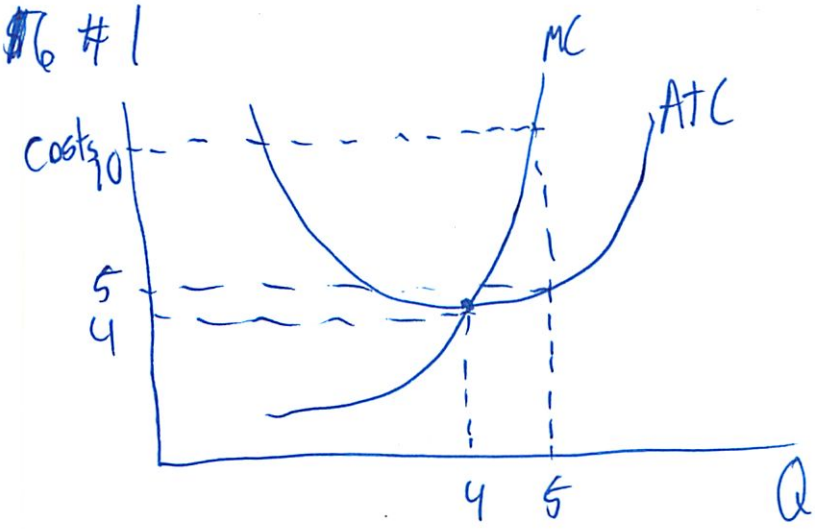
Shut down

firm can not recoupe even variable costs



firms individual supply curve

PS #6 #1



know since MC=ATC this is most efficient point

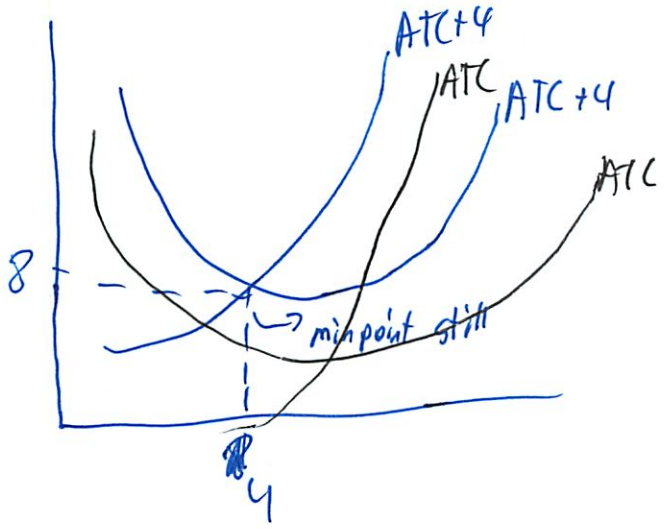
(5)

At $10 → will produce 5

$q^* = 5$ $p = 10$ $ATC(5) = 10$

tax = $4

Tax $4/unit



would produce $4 < x < 5$ where $C = 10$

~~ATC~~ $8 < ATC < 10$

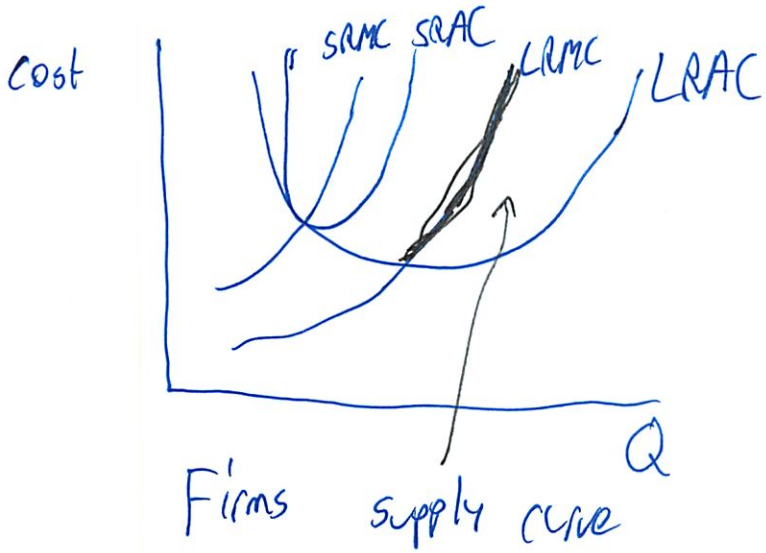
↳ still less than 10

actually still making a profit w/ the tax

↳ opps way wrong

w/ tax still below price

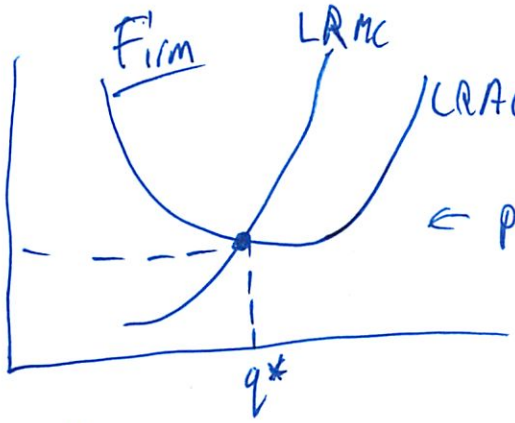
(8) SR and LR



But w/ free entry + exit

↳ firms make 0 economic profit in LR

$\pi = 0$



← price in min of LRAC

LRMC = LRAC

$Q_D = Q_S$

↑ how much output demanded at this price

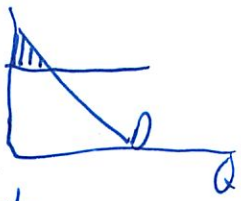
how find total # firms participating

$\#\ \text{Firms} = \frac{Q}{q^*}$

Lecture 13 Welfare Econ

6/1/25

- well-being
- we know what they do - but why?
- Last time: consumer surplus
  - Consumer's WTP > price of good



- Market level: aggregation of every individuals
  - integrate

13-1

price set = to WTP of marginal consumer
- consumer who is indifferent b/w consuming and not consuming
- at that price
- no consumer surplus for that person
- every consumer before that must be getting some consumer surplus

Price increase fig 13-2

Depends on elasticity

fig 13-3

more inelastic = steeper demand curve

" elastic = flatter " "

inelastic - not many substitutes
- if price rises, can't go elsewhere
- higher WTP

(2)

Producers

diff b/w firms marginal willingness to supply and price
↑ supply curve

(easier for producers) for competitive firms = MC

fig 13-4

Now can measure social welfare of society

$SW = CS + PS$

↑ ↑

care about both = 1/4

(alt definitions when talk about efficiency vs equity later)

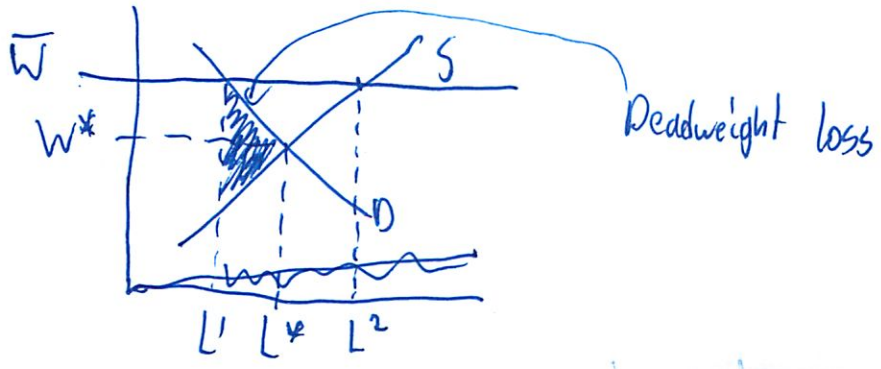
where D=S is welfare maximizing outcome

moving away from pt ↓ social welfare

fig 13-5

Deadweight loss = net reduction in efficiencies which are not made. Surplus/welfare gone. Trade would have made both parties better off - but did not happen due to gov.

- can formally say why min wage ↓ societies' welfare



(3)

At that former equilibrium wage, people are indifferent
Indifferent getting that salary
and firm producing exactly what he is outputing

As min wage ↑, lose consumer surplus
Distortion gets larger as you move away from equilibrium

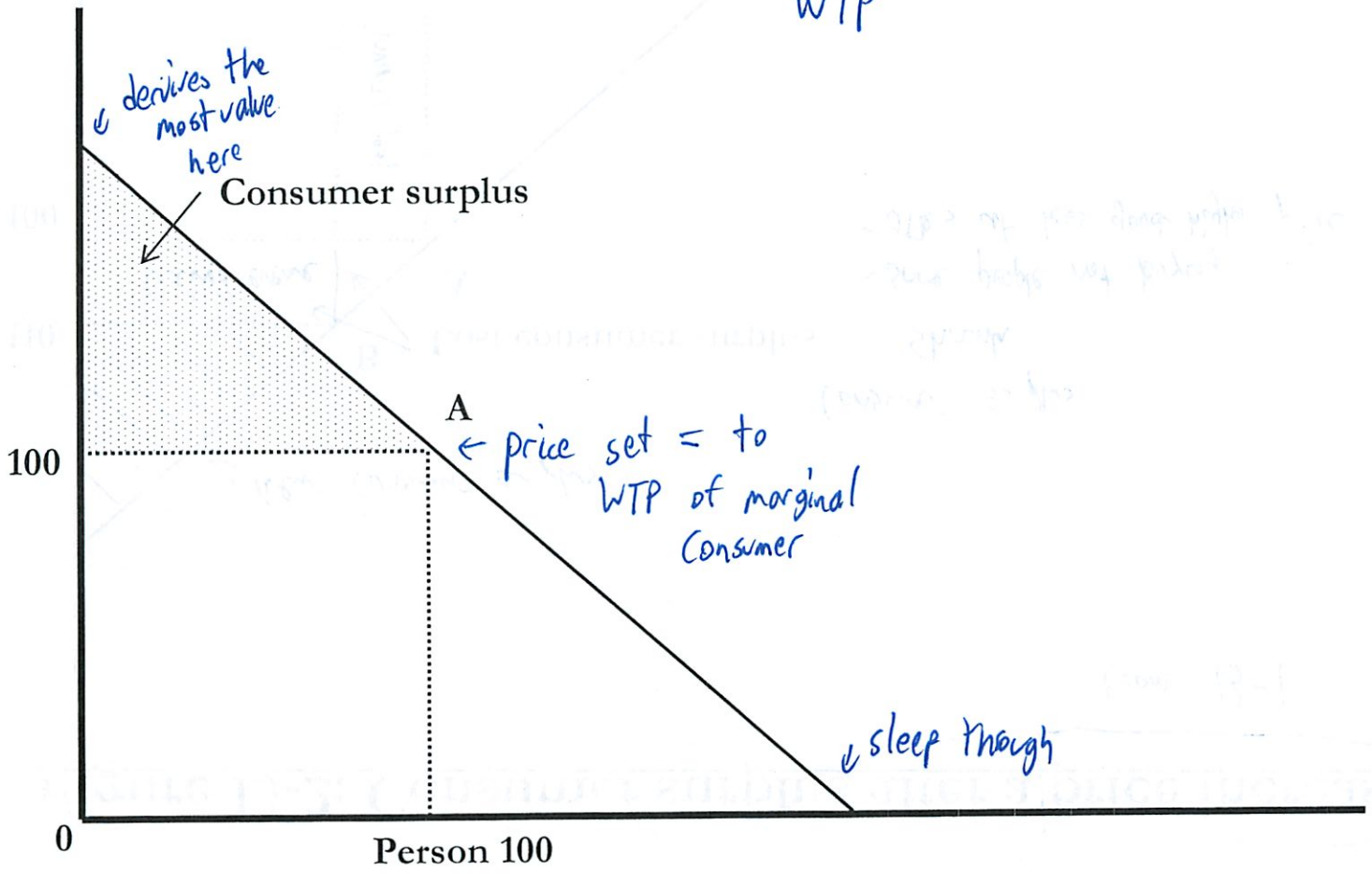
Example Taxi Medallian
Fig 13-6

10/25

Market's

Figure 13-1: Consumer surplus for lectures

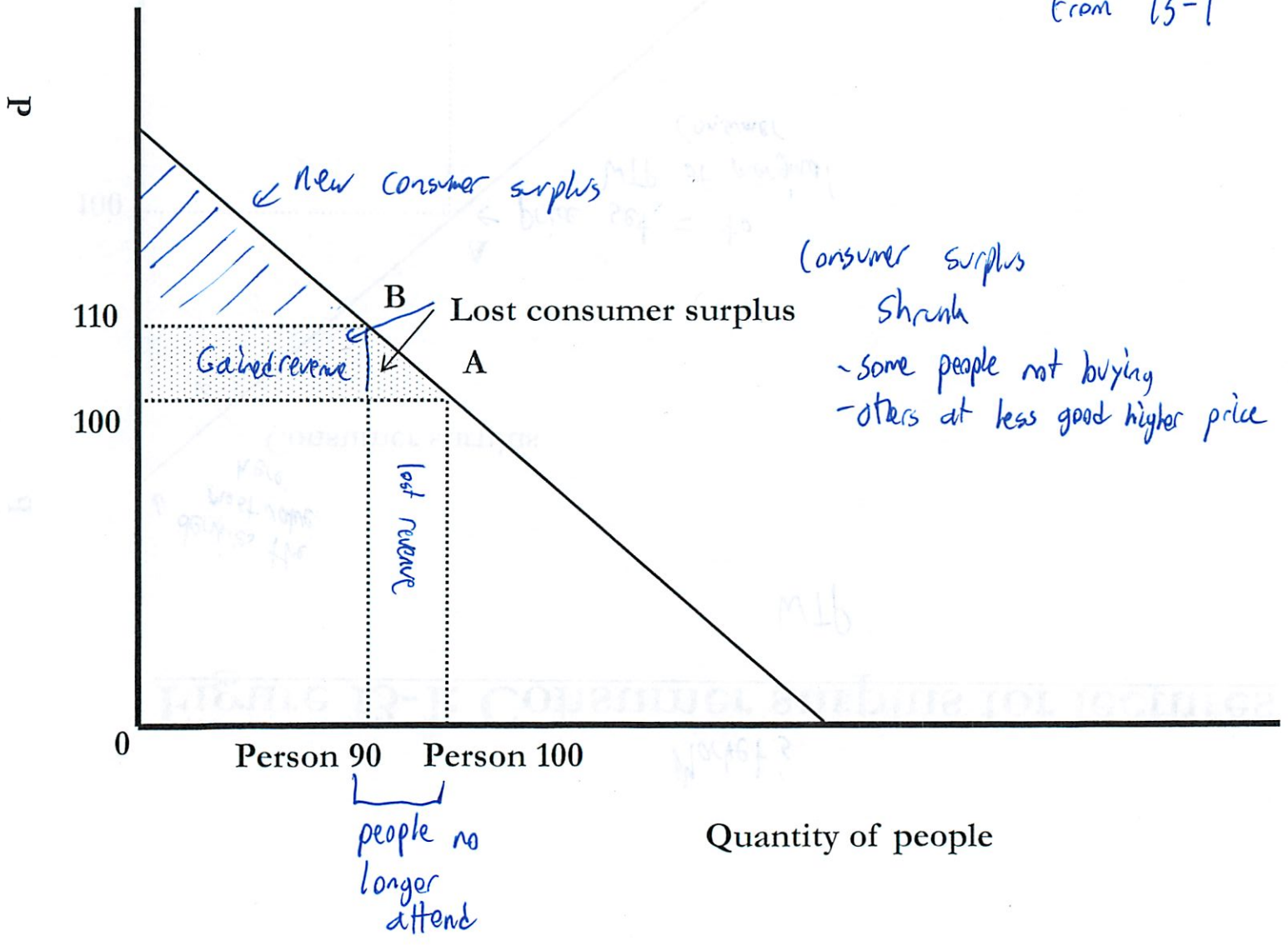
WTP



Lecture 13

Figure 13-2: Consumer surplus after a price increase

From 13-1



Consumer surplus shrink
- some people not buying
- others at less good higher price

Figure 13-3: Consumer surplus and elasticity of demand

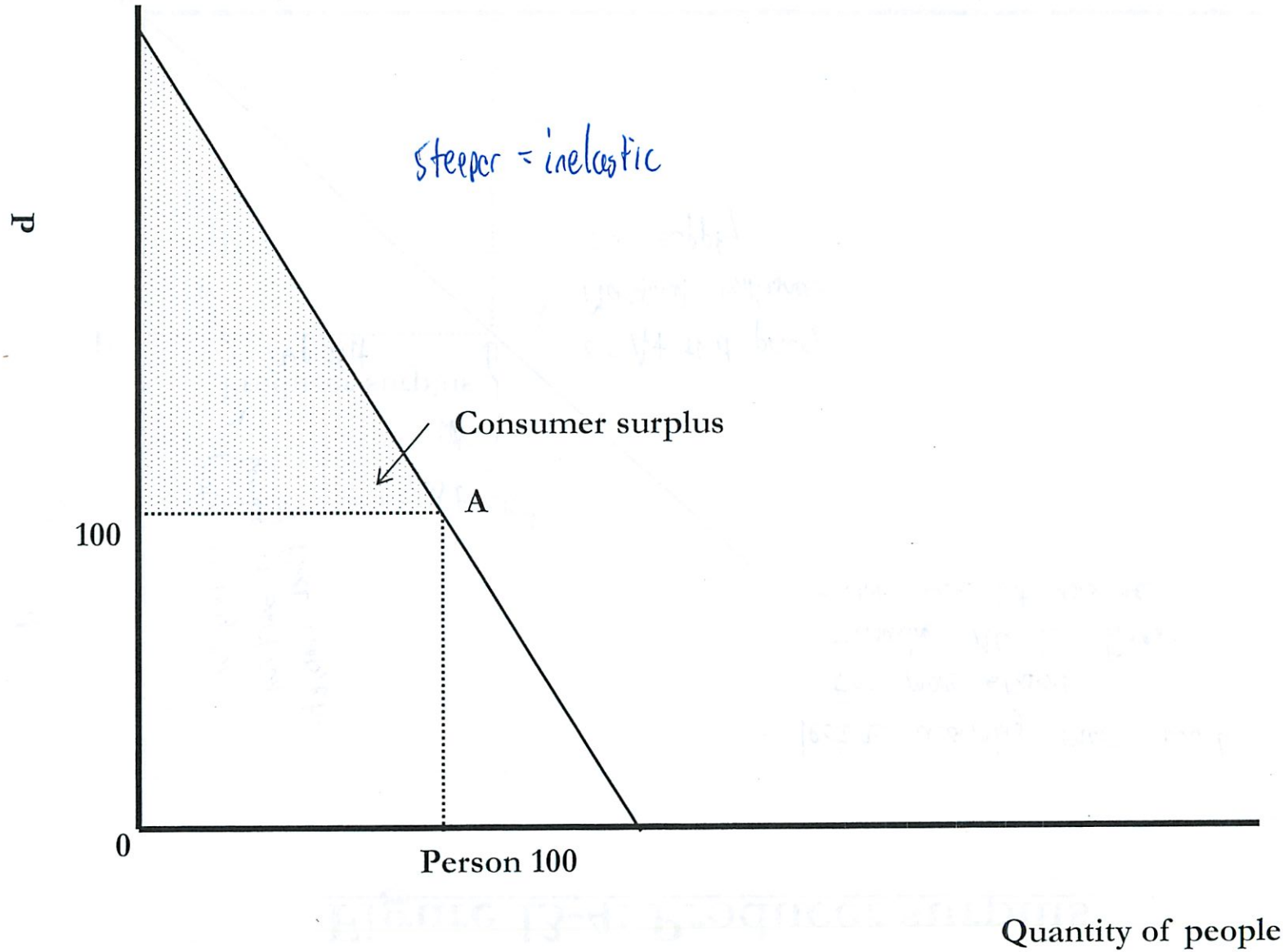


Figure 13-4: Producer surplus

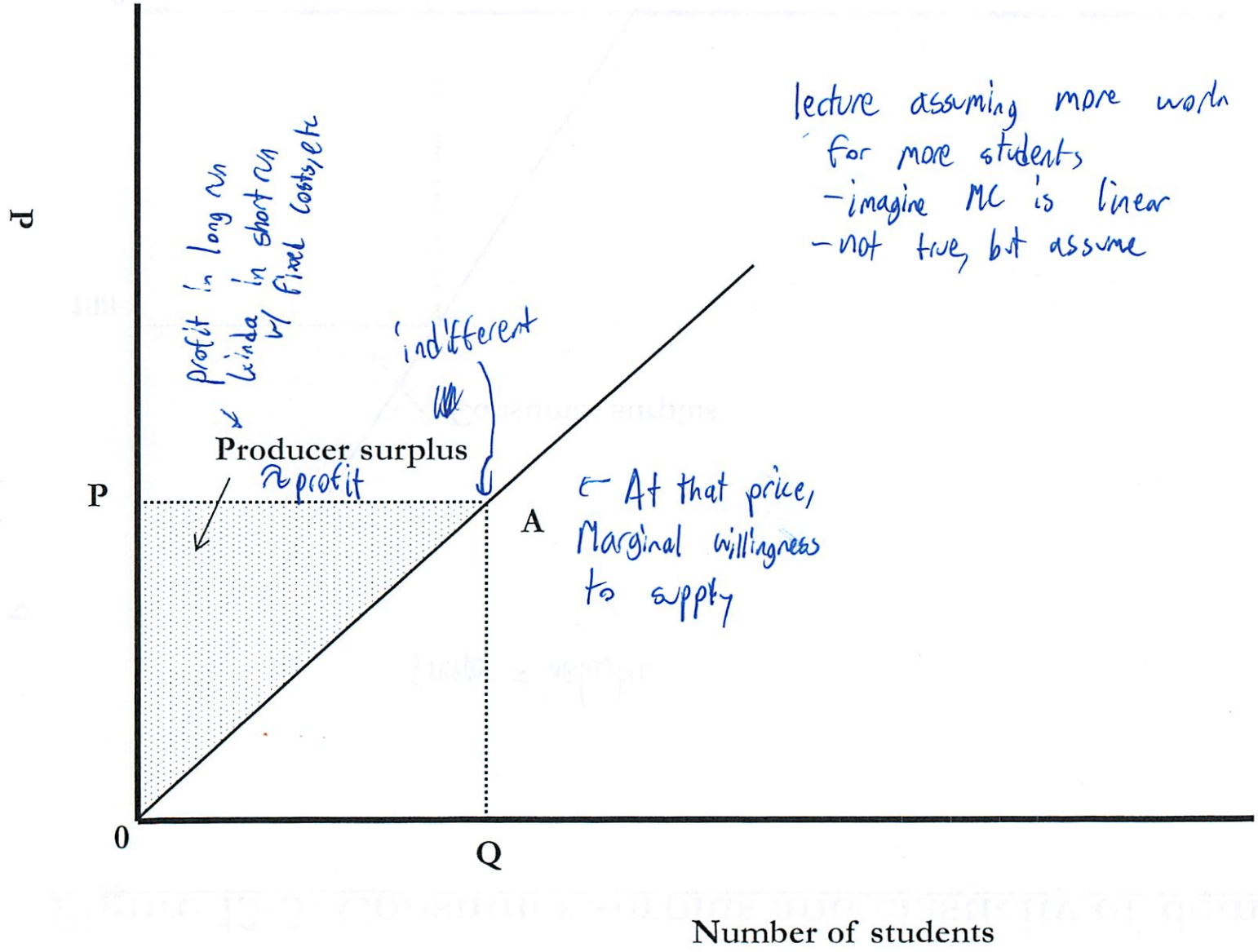


Figure 13-5: Impact of a decrease in output on welfare

Consumer Surplus = R + S + V
Producer Surplus = T + U
No way to make the shaded area better

If gov raises price to p_2
equalibrium p_2, q_2
Consumer Surplus = R
Producer Surplus = T + S
Deadweight loss = V + U

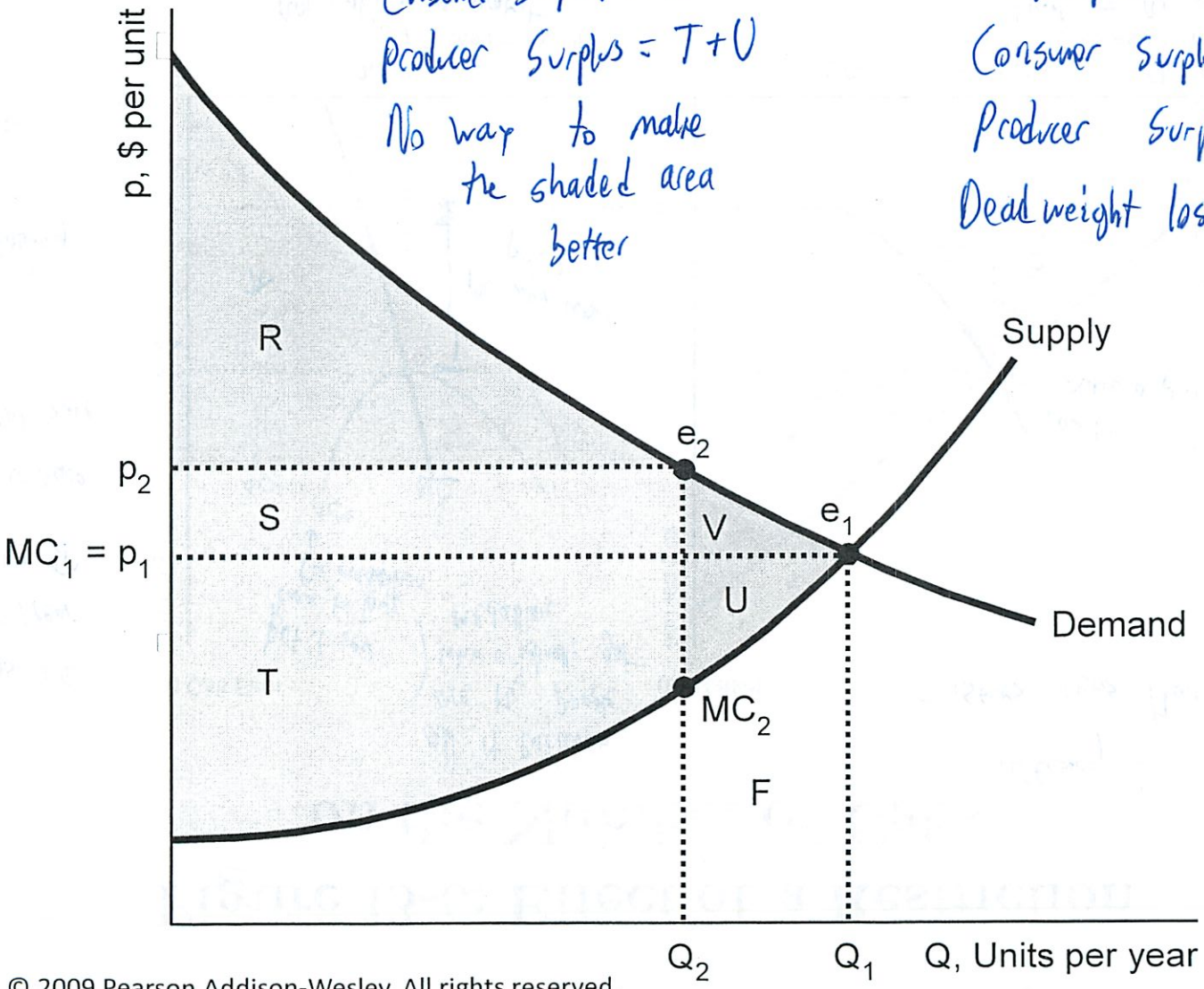
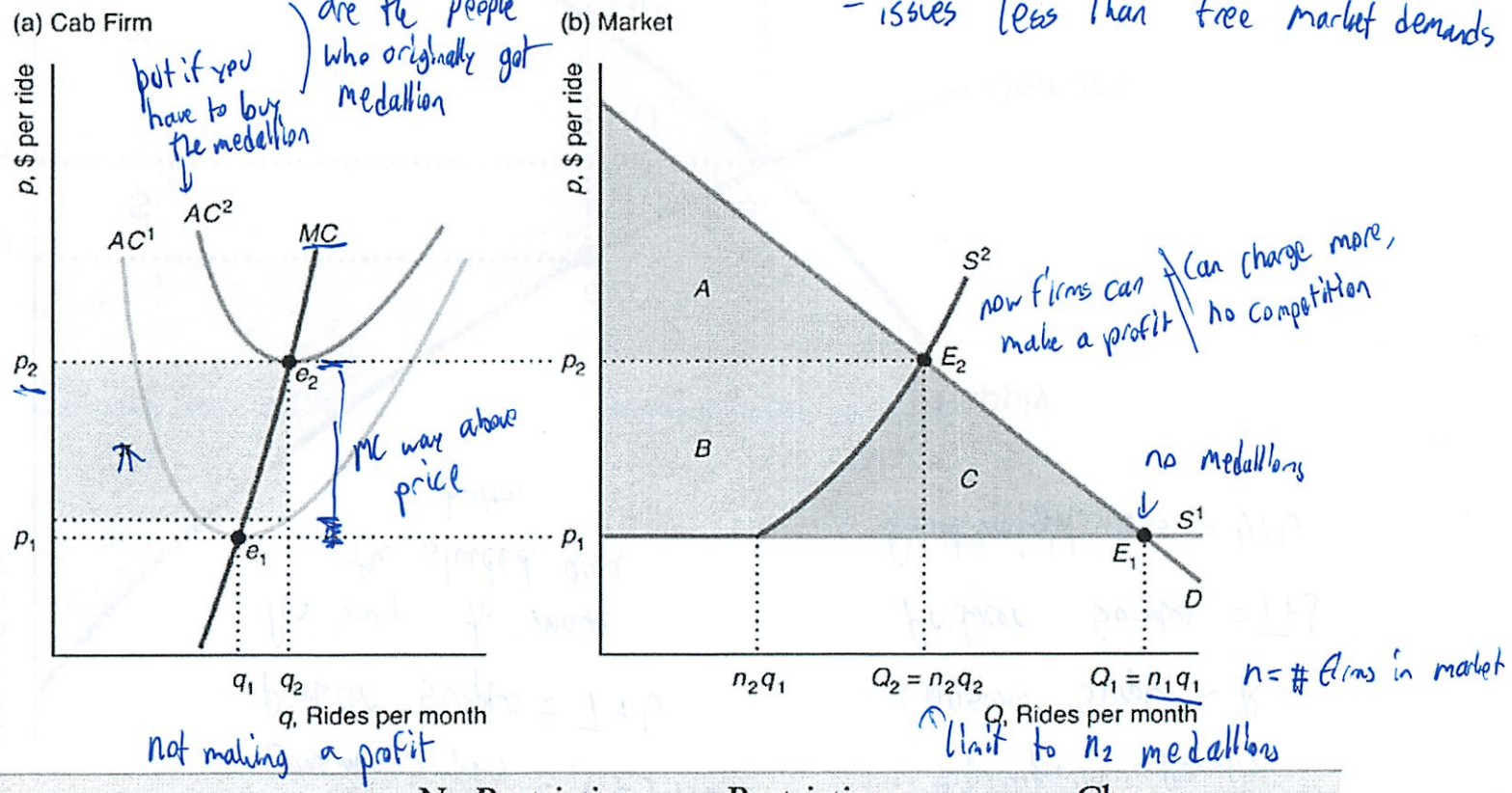


Figure 13-6: Effect of a Restriction on the Number of Cabs

licensing for cabs
- issues less than free market demands

in SF medallions are rented $42,000/year
- the entire surplus ↑

NYC $400,000 sale
Boston $250,000 sale



all it enriches are the people who originally got medallion

put if you have to buy the medallion

MC was above price

not making a profit

now firms can make a profit / can charge more, no competition

no medallions

n = # firms in market

limit to n_2 medallions

Occupational licensing
- safety
- gov or private associations

	No Restrictions	Restrictions	Change
Consumer Surplus, CS	$A + B + C$	B	$-B - C = \Delta CS$
Producer Surplus, PS	0	A	$B = \Delta PS$
Total Welfare, $W = CS + PS$	$A + B + C$	$A + B$	$-C = \Delta W = DWL$

Cheap cab rides

14.01 Monopoly

10/27

most markets are not perfectly competitive
a small # of firms = oligopoly
today monopoly

- no good substitutes
- be price setter

ie Windows
- Gates had to decide how many to produce

Marginal Revenue

- perfect competition MR = MC
- do I produce the next unit?
- In perfect competition p = MC
- figure 14-1 ↗
- Monopolist 14-2
- residual demand = total market demand
  ↳ so downward sloping demand
- assume monopolist can't discriminate on price - must set 1 price

to sell more units, need to lower price

$MR = \text{Rect } B - \text{Rect } C$

$= P_2 - (P_1 - P_2) \cdot Q_1$

$= P + \frac{\Delta P}{\Delta Q} \cdot Q_1$

(2)

$R = p \cdot q(p)$

$MR = p + \frac{dp}{dQ} Q$

* if lower price, you take away some of the previous revenue from lowering the price on all units

- figure 14-3
  - see math there
- important relationship b/w MR + elasticity of demand

$MR = p + \frac{\Delta p}{\Delta q} q$

$= p + p\left(\frac{\Delta p}{\Delta q}\right) \cdot \frac{q}{p}$ ← multiply + divide by p

↑ looks like inverse of elasticity of demand

$= p * \left(1 + 1/\epsilon\right)$

↑ remember in perfectly elastic firm $\epsilon = \infty$

- when elasticity of demand $= -1$, $MR = 0$
  since lost revenue from price cut = revenue gain from selling more
- as elasticity of demand $\to 0$, you lose $ inelastic
  as " " " $\to -\infty$, you make $ elastic

(3)

Monopoly Profit Maximization

14-4 figure

Also need to think about shut down rule

- shut down if $P < AVC$

MR just to help monopolist pick q

- not really in the market
- just easy to see profits change
  - "poisoning effect" of having to give everyone a price cut

MSFT

- MC very low
- high q
- lots of profit

Market Power

- ability to charge price above MC $\boxed{P > MC}$
- $MR = P(1 + 1/\epsilon) = MC$

$$\frac{MC}{P} = 1 + \frac{1}{\epsilon}$$

- $\text{markup} = \left(\frac{\text{price} - MC}{\text{price}}\right) = \left(\frac{P - MC}{P}\right) = -\frac{1}{\epsilon}$
- monopolist will set very high price
- but then if the lower the price, will lose lots of $
- Constraint: other way to do something - typewritters

always some elasticity of demand
substitutes outside the specific market

(4)

Welfare effects of monopoly

- deadweight loss
- figure 14-5

Assumption we made: can only set 1 price

but is price discrimination
- specials
- senior cit. discount
- last min plane fim

* maximizes social welfare
  - as good as a competitive firm
  - if perfectly discriminating
    - ie each person pays own price
    - = to WTP

no poisoning effect

So sell at lower price, money to be made

Will work down demand curve to competitive outcome MR = MC

Ultimate screw on consumers

but how can it be =ly good for society

Since said welfare = consumer surplus + producer surplus

just care about <u>size</u> of pie

Shows how dumb this welfare decision is

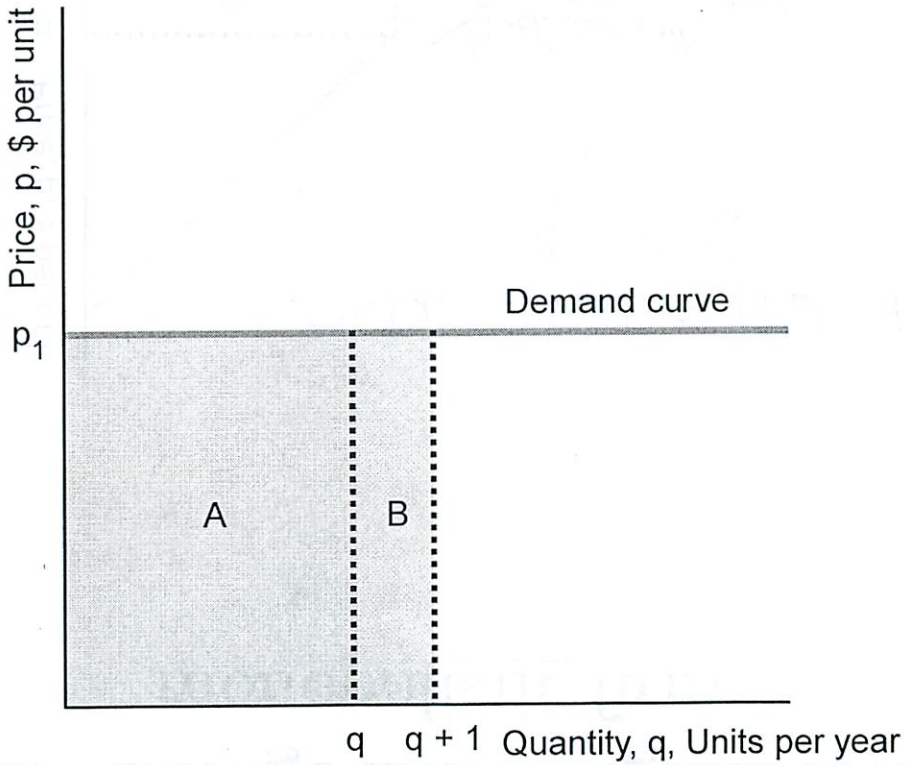
need to think about equity (lect. 23 + 24)

also perfect price discrimination <u>not</u> really

10/27

Figure 14-1: Average and marginal revenue for a competitive firm

Review of perfect competition



Lecture 14

Figure 14-2: Average and marginal revenue for a monopolistic firm

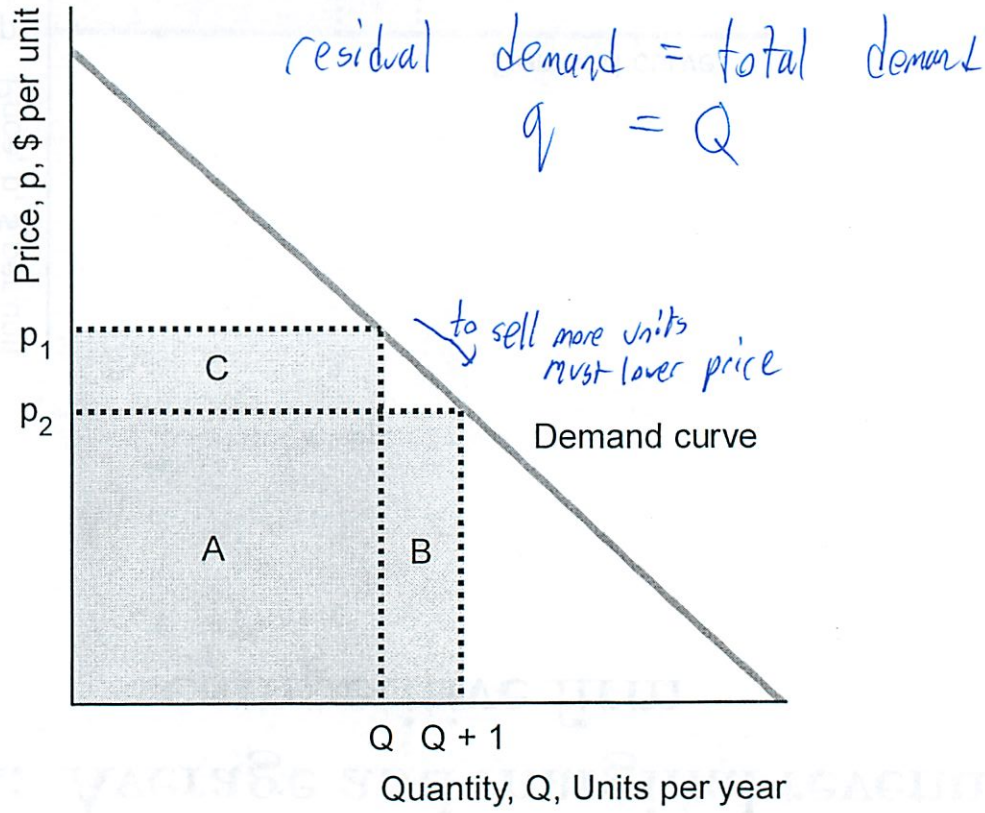


Figure 14-3: Marginal revenue for a monopolist

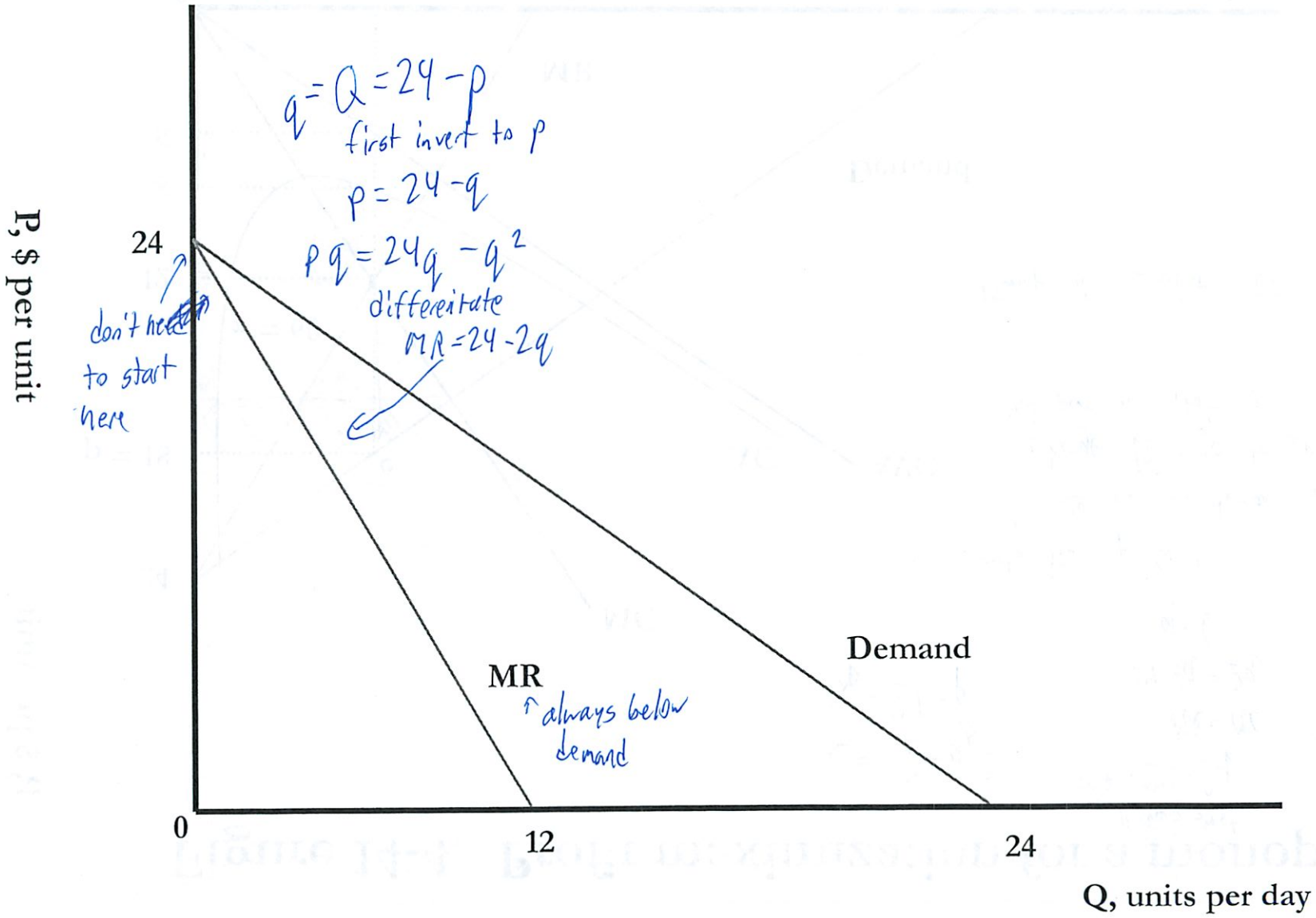
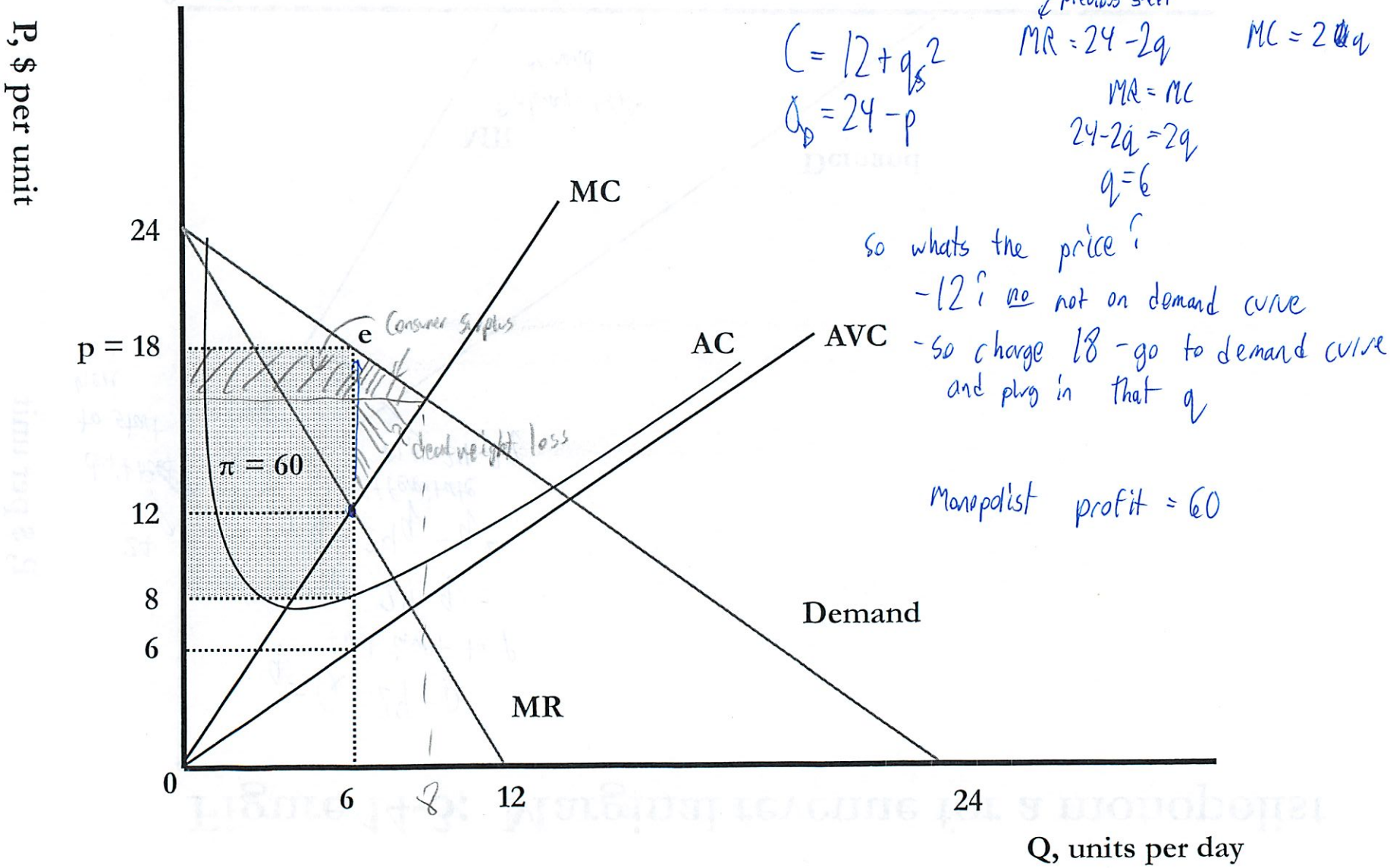


Figure 14-4: Profit maximization for a monopolist



$C = 12 + q_s^2$

$Q_D = 24 - p$

← previous sheet

$MR = 24 - 2q$

$MC = 2q$

$MR = MC$

$24 - 2q = 2q$

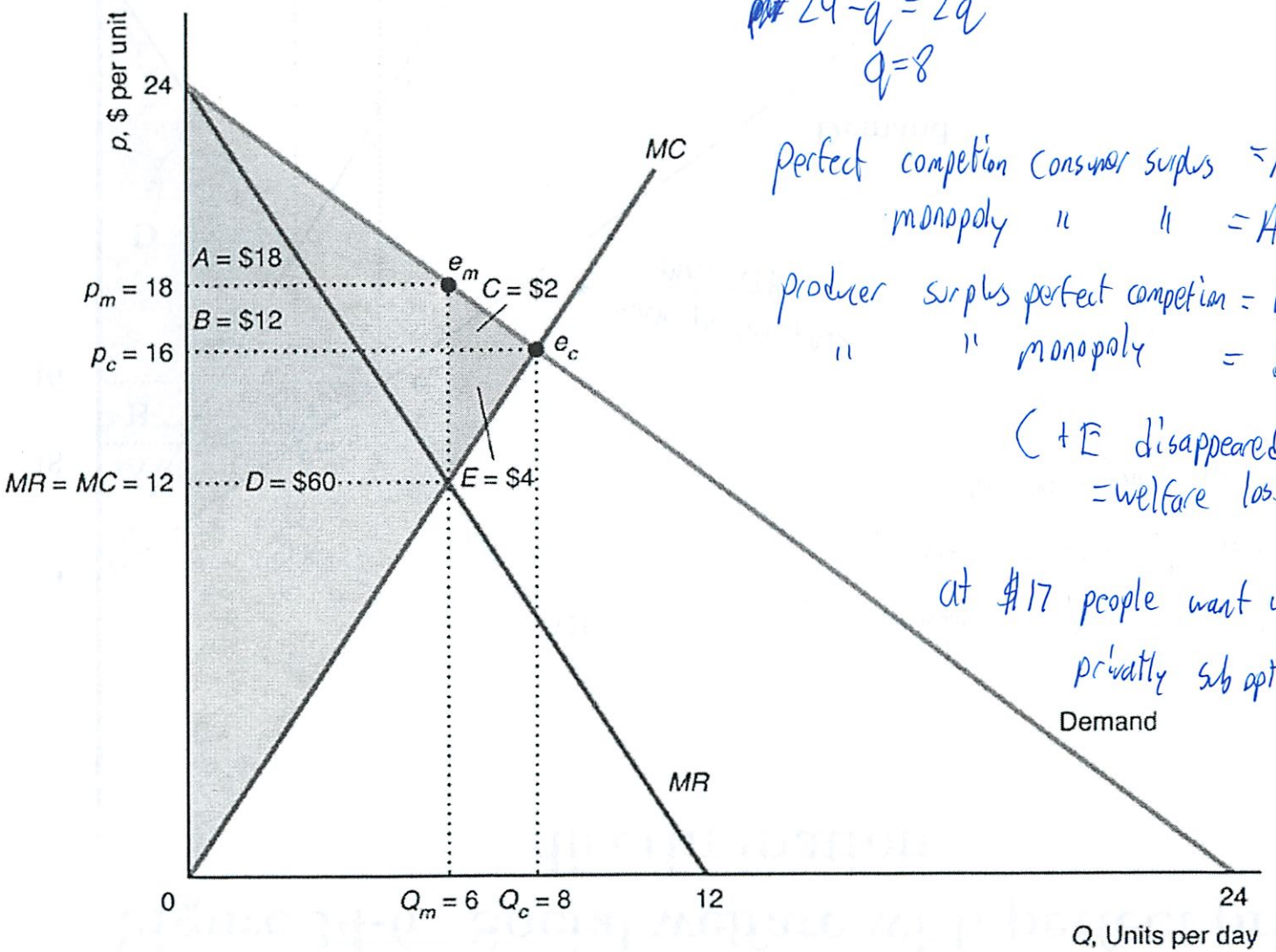
$q = 6$

so whats the price?

- 12? no not on demand curve
- so charge 18 - go to demand curve and plug in that q

Monopolist profit = 60

Figure 14-5: Deadweight Loss of Monopoly



MR = MC

$24 - q = 2q$

$q = 8$

perfect competition consumer surplus = A + B + C

monopoly " " = A

producer surplus perfect competition = D + E

" " monopoly = D + B

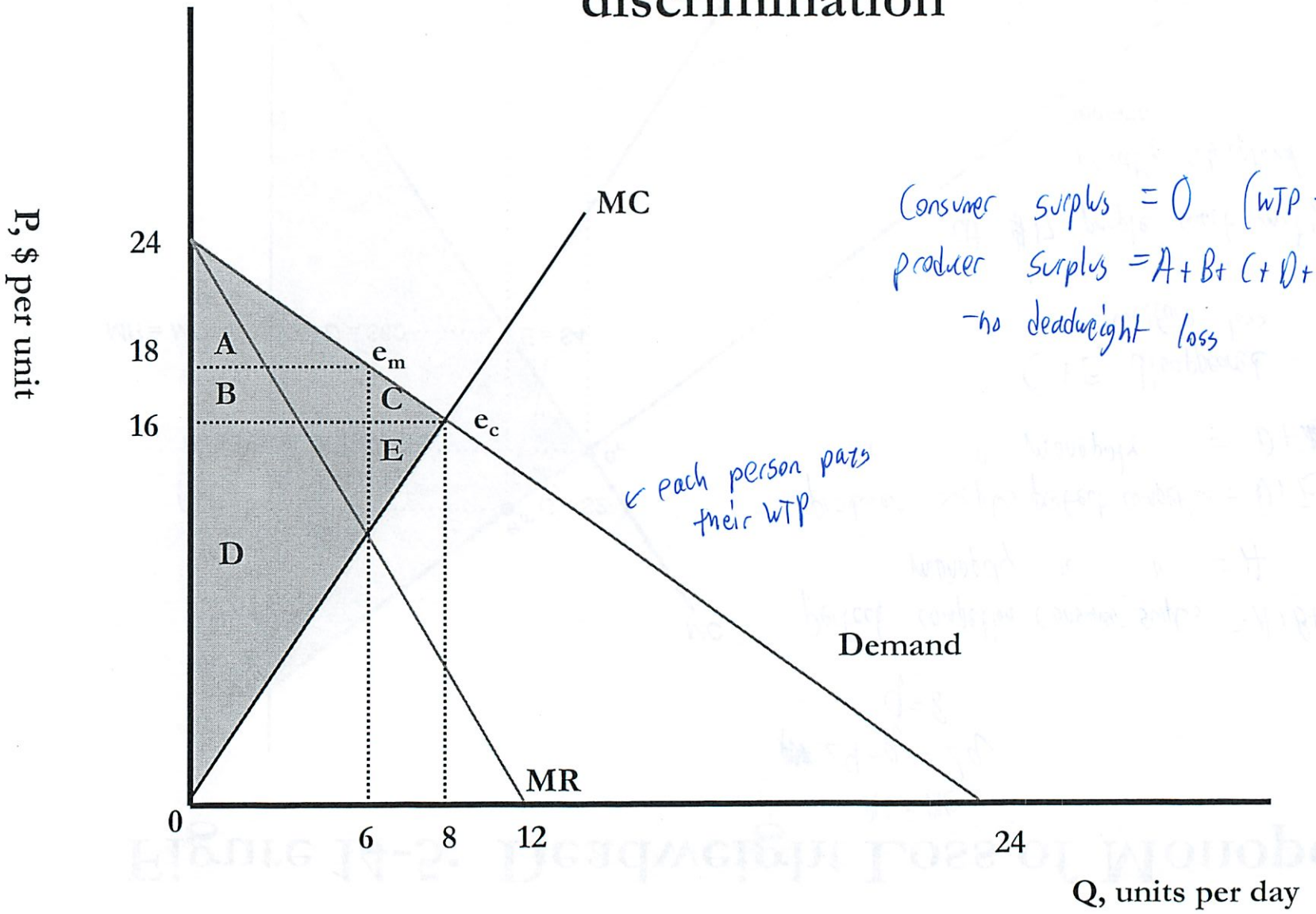
C + E disappeared

= welfare loss

at $17 people want units, above MC not produced

privately sub optimal since poisoning effect

Figure 14-6: Social welfare with perfect price discrimination



Consumer surplus = 0 (WTP - price)
producer surplus = A + B + C + D + E
- no deadweight loss

← each person pays their WTP

Michael Plosmeier

87

14.01 Fall 2010

Problem Set 6

Due in class on October 29

1. (10 points) In Pal Alto, California, citizens can get their electric power from two sources: a hydroelectric generator and a coal-fired steam generator. The hydroelectric generator can supply up to 100 units of power per day at a constant marginal cost of one cent per unit. The steam generator can supply any additional power that is needed at a constant marginal cost of 10 cents per unit. When electricity costs 10 cents per unit, residents of Pal Alto demand 200 units per day.

a) (5 points) Draw the marginal cost curve of electric power production in Pal Alto.

b) (5 points) How much should the city charge for electric power? Explain. Should it charge the same price for a family whose power comes from the hydroelectric generator as it does for a family whose power comes from the steam generator?

2.(20 points) In *The Wealth of Nations*, Adam Smith writes:

The high duties (tariffs) upon the importation of corn, *which in times of moderate plenty amount to a prohibition*, give a like advantage to the growers of that commodity.

(a) (10 points) Explain why the italicized portion of the quote above is true by assuming were a small country that imports corn. Specifically, how might a year of moderate plenty result in a given tariffs being prohibitive of all imports? Use a graph to help prove your answer.

(b) (10 points) Could our small country become an exporter of corn in those times of moderate plenty? Why or why not? Again, a graph will help here, too.

3. (35 points) *(Suggestion: It may be helpful to read section 9.6 before doing this question.)* Moldavia is a small country that currently trades freely in the world barley market. Demand and supply for barley in Moldavia is governed by the following schedules:

Demand: $Q^D = 4 - P$ $\quad P - -\$/$ bushel of barley

Supply: $Q^S = P$ $\quad Q - -$ bushels of barley

The world price of barley is \$1/ bushel.

a. (12 points) Calculate the free trade equilibrium price and quantity of barley in Moldavia. How many bushels do they import or export? On a well-labeled graph, depict this equilibrium situation and shade the gains from trade relative to the autarkic (no trade) equilibrium in Moldavia.

b. (12 points) The Prime Minister of Moldavia, sympathetic as always, believes he can help those hurt by free trade in barley relative to the situation in autarky. He taxes the party that has benefited from free trade

(either consumers or producers) an amount per bushel that is the difference between the autarkic price of barley and the free trade price. Furthermore, he rebates the entire government revenue of the tax back to the party harmed by free trade (again, either consumers or producers). In a new, well-labeled diagram, show this post-tax equilibrium situation. Calculate and show:

*The new equilibrium price and quantity of barley in Moldavia

*Changes in the quantity of imports or exports

*The amount of revenue collected by the Prime Minister

Who pays the larger burden of this tax, consumers or producers in Moldavia? Why?

c. (11 points) Are the free trade losers better off or worse off after the rebate than they were under autarky? Why?

On your diagram from (b), SHADE the DWL (if any) of this tax rebate policy relative to the free trade equilibrium you found in (a).

4. (35 points) A monopolist firm faces the following cost curve: $C(Q) = Q^2 + 12$, where Q is the output produced. The demand for its product is given by $P = 24 - Q$.

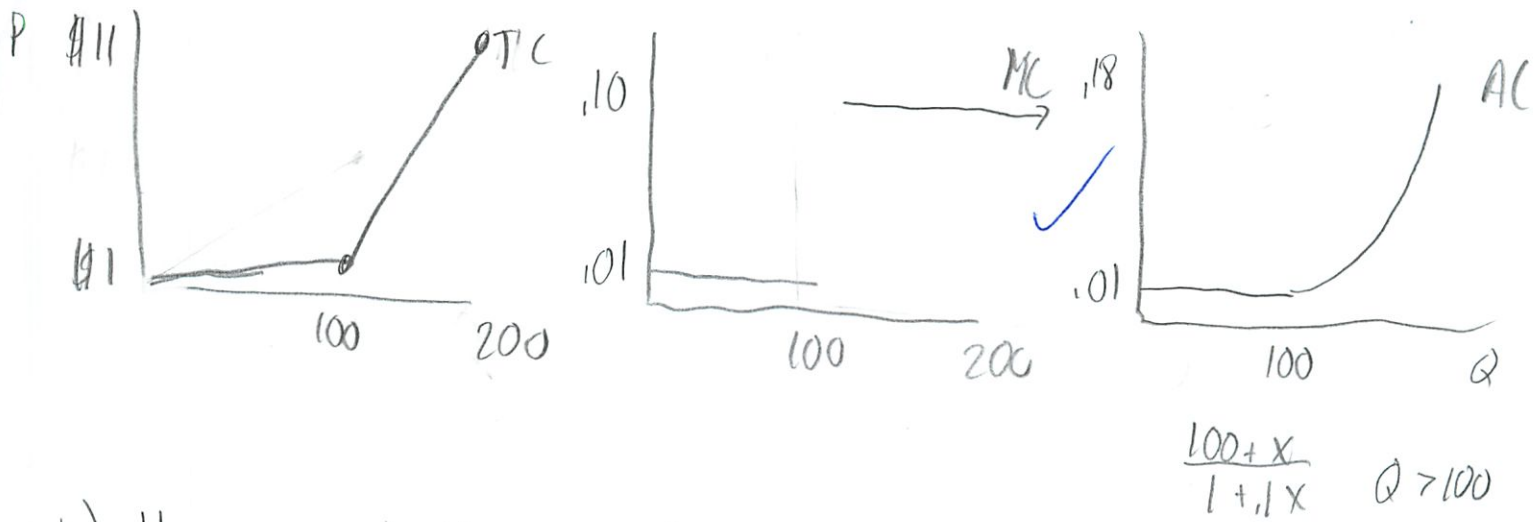
(a) (15 points) Calculate the non-price discriminating Consumer Surplus, the Producer Surplus and the Deadweight Loss associated to the monopoly.

(b) (15 points) How does charging the monopolist a specific tax of \$8 per unit affect the monopoly optimum and the welfare of consumers, the monopoly and society (where societys welfare, or surplus, includes the tax revenue)?

(c) (5 points) How does imposing a tax on profits (i.e. profit after tax= (1-t) * profit before tax) affect the monopoly optimum and the welfare of consumers, the monopoly and society?

Michael Plasmeier P Set 6 10/29

1. Do you mean Palo Alto? And Palo Alto is not near hydroelectric power.



$\frac{100+X}{1+.1X}$ $Q > 100$

b) How much should the city charge?

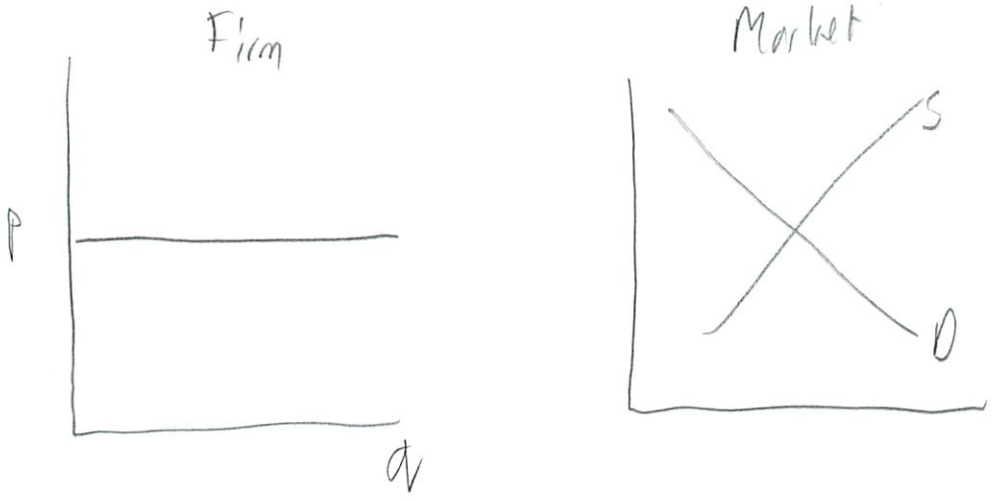
- its a regulated monopoly so what ever the politicians say!
- ok assume its an unregulate monopoly, where MR=MC
- so it should charge families the same amount no matter the cost of the electricity because it wants to maximize profits
- (in fact it should extra for "green" power, despite it being the same thing)

Can't find # since only given one demand point.

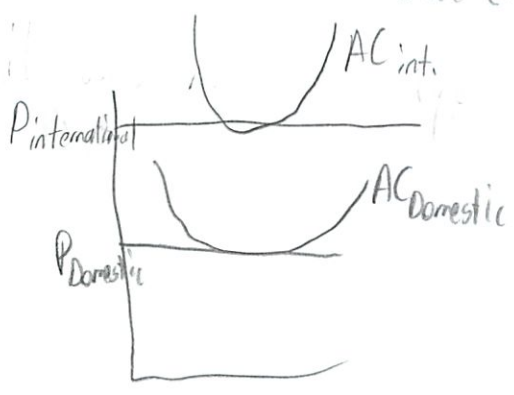
X (-3)

(2)

2. a. The tarrifs add to the cost of the corn, since the market for corn is perfectly competitive (like most agricultural goods)

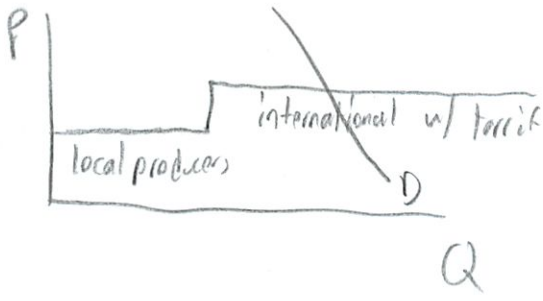


Because all goods are perfectly substitutable, consumers will only buy from the lowest cost producer (assuming these producers have the capacity to meet market demand - not like fig 11-7). In order for consumers to want to buy from foreign producers, their costs (inc tarrifs and shipping) must be lower than local producers (w/o tarrifs and international shipping). This is difficult to achieve.

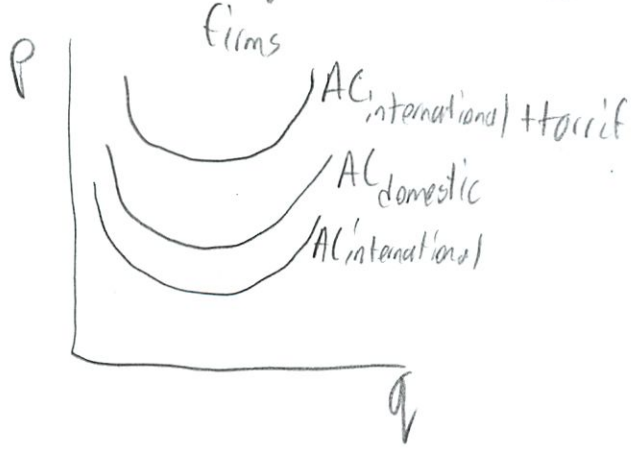


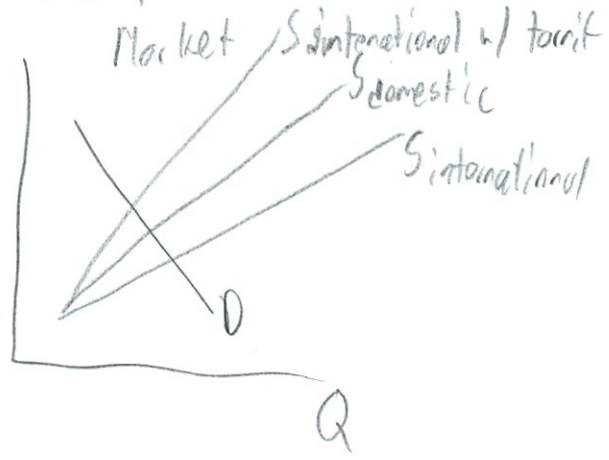
(3)

If the year is not moderate plenty, then we have a graph like 11-7 where market will buy internationally once all of the domestic supply has be used up.



If the country does not grow any corn, then the tarrif will induce growers to enter the market.

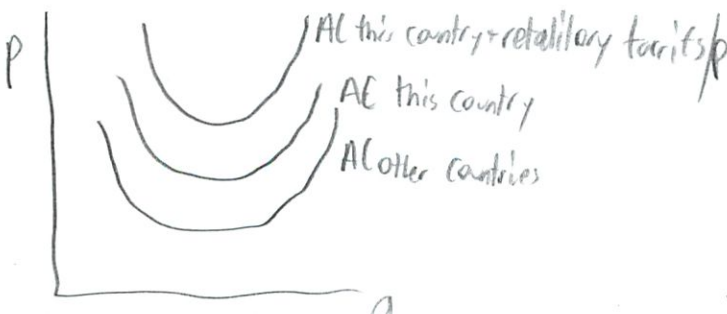


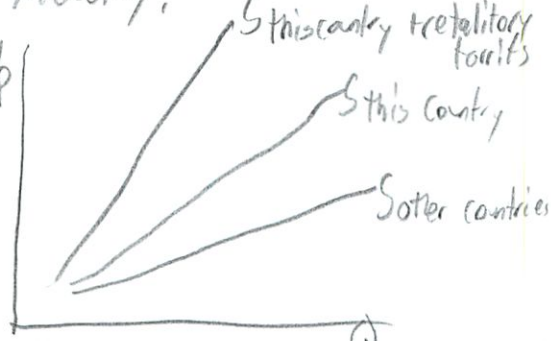


b) Could country become an exporter?

No, since the pure international price is still lower than the domestic price. They can not compete internationally. Plus countries will likely retaliate with tarrifs, further decreasing the competiveness of this industry.

Domestic price could fall below world price X -5





(4).

3. Moldavia in Barly market

$Q_D = 4 - P$ $\quad Q_S = P$

World price is ₰1

a) Calculate free trade equalibrium p + q of Moldavia.

$Q_D = Q_S$

$4 - P = P$

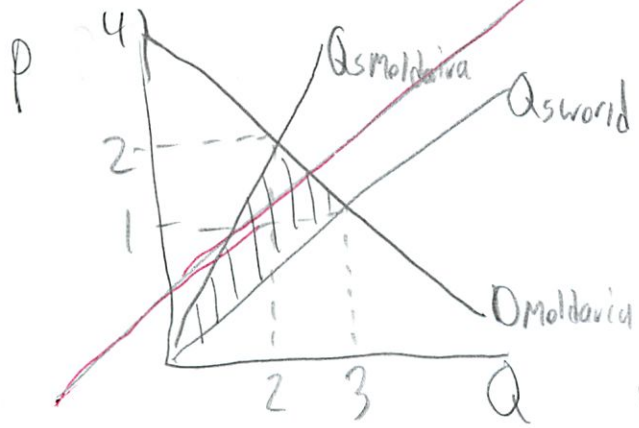
$4 = 2P$

$P = 2$

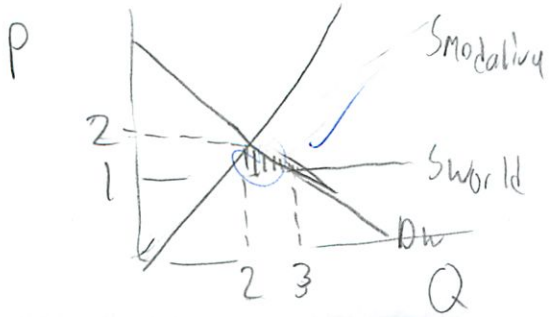
They do not produce any barly and instead import all $Q_D = 4 - 1$ at the world price ₰1 ✓

$= 3$ bushels ✓

Assuming no shipping charges.



▥ Gains in welfare from world trade



↓ Opps wrong world supply curve

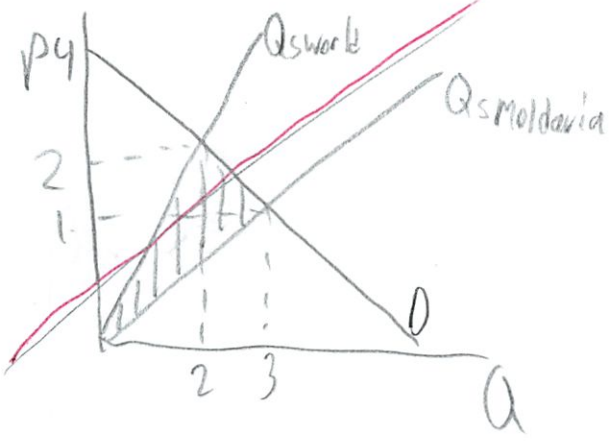
we haven't really done international trade

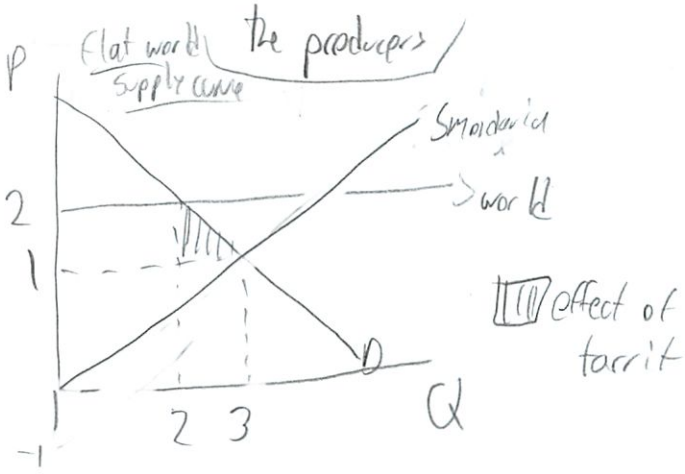
(5) b) The PM of Moldavia messes stuff up

He taxes consumers ✓ ₰1 per bushel and gives it to the producers

World price = ₰1 + ₰1 tarrif = ₰2

Moldavia price = ₰Q − ₰1 ← assuming ∧ rebate it



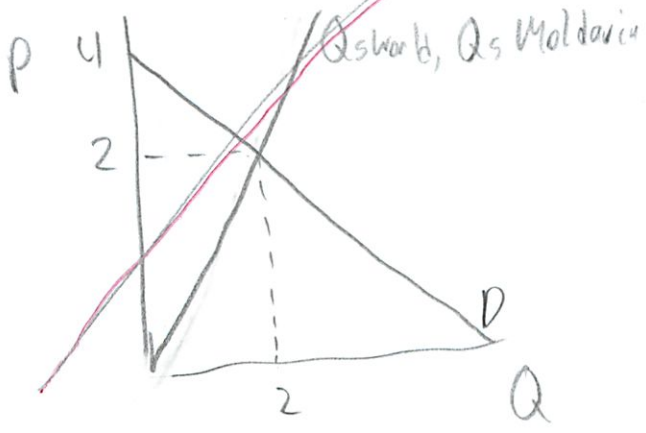


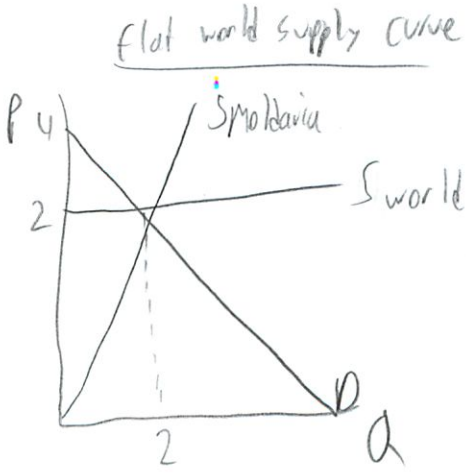
Now consumers still buy 3 at ₰1 but all Moldavian money stays as consumer surplus – but of course this strategy would not transfer money for long – it would just get consumers to buy Moldavian.

Now what if producers kept ₰1

World price = ₰1 + ₰1 = ₰2

Moldavia = ₰2





(6)

Consumers would buy 1 Moldavia and 1 World at $2 each

$1 in tax would be generated and given to Moldavian producers who would have $2 + $1 rebate = $3 income

The consumers face a large burden of paying more for less goods.

$1 deadweight loss of 3rd item not sold
$2 consumer surplus lost due to price rise
$1 of producers surplus from rebate
} consumers bear bigger burden

change in Moldavian welfare $-1-2+1 = -\$2$

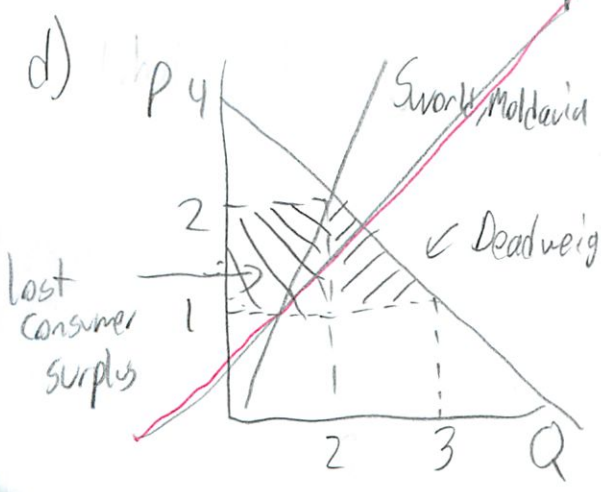
c) ↗ Drop in Moldavian society welfare, so worse off

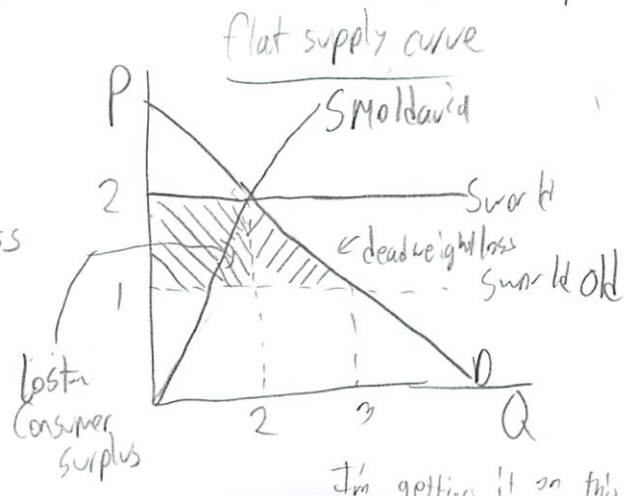
See above

Producers in Moldavia would be better off with $2 vs $0 in revenue plus $1 rebate check

But consumers are $3 worse off with $2 consumer surplus lost and $1 deadweight loss

d)





I'm getting it on this p-set

(7) Check

MR = MC

Not relevant here, since no market power

$R = P(4-P) = 4P - P^2$

$C = QP = P^2$

$MR = 4 - 2P$

$MC = 2P$

$MR = MC$

$4 - 2P = 2P$

$4 = 4P$

$1 = P$

(8).

4. Monopolistic firm

Q_s = output

$C(Q) = Q_s^2 + 12$ ← total cost

$P = 24 - Q_D$

$Q_D = 24 - P$

(was a bit confused here need to review well was due to copy error)

Revenue: $Q(24-Q)$

Cost: $Q_s^2 + 12$

$24Q - Q^2$ ← want in terms of q here

$MR = \frac{dR}{dQ}$ $MC = \frac{dC}{dQ}$

$24 - 2Q$ $2Q$

Monopolist production decision

$24 - 2Q = 2Q$

$24 = 4Q$

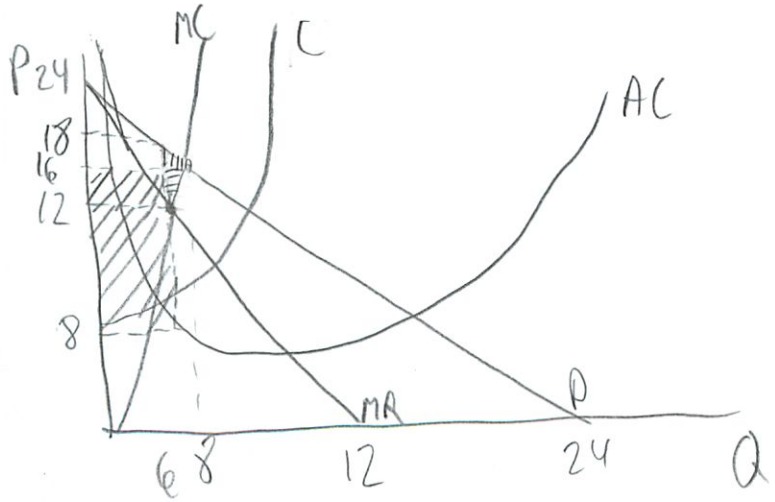
$Q_s = 6$ ← same values as lecture $MC = 2Q = 2 \cdot 6 = 12$

$P = 24 - 6 = 18$

$Q_D = 24 - 18 = 6$

$Q_s = Q_D$ ✓

$AC = \frac{Q^2 + 12}{Q} = \frac{6^2 + 12}{6} = 8$



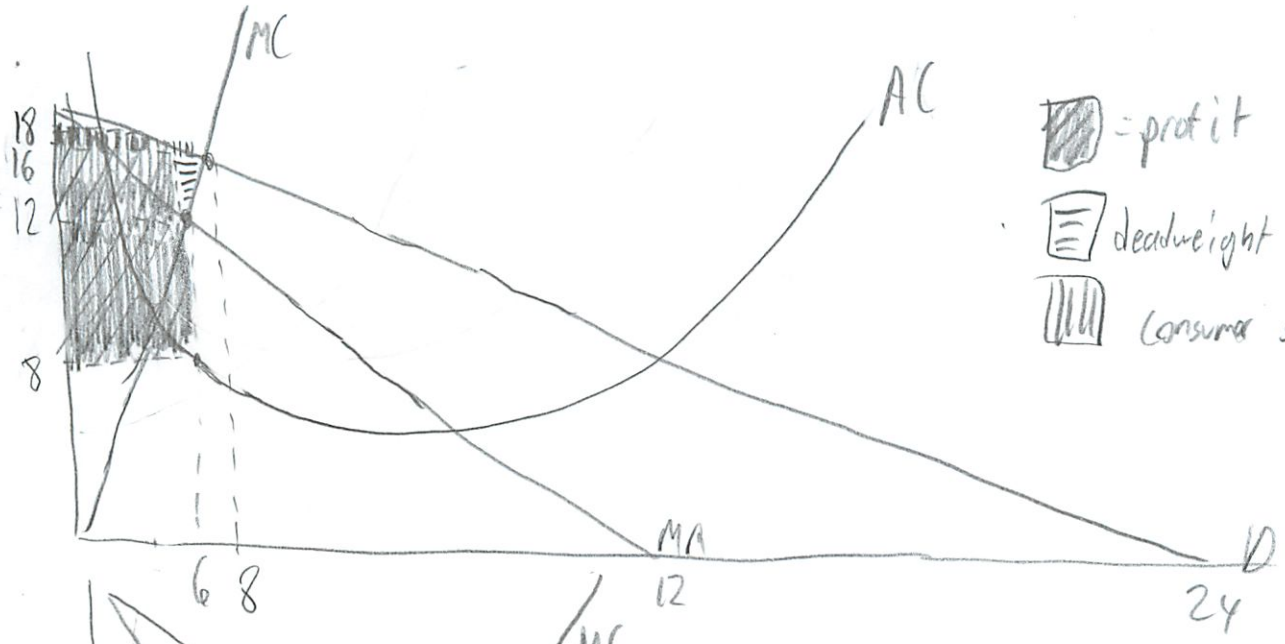
profit

Consumer surplus lost

deadweight loss

I should make that bigger

(9)

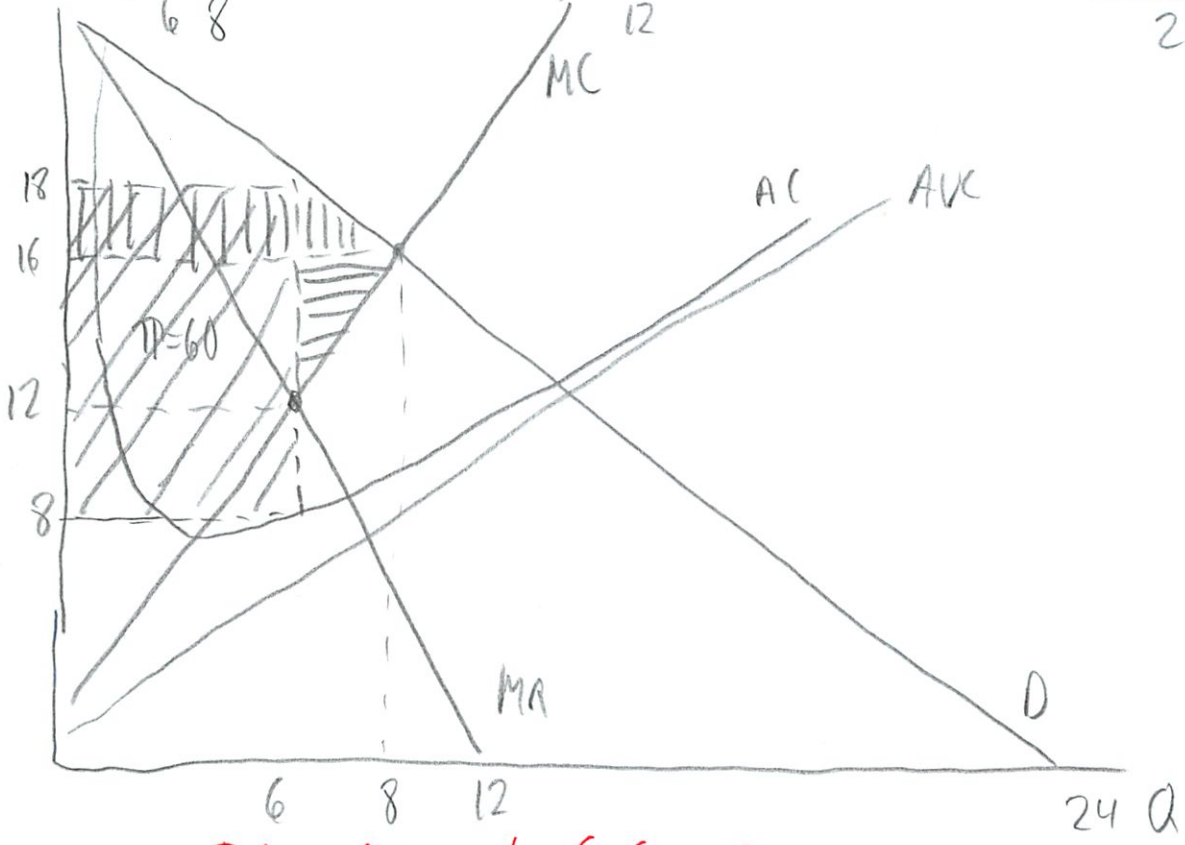


= profit

= deadweight loss

= consumer surplus lost

draw again



Total CS = $\frac{1}{2} \cdot 6 \cdot 6 = 18$

Consumer surplus lost = $(18-16) \cdot 6 + \frac{1}{2}(18-16)(8-6)$

$12 + 2 = 14$ ✗

-5

Deadweight loss = $\frac{1}{2}(16-12)(8-6)$

$\frac{1}{2} \cdot 4 \cdot 2$ ✗

4

$\frac{2 \cdot 6}{2} = 6$

Producer surplus perfect competition = $\frac{1}{2} \cdot (12-0)(6-0) + (16-12)(6-0)$

(10)

$$+ \tfrac{1}{2}(8-6)(16-12) = 64$$

Producer surplus monopoly

$$= \tfrac{1}{2}(12-0)(6-0) + (18-12)(6-0)$$

$$36 + 36 = 72$$ ✓

Gain $72 - 64 = 8$ in producer surplus due to monopoly

want total — not change ↑↓ always default to

b) How about an $8 levy on the monopolist? This would increase its costs by $8

$$C(Q) = Q^2 + 12 + 8Q$$
$$= Q^2 + 8Q + 12$$

$$MC = 2Q + 8$$

$$AC = \frac{Q^2 + 8Q + 12}{Q}$$

MR unchanged

$$MR = MC$$
$$24 - 2Q = 2Q + 8$$
$$+2Q \qquad -8$$
$$16 = 4Q$$
$$Q = 4$$ ← will sell even less

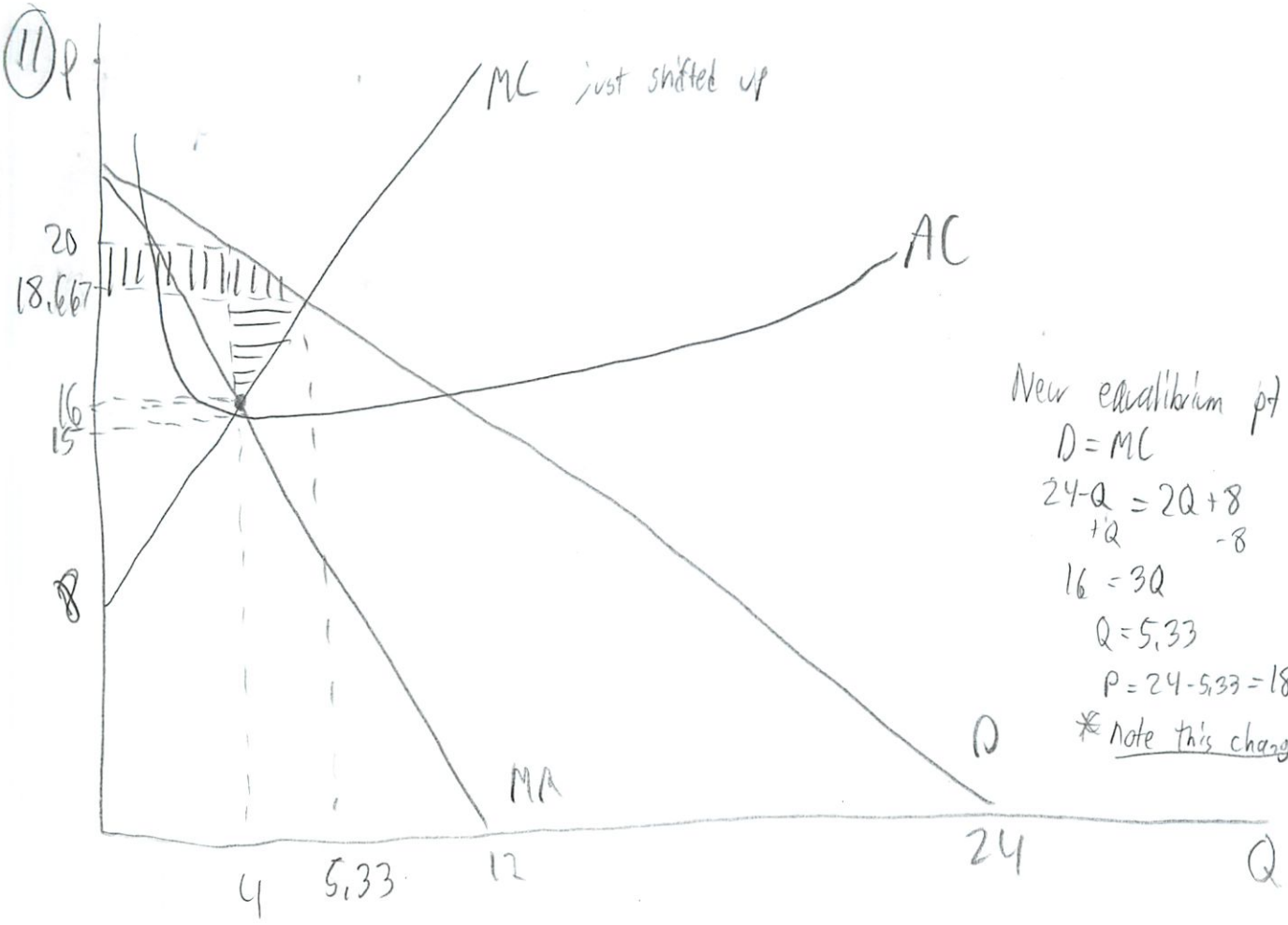
$$AC = \frac{4^2 + 8 \cdot 4 + 12}{4} = 15$$

$$MC = 2 \cdot 4 + 8 = 16$$

$$P = 24 - 4 = 20$$

This policy is a disaster, will sell less at lower price

(11)



New equilibrium pt w/o monopoly

$D = MC$

$24 - Q = 2Q + 8$

$+Q \quad -8$

$16 = 3Q$

$Q = 5.33$

$P = 24 - 5.33 = 18.667$

* Note this changes too

Profits $= 20 \cdot 4 - 15 \cdot 4 = 20$

Consumer surplus loss $= (20 - 18.66)(4 - 0) + \frac{1}{2}(20 - 18.66)(5.33 - 4)$

$5.33 + \frac{8}{9} = 6\frac{2}{9}$

deadweight loss $= \frac{1}{2}(18.66 - 16)(5.33 - 4)$

$= 1\frac{7}{9}$

producer surplus $= \frac{1}{2}(16 - 8)(4 - 0) + (20 - 16)(4 - 0)$

$16 + 16$

32 ✓

Producer welfare drop $72 - 32 = 40$

Consumer welfare on next pg

Consumers are better off with less consumer surplus loss and deadweight loss due to the monopoly price.

(12).

The monopoly is far worse off with its welfare cut in half.

Calculate total welfare for consumers

but how

people that are happy at that price

before $6 \cdot 18 = 108$

after $4 \cdot 20 = 80$

all you said is that it had to —

Consumer welfare loss $108 - 80 = 28$ ✗

Tax collected $= 8 \cdot 4 = 32$ ✓

tax collected is over the welfare loss of consumers

Total welfare Before tax

$108 + 72 = 180$

Consumers

Total welfare After

$80 + 32 + 32 = 144$

net loss to Society $36 ✓

Consumers only pay part of the tax

New price = 20

Price before tax = 18

Consumers pay $\frac{2}{8}$ of tax

Monopolist pays rest

hope got that right - seems realistic

(13).

c) How does imposing tax on profits

profits = $(1-t)$ * profit before tax

Previous demand, MR, C, MC, AC there so original P, Q

So just trasfor profits from monopoly to society/gov

= Same total welfare ✓

Assuming tax on profits does not affect disincentives since they still want to maximize tax rate since only 1 tax rate, - so it is a valid assumption

actually did better than I thought finished all on my own - should aim for A in LY.01

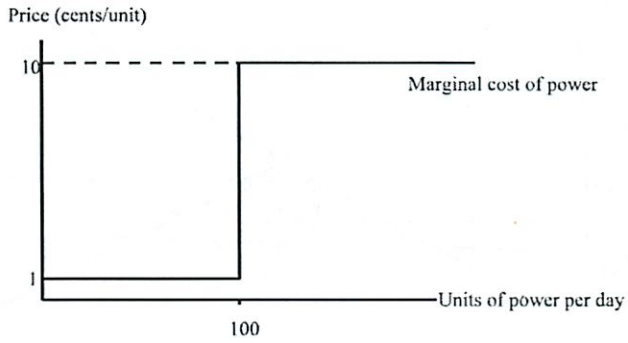
14.01 Fall 2010

Problem Set 6

Due in class on October 29

1. In Pal Alto, California, citizens can get their electric power from two sources: a hydroelectric generator and a coal-fired steam generator. The hydroelectric generator can supply up to 100 units of power per day at a constant marginal cost of one cent per unit. The steam generator can supply any additional power that is needed at a constant marginal cost of 10 cents per unit. When electricity costs 10 cents per unit, residents of Pal Alto demand 200 units per day.

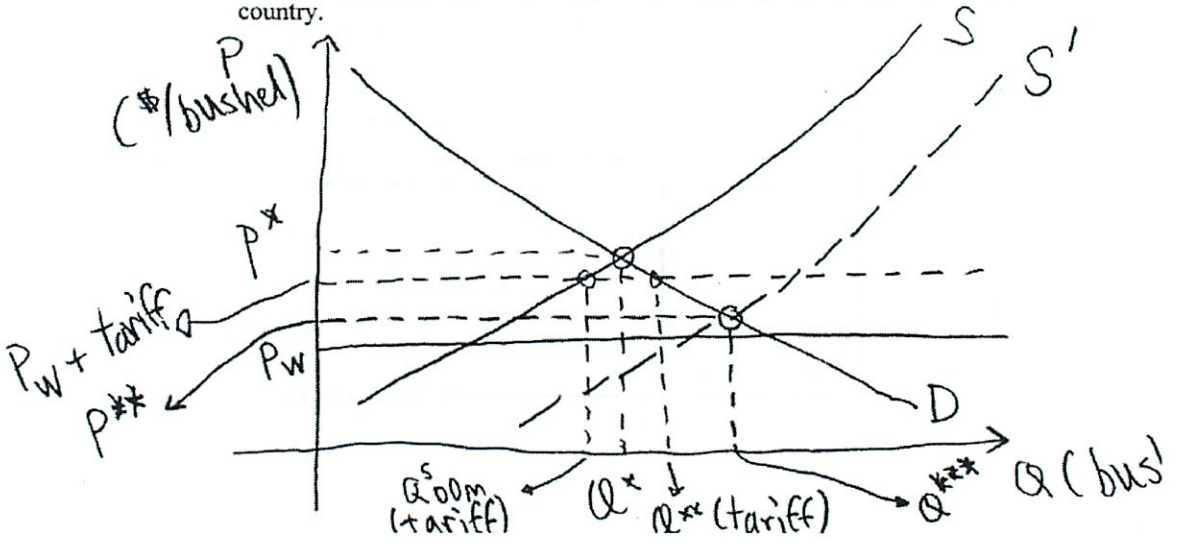
a) Draw the marginal cost curve of electric power production in Pal Alto.



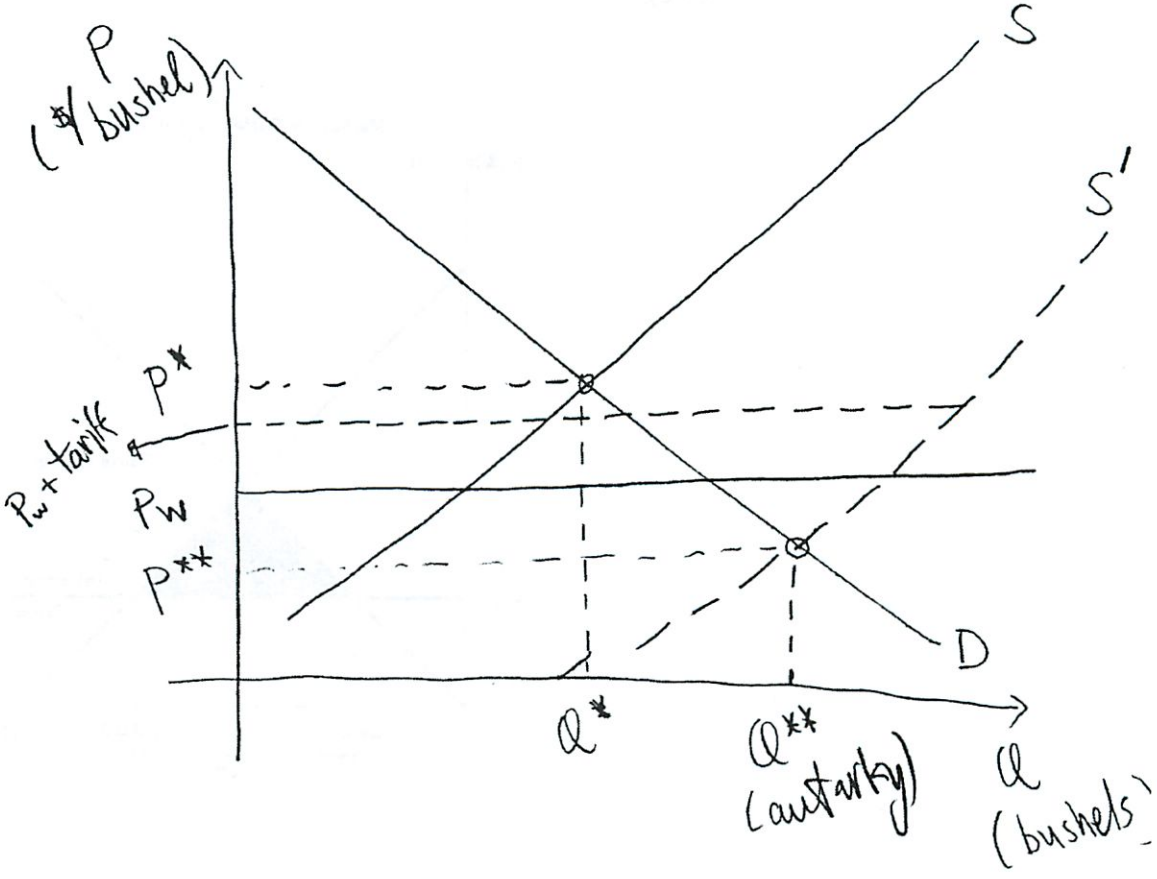
b) How much should the city charge for electric power? Explain. Should it charge the same price for a family whose power comes from the hydroelectric generator as it does for a family whose power comes from the steam generator?

The city should charge 10 cents per unit since that is the marginal cost when residents use at least 100 units/day, which they will if the city charges 10 cents or less. It should charge 10 cents per unit to all users, even those who are receiving their power from the hydroelectric facility, since if those users were to cut their consumption, they would free up hydroelectric capacity, which could then be used to serve others who are currently receiving their power from the more costly steam generator.

2 Smith was right! See first diagram below. High duties may result in very few imports initially, such that any year of "moderate plenty" (a bumper crop for instance) shifts the domestic supply curve out (S'), which may force domestic prices (P**) below the prices of those imports with high duties (P_W + tariff). Then, those duties would become prohibitive, keeping all imports out of the country.

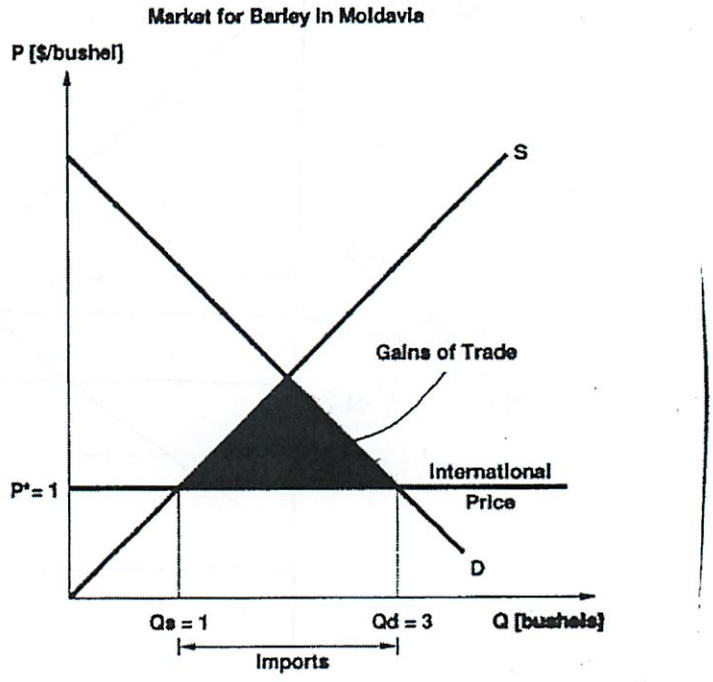


How might our small country become an exporter in this case? Well, if that year of "moderate plenty" resulted in enough of an increase in domestic supply that P** dropped below the WORLD price P_W, our country would then export corn rather than import it. Remember, P** in this case must drop below the world price and not just below the world price plus the tariff. See diagram below.



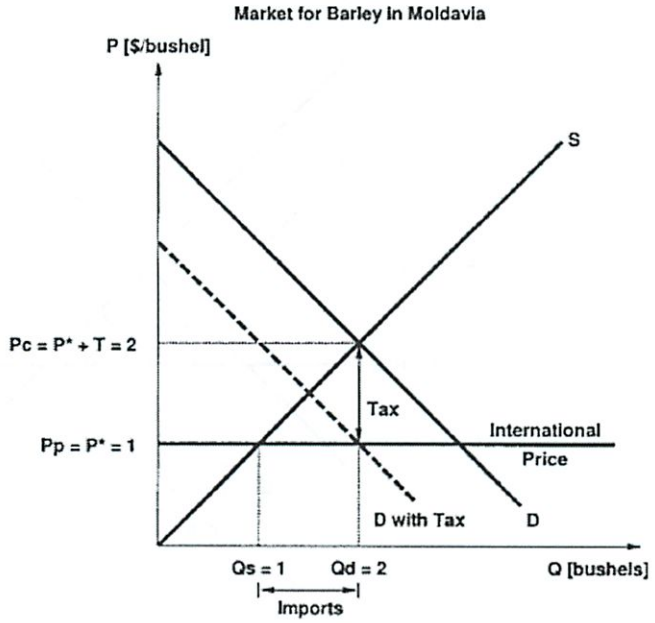
Can you finish this diagram by identifying the new Free trade eq. P & Q if S shifts to S' above??

a. In free trade, Moldavia will import barley because the world price of $1 / bushel is lower than the autarkic price of $2 / bushel. Free trade equilibrium price will be $1 / bushel, and the free trade equilibrium quantity will be 3 bushels, of which 1 is produced at home and 2 are imported. See diagram below for shaded gains from trade. We know that the rest of the world has a comparative advantage in the production of barley, because their opportunity costs (as reflected in the $1 / bushel world price) are lower than ours (as reflected in our $2 / bushel autarkic price).

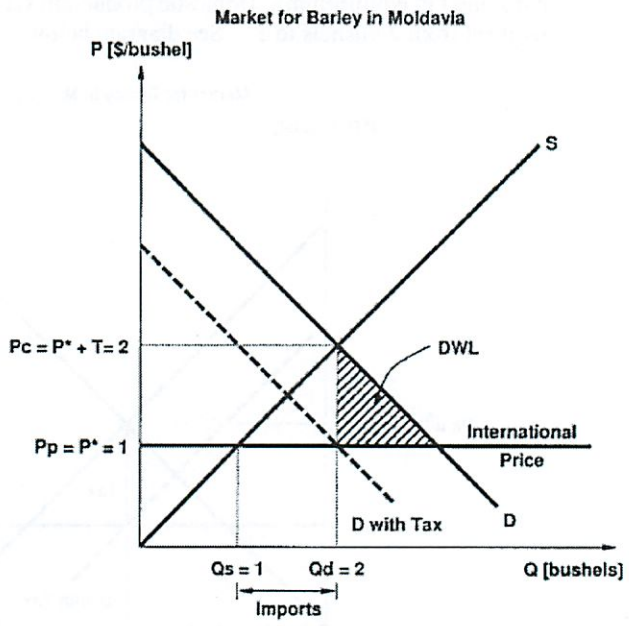


b. Those harmed by free trade (domestic barley producers) will receive the tax rebate from revenues collected by the government from their $1 / bushel tax on consumers of barley in Moldavia. Consumers win with free trade here, so the $1/ bushel tax on them (the difference between the free trade price of $1/bushel and the autarkic price of $2/bushel) effectively shifts their demand curve down by $1/bushel. The new equilibrium price in the barley market is still $1/bushel (the world price and still the price to domestic producers of barley) but the market equilibrium quantity falls from 3 bushels to 2 bushels. If you drive a $1/bushel wedge between domestic demand and the total supply curve, you will shift the entire burden of this tax onto consumers, because total supply is perfectly elastic along the relevant portion of the curve here. Thus, the price to consumers after

tax will be $2/bushel (exactly the amount of the tax higher than under free trade), and the government will collect $2 in revenue ($1/bushel tax * 2 bushels consumed in equilibrium). Domestic production stays at 1 bushel, but imports are reduced from 2 bushels to 1. See diagram below.



c. The free trade losers (domestic producers) are better off under the rebate system than they were in autarky. Why? Well, their new producer surplus plus the rebate exceeds their producer surplus in autarky by the area of a triangle representing a very interesting non-distortion of this tax that is a distortion with a tariff (which by proper comparison should be the prohibitive tariff of $1/bushel). Relative to autarky (or effectively a prohibitive tariff of $1/bushel), then, the triangle "saved" by society (and here gained by producers relative to their situation in autarky) represents bushels of wheat that should be produced abroad and are indeed produced there under our tax rebate scheme. Rather than produce those extra units (here 1 bushel) at home, as you would with a tariff, you can give them (producers) the same revenue with a rebate as they would have had producing those units under autarky, while saving the higher costs of producing those units at home relative to buying them from abroad. Wild! Paying them not to produce another bushel of wheat.....Note that you still have DWL here, coming from the distortion to consumption as a result of the tax. See diagram below for that shaded DWL. Thus, taxing wheat consumption rather than taxing imported wheat (a tariff) results in a lower DWL (and is thus more efficient).


Market for Barley in Moldavia
P [$/bushel]
S
Pc = P* + T= 2
DWL
Pp = P* = 1
International
Price
D with Tax
D
Qs = 1
Qd = 2
Q [bushels]
Imports

4. A monopolist firm faces the following cost curve: $C(Q) = Q^2 + 12$, where Q is the output produced. The demand for its product is given by $P = 24 - Q$.

(a) Calculate the non-price discriminating Consumer Surplus, the Producer Surplus and the Deadweight Loss associated to the monopoly.

MR $= 24 - 2Q$.
MR = MC, so $24 - 2Q = 2Q$ and then $Q = 6$. Now plug this Q in the demand curve to get $P = \$18$.
profit $= 18 * 6 - (36 + 12) = \$60$.
CS $= \frac{1}{2}(6 * 6) = \$18$
PS $= 36 + 36 = \$72$
DWL $= 2 * 6/2 = \$6$
(The best way to figure out these values is to draw a graph. Try it!)

(b) How does charging the monopolist a specific tax of \$8 per unit affect the monopoly optimum and the welfare of consumers, the monopoly and society (where societys welfare, or surplus, includes the tax revenue)?

The tax here will affect the MC and then the quantity produced and the price charged. So, MC after tax = MC before tax +\$8. And then, MC after tax $= 2Q + 8 = 24 - 2Q$ =MR. Solving you will get Q = 4 and $P = \$20$. A graph will help you to see that the tax will reduce the CS and PS and will produce a tax revenue to the government of $\$32 = \$8 * 4$. Finally, the DWL will increase as we move further from the competitive equilibrium. Also, the consumer will pay only part of the tax. Notice that the new price is \$20. And the price before tax was \$18. So, consumers only pay 2/8 of the tax. The monopolist pays the rest.
(c) How does imposing a tax on profits (i.e. profit after tax= (1-t) * profit before tax) affect the monopoly optimum and the welfare of consumers, the monopoly and society?

A tax on profits does not change the quantity nor the price chosen by the monopolist since profit after tax = (1 -t) * profit before tax = (1 - t)*(revenue - costs), where t is the tax rate on the profits. Well, this tax will not change the quantity chosen by the monopolist and as a consequence will not change the price. We have the same surplus and the same deadweight loss as in 2. The difference is that part of the producer surplus now goes to the government in the form of taxes.

Recitations

10/29

Replacement TA - 10 min late

2 forms of gov intervention

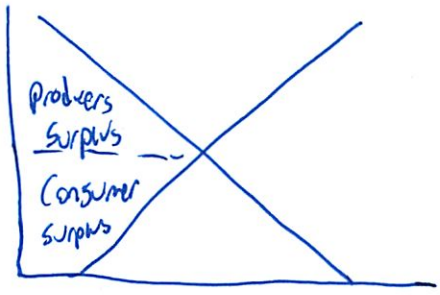
1. Price Ceiling (handout fig 1)

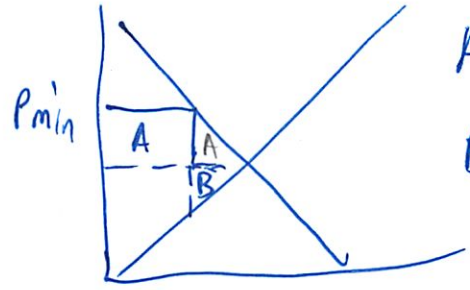
$\Delta CS = A - B$
$\Delta PS = -A - C$
) Δ Society welfare $= -B - C$

2. Price floor (fig 2)

Suppliers over produce at Q_2

$\Delta CS = -A - B$
$\Delta PS = A - C - D$
) Δ welfare $= -B - C - D$





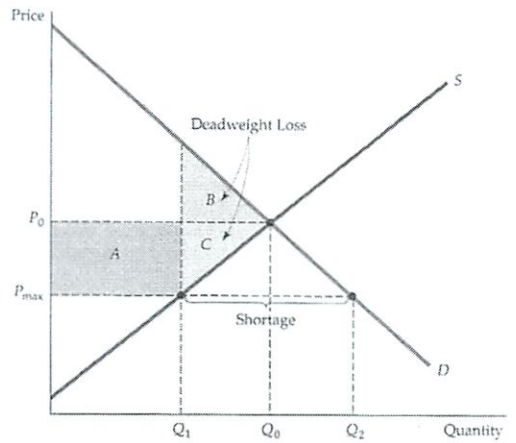
A = Consumer surplus loss

B = Deadweight loss?

(TA is not very clear)

fig 1

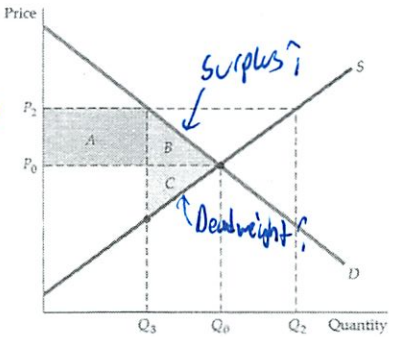
max price →



Price Ceiling: Change in Consumer and Producer Surplus from Price Controls

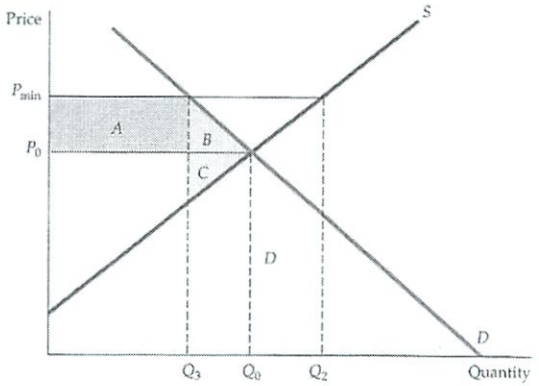
fig 2

min price →



Price Floor: Welfare Loss When Price is Held Above Market-Clearing Level

fig 3



Price Minimum

Lecture 15

11/1

- more monopoly

Price Discrimination

- no one charges WTP
- try to find signal of WTP
- airlines (straight out of 16.71 J)
- movie theater matenee discount
- restaurant early bird schedule
  - people w/ a lot of time
  - may not have enough $
* price sensitive
* income
- Disney for FL residents
  - one of many choices
  - vs if flying there, admission does not matter
- Amazon - pricing by IP address
  - shutdown
- MIT
  - not about price sensitivy
  - equity / income distribution
- all monopolists do some price discrimination

(2)

2 sources of monopolies

1. Cost advantages

- some markets have natural cost advantages
- like a utility
- only 1 source of natural resource
- whoever paid the fixed cost has natural advantage
  - Ls natural monopolies
    - AC of 1 firm always below AC of any new entrant
- when very large fixed cost, low MC
- AC always declining
- figure 15-1
- other firms face barriers to entry
- in this case actually economically efficient to have a monopoly

2. Government actions

- like US Postal Service
- now very rare in US
- getting rarer in other parts of the world
- Patents - gov gives you 17 year monopoly
  - incentive for R+D/innovation
  - need to balance
  - figure 15-2

(3)

Patents for something a little more than exists
- would not help society as much

Needs to ↑ demand to help society

Can gov help in natural monopoly?
- regulate to maximize social surplus
- 15-3

Problem
- How does gov know what competive price is?
- Could survey people to measure demand curve
  - quite hard
  - believe what people do, not say
  - People give silly answers
  - need to vary answer
- Firm's supply curve even harder
  - Firm not telling you
  - hard to find out

If gov gets it wrong, worse than not regulating
firm still sets MR = MC
↑ MR = regulated p

firm produces too small # of units
very high Consumer surplus

(4)

In pratice gov sets price too high
err on side of monopolist
regulators are often people from the industry
- not too tough on their buddies
after dave being regulator go back to biz
How much is that upward bias vs ~~[illegible]~~ "free" monopoly?
- can make things better + worse
~~[illegible]~~

Natural monopolies are market failures
- a place in ~~[illegible]~~ our ideal model where gov can make things better

---

Contestable Market

- is a natural monopoly
- but someone could come in + compete
- fixed cost high, but not unsurmountable
- monopoly keeps price near MC to avoid new entreants

~~[illegible]~~ gov viewed natural monopolies - 60s-70s
airlines as
the gov opened airlines to competition
1. Prices fell by a third
2. Many more routes open - now possible
3. Quality of airline travel deteriorated

(5)

Why?

Before competed on service, not allowed to compete on price

Everyone bitches about bad service, but not cheap prices

Consumers don't really care about service, enough to pay

But economists messed up on hub + spoke system

limited # of slots in airport

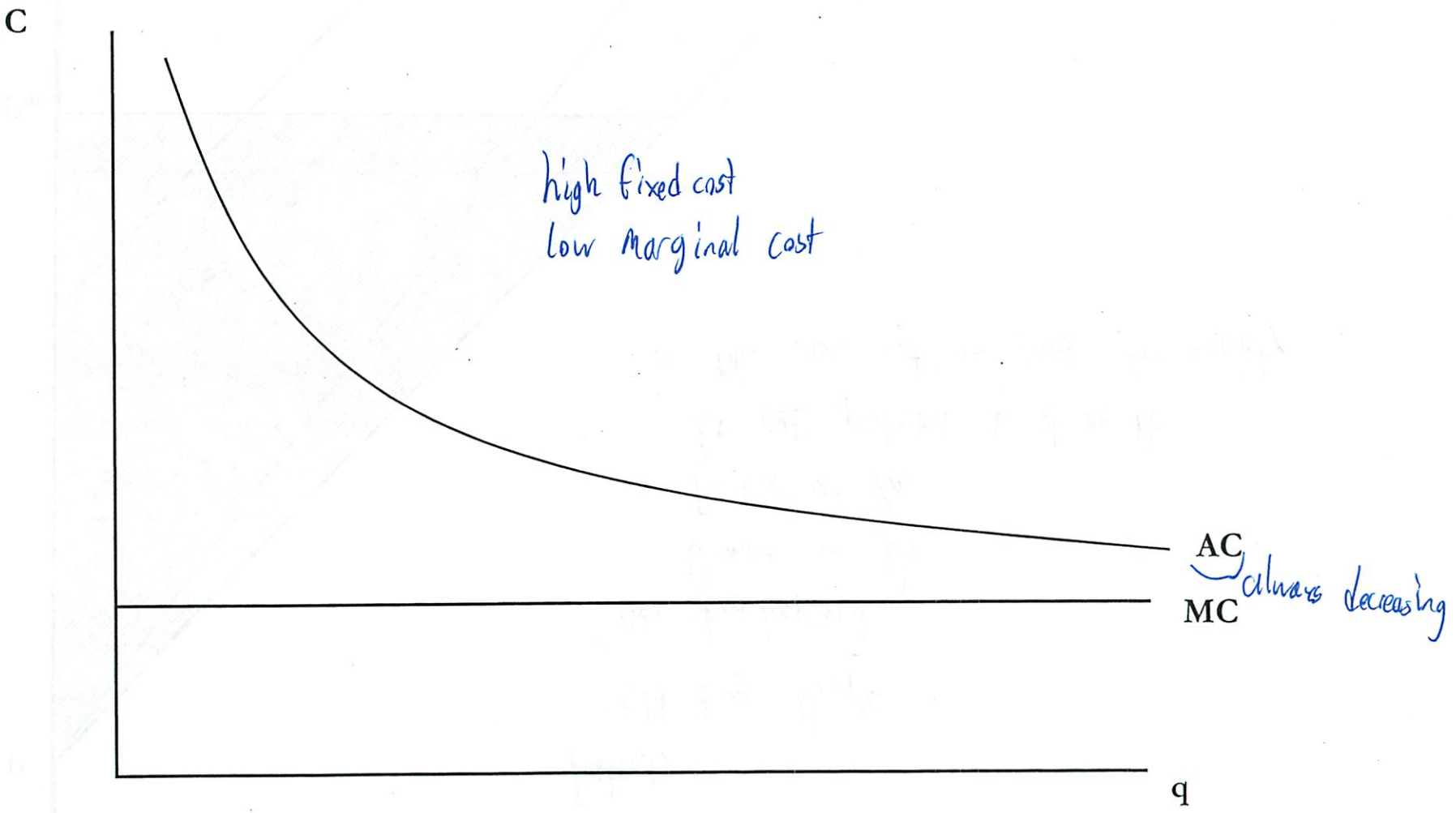
hard/impossible to expand

Can't get into hub

Constraint on slots

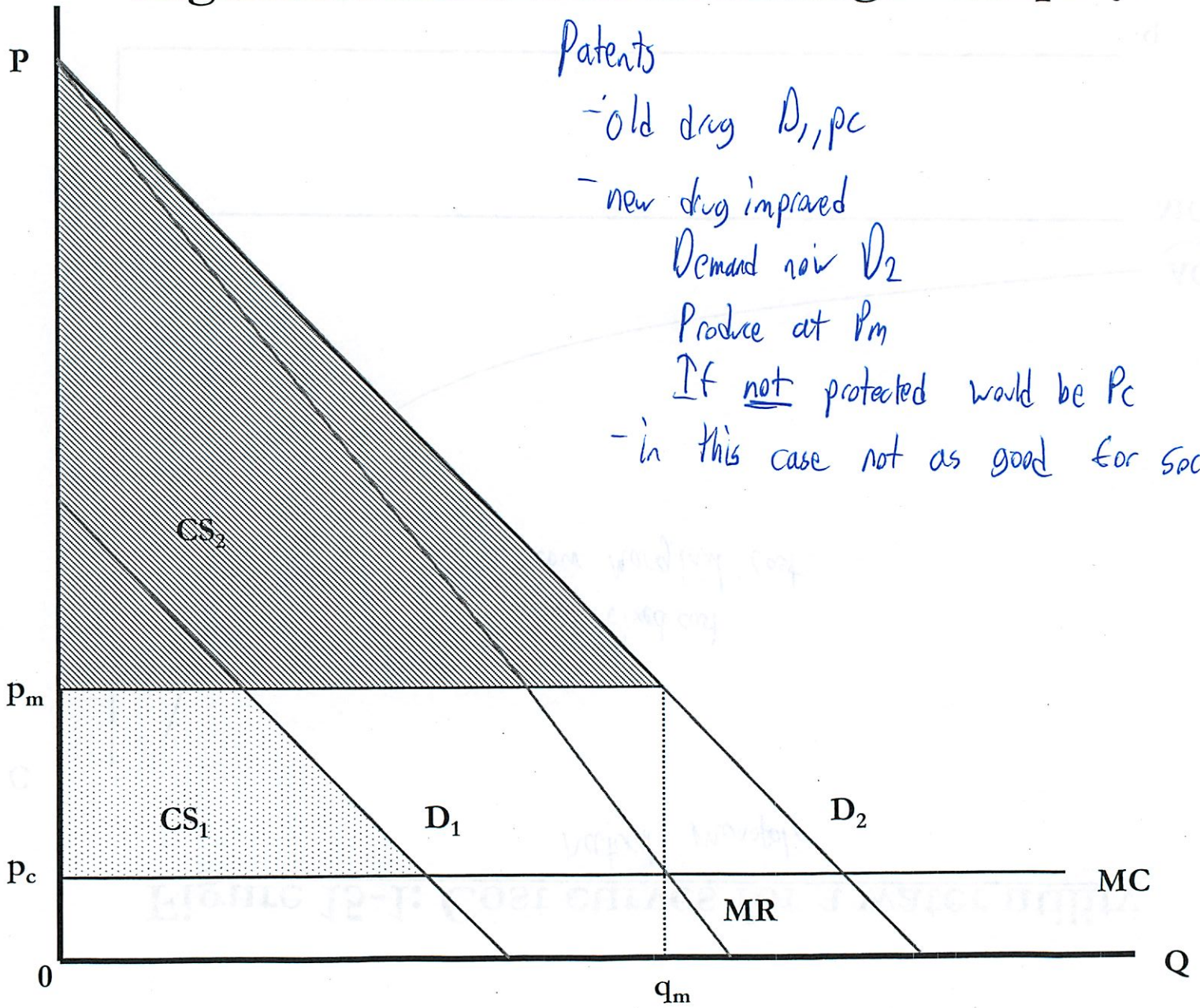
Figure 15-1: Cost curves for a water utility

natural monopoly



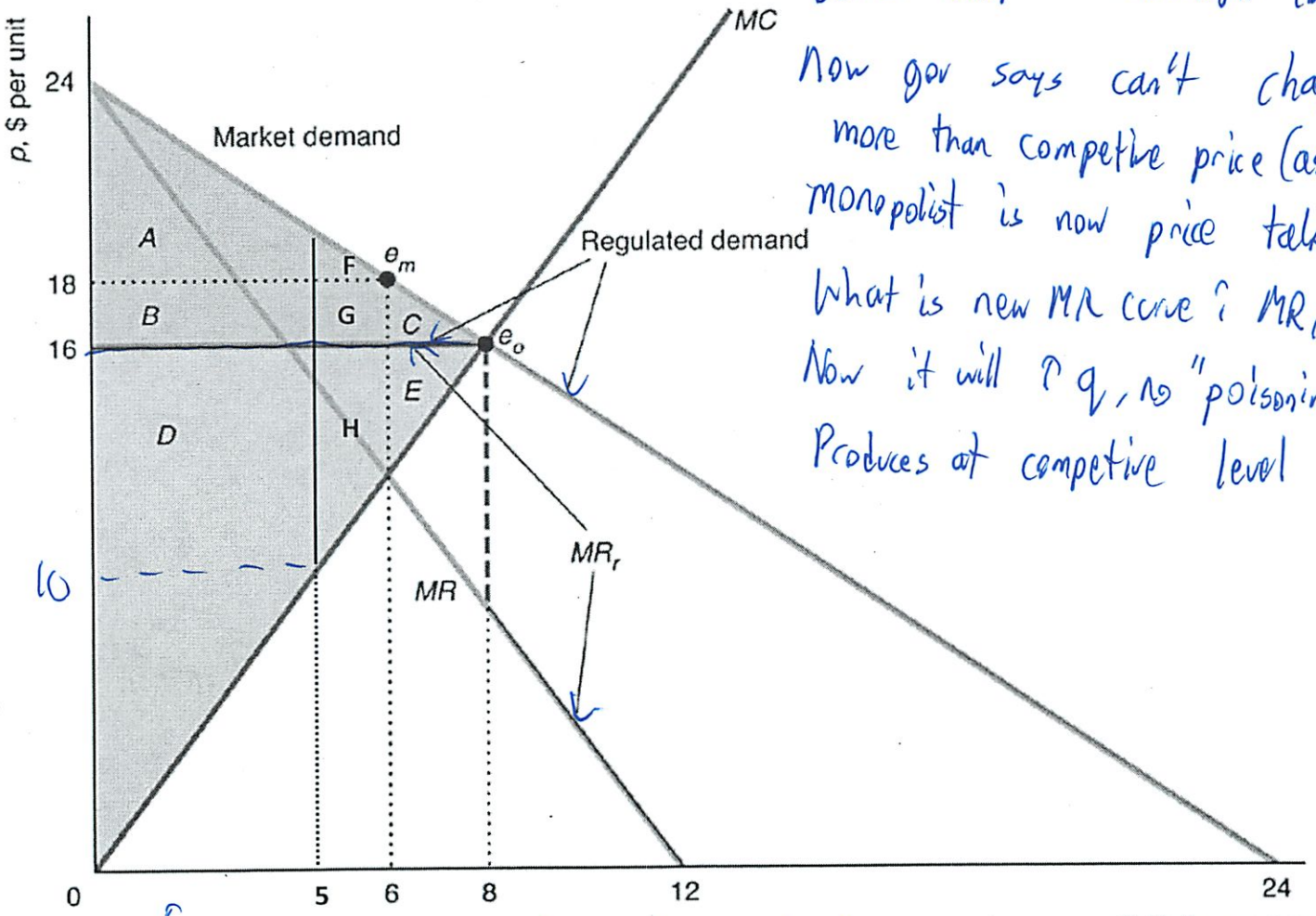
Lecture 15

Figure 15-2: Welfare-increasing monopoly



Patents
- old drug D_1, p_c
- new drug improved
  Demand now D_2
  Produce at p_m
  If not protected would be p_c
- in this case not as good for society

Figure 15-3: Optimal price regulation



DWL-
below price
above supply curve

Before monopolist dead weight loss C+E
Now gov says can't charge more than competive price (assuming it new)
monopolist is now price taker
What is new MR curve? MR_r
Now it will ? q, no "poisoning level"
Produces at competive level

Gov sets too low price CS = A+B+D
DWL = F+G+H+C+E ← small at optimum

could be worse - firm could just shut down

Lecture 16 Oligopoly

11/3

- more realistic
- most monopolies described by
- small # of firms in market, w/ strong barriers to entry
- car industry
- have some market power, but need to worry about competitors
- behave cooperatively = cartel
  - ↳ OPEC
    turn oligopolies into monopolies
    - but hard to do
- behave non-cooperatively
  - most oligopolies
  - today will cover
- game theory
  - has come to dominate economic thinking
  - market has become a game
  - each firm has a strategy
- so we want to know when a bunch of firms strategy combine - what happens
- equalibrium concept - what determins when the game has ended
  - ie where market at equalibrium
  - not when firms shut down

(2)

Nash equalibrium - no firm will want to do anything (based on what other firms doing)
- each firm is doing the best they can

Prisnors Dilema - example of Nash equallibrium

Write a payoff matrix

B \ A	silent	talk
silent	A=1, B=1	A=0, B=5
talk	A=5, B=0	A=2, B=2

(Slightly modified)

Optimal cooperative strategy - silent/silent
- if can discuss
- and trust each other

Dominant strategy - best thing to do despite what the other person does
- A is better off talking no matter what B chooses to do

so Nash Equalibrium is to talk/talk

(class 14.12 is on this - math gets complex though)

if what you do depends on other person does -
- no dominate strategy
- no nash equalibrium

(3)

Note: Goal always is profit maximation

Example for business: advertising

If both firms did not advertise → would split market

But better off advertising

		Pepsi: No Ads	Pepsi: Ads
Coke	No Ads	P=8, C=8	P=13, C=-2
	Ads	P=-2, C=13	P=3, C=3

is profits (in billions)

↑ each has 50-50 market share but both spent #5 on ads

Dominate cooperative strategy - both don't advertise

Dominate non-coop strategy - advertise, despite what other does

Nash equalibrium = ad/ad

tends to be a <u>race to the bottom</u>

Or your personal problems

	Make-Up	Break up
Make up		
Break up		

If both party is so afraid of being dumped

end up w/ worse position than both

(4)

One thing that allows you to overcome: repeated games

- advertising decision every period
- Coke: we won't advertise, except if you do, then we will forever
  - if they trust: Pepsi makes 8 forever
  - if Pepsi does not trust: 13 1st then 3 forever
- so this repeated games enforces cooperation
- Only works if game goes on forever
- If know game will end, then that firm will advertise last period (n)
  - Then other firm says fine, I need to ad. in period (n-1)
  - Then original " " " (n-2)
  - Assuming symetric info

What if asymetric info?

3 players?

Orders to move not simeltaneous

Back to Oligopoly

Covernot model

firms have a whole bunch of choices - not 2

how much to produce, and what price to charge?

nash equalibrium = covernot equalibrium

(5)

Q for each firm chosen so that holding all other firms Q constant, they are making max profit

Steps to Solve

1. Compute each firm's residual demand
   - demand not met by other players
2. Develop a MR
   - function of other firm's Q
3. Do #1, #2 for all firms
4. Have N equations in N unknowns + solve

(Graphically today, math next time)

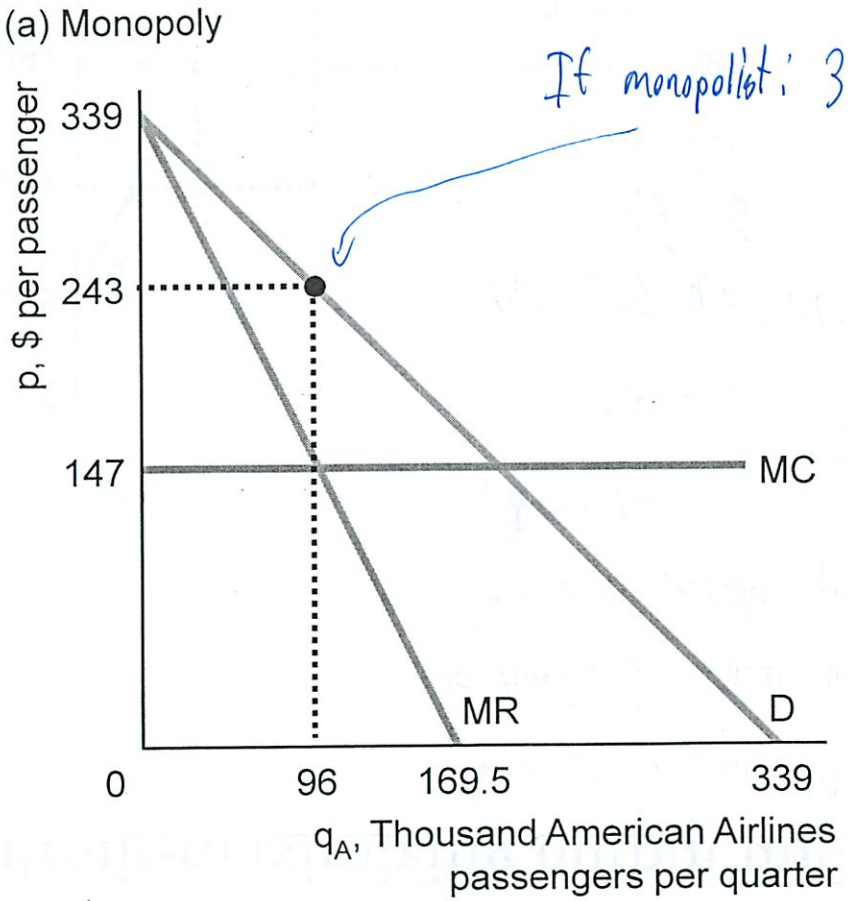
fig 16-1, 16-2, 16-3

11/3

Figure 16-1: Profit-maximizing output under monopoly

D: $p = 339 - Q_D$

MC: 147



Lecture 16

Figure 16-2: Profit-maximizing output under duopoly

Now United enters q_U — Spy says 64

So American's residual demand $q_A = D - q_A$

Then just resolve problem using residual demand

$p = 339 - q_A - q_U$ (≈64)

$p = 275 - q_A$

$MR = 275 - q_A = MC = 147$

$q_A^* = 64$

$p = 211$

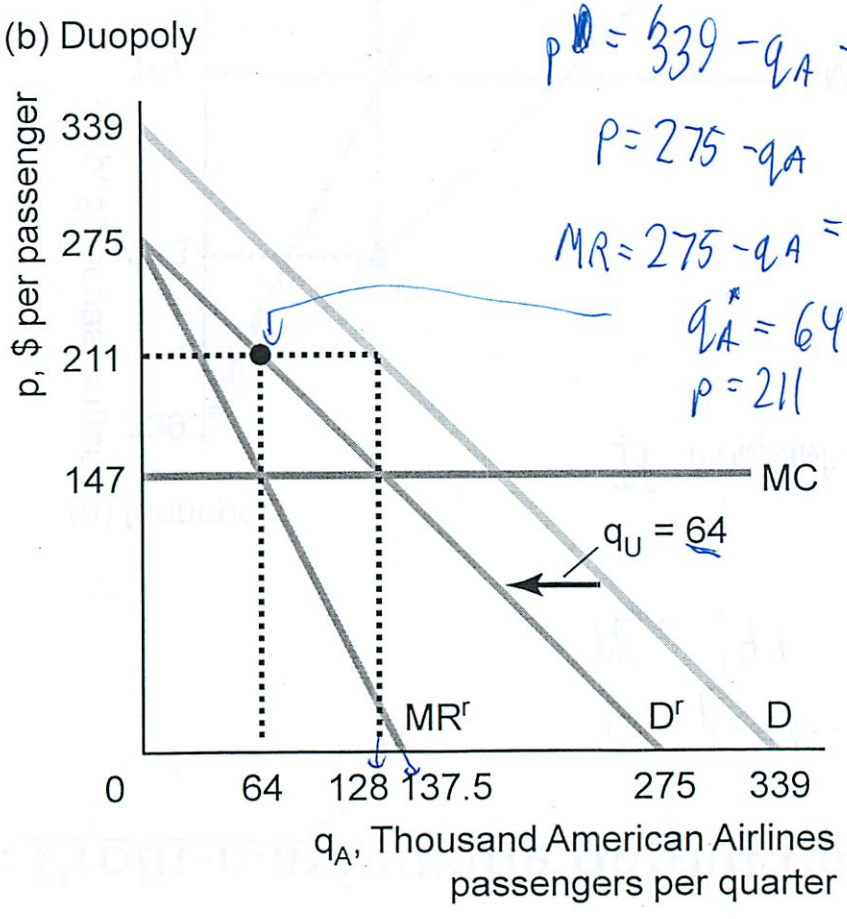
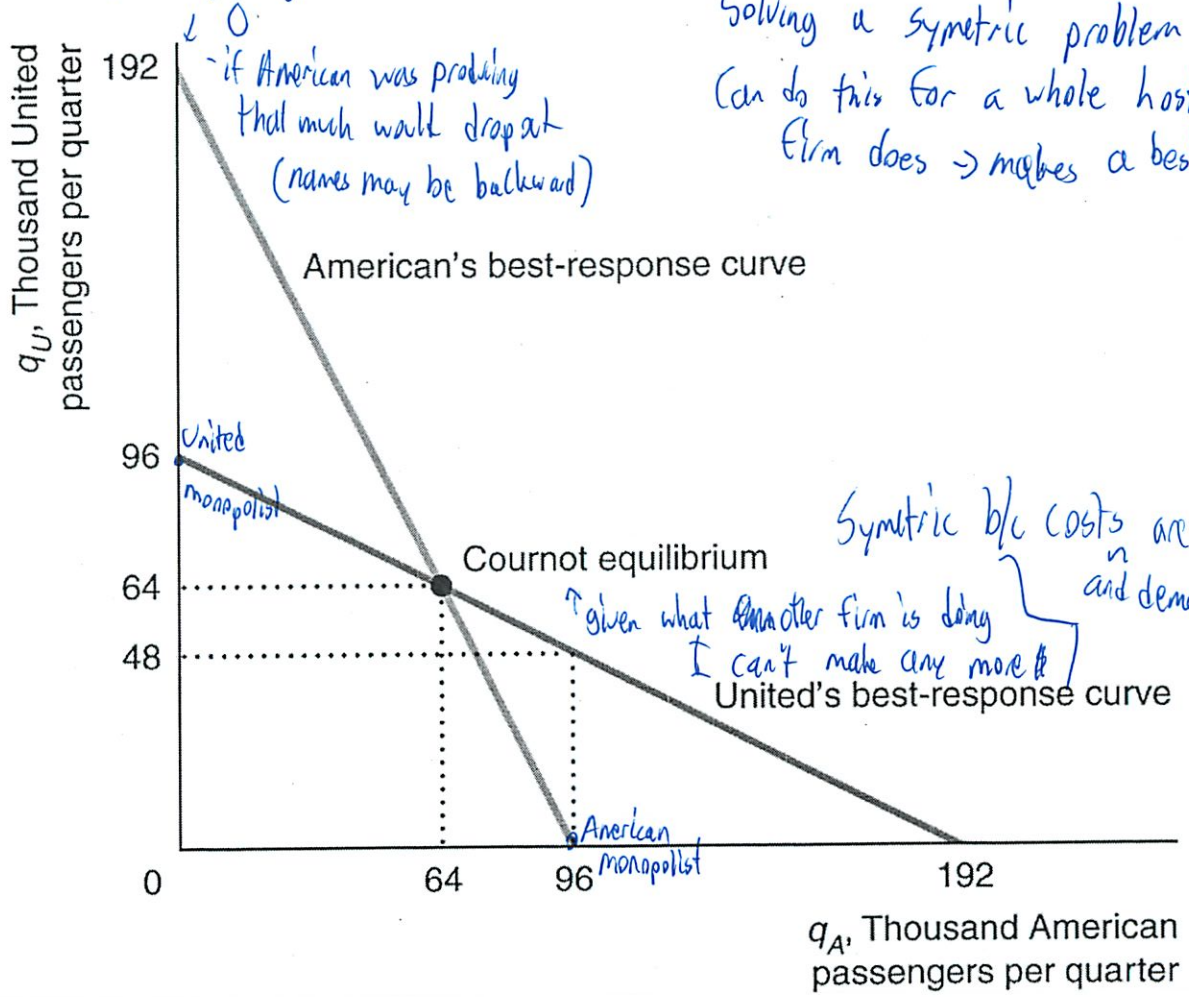


Figure 16-3: American and United's best response curves



How much united would produce if American producing 0

- if American was producing that much would drop at (names may be backward)

But there is no spy -
Each is trying to solve the problem at the same time!
Solving a symetric problem
Can do this for a whole host of what the other firm does → makes a best response curve.

Only possible equilibrium on the curve.

Symetric b/c costs are same in and demand

↑ given what other firm is doing I can't make any more $

Old P-set

14.01 Fall 2009
Problem Set 8
Due: November 13th

1. Please write your **Kerberos ID**, your name, and your section/recitation (e.g. MWF 11am, or F 1pm) on top of your solutions.
2. Problem sets are due IN SECTION/RECITATION. Incomplete problem sets will be accepted; late problem sets will not. Maximize utility accordingly.

Questions:

1. (15 points) For each of the following statements, please indicate whether they are TRUE, FALSE, or UNCERTAIN. No credit will be given without an explanation as to why your claim is true.

   (a) (5 points) Suppose there are two groups of consumers, group A has the less elastic demand and group B has the more elastic demand. Consumers in group A is most likely to be better off under a price-discriminating monopoly than under a non-discriminating monopoly?
   False, Price increases (decreases) for consumers with a more inelastic (elastic) demand.

   (b) (5 points) A monopolist maximizing profit will produce up to the point where $MC = P$ if the market demand is perfectly elastic.
   True, The pricing is given by $MC = P\left(1 + \frac{1}{\epsilon_d}\right)$. *A perfectly elastic demand is translated by* $MC = P$.

   (c) (5 points) A monopolist will never produce in an inelastic (between -1 and zero) part of the demand curve.
   True, If producing at the inelastic portion of the deman curve, the monopoly could lower the quantity produced and raise the price to achieve more total revenue.

2. (40 points) Assume a monopolist faces a market demand curve

$$D(p) = 50 - 20p$$

and has the short-run total cost function

$$C(q) = 1 + 2q$$

   (a) (8 points) What is the profit-maximizing level of output?
   The profit-maximizing level of output is defined as follows

$$\max_q \{p \cdot q - (1 + 2q)\}$$

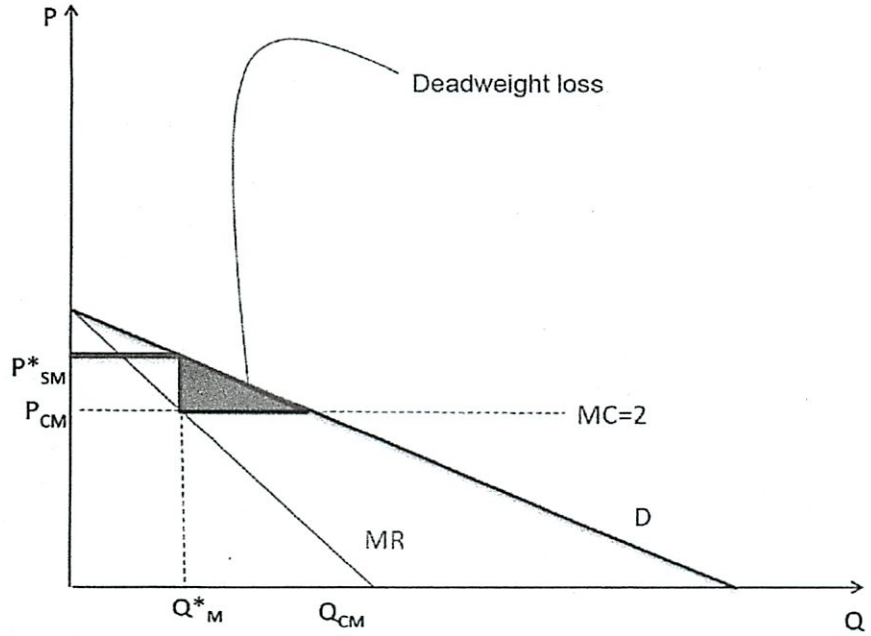
   or $MR = MC$, *where* $TR = p \cdot q = \frac{50 - q}{20} \cdot q$ *and so* $MR = \frac{50 - 2q}{20}$. *Hence, the level of output is* $q^m = 5$.

   (b) (8 points) What are profits of the monopolist?
   The profit is defined as

$$\begin{aligned} \pi &= \frac{45}{4} - (1 + 2 \cdot 5) \\ &= \frac{1}{4} \end{aligned}$$

   where $p^m = \frac{50 - 5}{20} = \frac{9}{4}$.

(c) (8 points) Graph the marginal revenue, marginal cost, and demand curves, and show the area that represents deadweight loss on the graph.



(d) (8 points) What would price and output be if the firm priced at socially efficient (competitive) levels?

$MC = p$ where $MC = 2$. Hence, $p^c = 2 < p^m = \frac{9}{4}$. $q^c = 10$.

(e) (8 points) What is the magnitude of the deadweight loss caused by monopoly pricing?

The Deadweight loss is given by:

$$\begin{aligned} DW &= (p^m - p) * (q - q^m) * \frac{1}{2} \\ &= \frac{1}{4} * 5 * \frac{1}{2} = \frac{5}{8} \end{aligned}$$

3. (45 points) Suppose the owner of a theater can identify between two types of consumers, the Student and the Non Student, by asking student their school ID. The non students and students have the following (inverse) demand functions, respectively:

$$P_N(t) = 200 - t_N$$

$$P_S(t) = 180 - t_S$$

where t is the number of theater tickets. Suppose that the cost of providing a seat at the theater is given by the following function:

$$c(t_N, t_S) = 2(t_N + t_S)^2$$

(a) (10 points) Find the prices the owner would charge each group and quantities the two groups of consumers are going to buy.

Since the owner of the theater can price discriminate, he is the following problem:

$$\max_{t_S, t_N} \{p_S t_S + p_N t_N - 2(t_N + t_S)^2\}$$

$(180 - t_s)t_s + (200 - t_N)t_N - 2(t_N + t_s)^2$

$200 - 2t_N - 4(t_N + t_s) = 0 \quad 200 - 6t_N + 4t_s = 0$

$\frac{100 - 2t_s}{3} = t_N$

where p_i for $i = N, T$ for i defined as above. The equilibrium quantities must satisfy

$$t_N = \frac{100 - 2t_S}{3}$$

and

$$t_S = \frac{90 - 2t_N}{3}$$

Hence, we have:

$$t_S = 14 \text{ and } t_N = 24$$

Furthermore, the equilibrium prices are just $p_S^* = 166$ and $p_N^* = 176$.

(b) (5 points) Compute the owner's profit.

The monopolist profit is given by

$$\pi = 176 * 24 + 166 * 14 - 2(14 + 24)^2 = 3660$$

(c) (10 points) Now suppose that the owner cannot price discriminate and can only charge one price. Find the quantity consumed by each group, the price the owner charges as well as the owner's profit.

Since the owner can't price discriminate, the total demand is $p = \frac{380 - t}{2}$ for $t > 20$ and $p = 200 - t$ for $t < 20$. So,

$$\max_t \{t \cdot p - 2t^2\},$$

The equilibrium quantity is $t^* = 38$ and $p^* = 171$. At this price student will buy less than before and the non student will buy more than before.

$$t_S = 180 - \frac{665}{4} = 9$$

$$t_N = 200 - \frac{665}{4} = 29$$

(d) (10 points) Is the owner better off with or without the price discrimination. What about the two groups of consumers.

The owner is better off with the price discrimination. His profit from non-discrimination is:

$$\pi' = 38 \cdot 171 - 2\,(38)^2 = 3610$$

which is less then his profit from price discrimination. The non students are better off and the students are worse off when the owner cannot price discriminate.

(e) (5 points) Now suppose the students have the following demand.

$$P_S\,(t) = 160 - t_S$$

Derive the new price without discrimination. How many tickets do students buy? What about the non students.

Now, the total demand faced by the monopolist is given by: $p = \frac{360-t}{2}$ for $t \geq 40$ and $p = 200 - t$ for $t < 40$. Now, it becomes optimal for the owner to exclude students and sell only to non-students, i.e. he would set $t^* = \frac{100}{3}$ and $p^* = \frac{500}{3}$. Students buy zero tickets at that price.

(f) (5 points) Compare the number of tickets bought by the students under no price discrimination to the number of tickets bought by the them under price discrimination. When are students better off?

Under the discrimination, the price is given by:

$$t_N = 28$$

and

$$t_S = 8$$

Under the non-discriminatory price, the group of students is not consuming because the price is too high and at this price they are not willing to buy. On the other hand, the group of non student is consuming a positive number. Price discrimination makes the students better off.

(20)

4. Duopoly

Firm 1 → $C_1(y_1) = (y_1)^2$ $\quad y_1 \geq 0$

Firm 2 → $C_2(y_2) = 12 y_2$ $\quad y_2 \geq 0$

Industry output $Y = (y_1 + y_2)$

$P = 100 - Y$

a) Find reaction of each duopolist

1. Each firms residual demand

$Y_1 = Y - Y_2$ $\qquad Y_2 = Y - Y_1$

Not demand ~~$C_1(y_1) = (Y - y_2)^2$~~ $\qquad C_2(y_2) = 12(Y - y_1)$

2. Develop a MR as function other firms q

$MR_1 = y_1(100 - Y_1)$ $\qquad MR_2 = y_2(100 - Y_1)$

$y_1(100 - y_1 - y_2)$ $\qquad y_2(100 - y_1 - y_2)$

MR not →

$Y - Y_2(100 - Y)$ $\qquad Y - Y_1(100 - Y)$

$100Y - 100Y_2 - Y^2 - YY_2$ $\qquad 100Y - 100Y_1 - Y^2 - YY_1$

Keep Y_1 Y_2 when Marginal disappears

Should be intuitive

Exam 2 11/9 Walker 7:30 Gym

Recitation

11/5

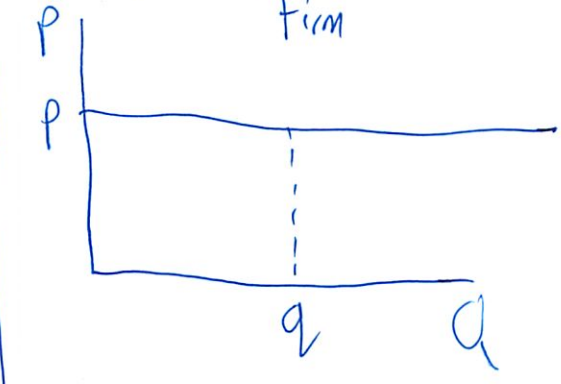
P-Set 7

#3

$Q = 30 - P$

$\text{Cost}(q_s) = \frac{1}{2}q^2$

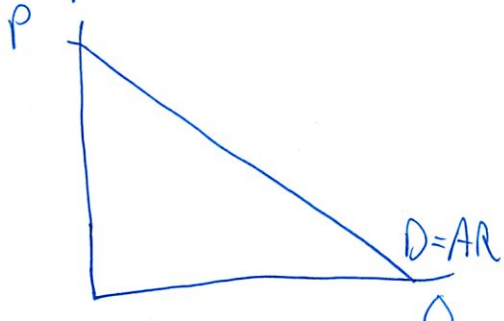
Perfectly competitive Firm



$MR = p$ = Demand

Demand curve = AR

Monopolist



$TR = P(Q) \cdot Q$

$AR = \frac{TR}{Q} = P(Q)$

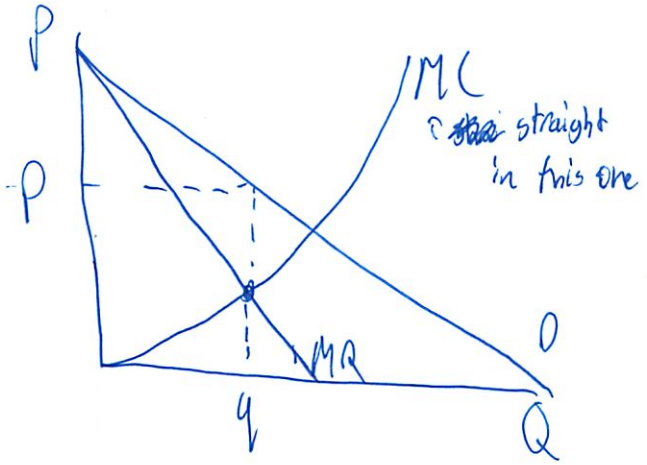
$MR = \frac{\Delta TR}{\Delta Q} = \frac{d\,TR}{dQ} = P(Q) + Q\frac{dP}{dq}$

Must decrease price for all marginal units sold

always $< P(Q) = AR$ "poisoning effect"

(2)

So MR below demand curve for monopolist



$Q = 30 - P$ $\quad P = 30 - Q$

$TR = P(Q) \cdot Q = (30 - Q)Q$

$MR = 30 - 2Q$

$MC = Q$

$MR = MC$

$30 - 2Q = Q$

(I got this - this is easy)

$Q_M = 10$

$P_M = 20$

$MR = P(Q) + Q \frac{dP}{dQ}$ In general

$= P(Q)\left(1 + \frac{Q}{P(Q)} \cdot \frac{dP}{dQ}\right)$

when don't have fixed cost

$\pi = PS$

Consumer Surplus $= \overset{\text{Total}}{WTP} -$ Total Actual Expenditures

demand curve = marginal WTP

$\int$ under demand curve $- \int$ total actual expenditures

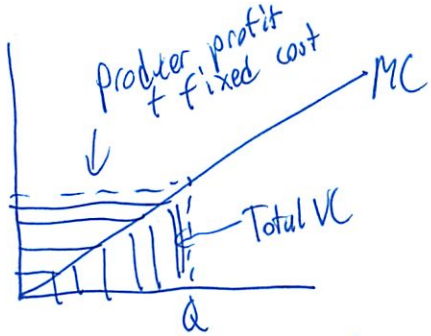
(~~I~~ I like thinking about it like that)

Producer Surplus =

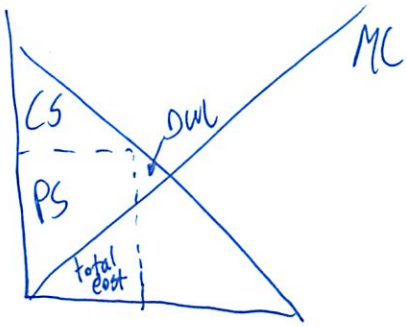
$MC = \frac{dTC}{dQ} = \frac{d(FC + VC)}{dQ} = 0 + \frac{dVC}{Q}$

(3)

$$\int_0^a MC\, dq = VC(q)$$



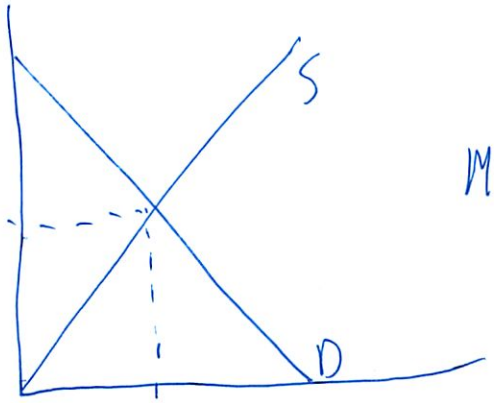
? Revenue is rectangle



Producer surplus = Producer welfare

DWL = demand WTP <u>above</u> MC to produce

Welfare maximized at perfectly competitive output level



MWTP = MC

No DWL at perfectly competitive

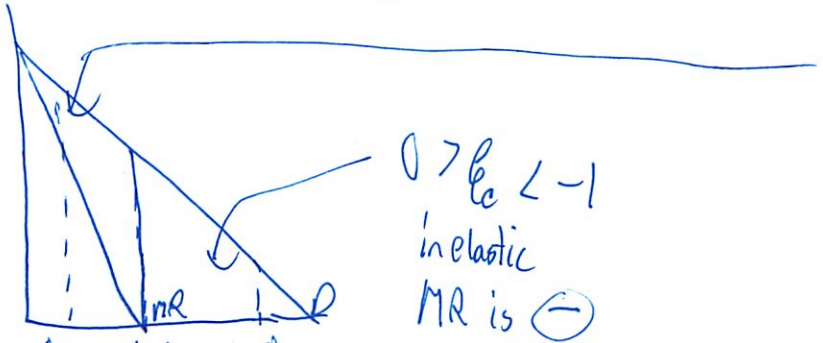
↳ any level not that leads to DWL

(4)

$$MR = P(Q) + Q\frac{dP}{dQ}$$

$$= P(Q)\left(1 + \underbrace{\frac{Q}{P(Q)} \cdot \frac{dP}{dQ}}_{\frac{1}{\frac{dQ}{dP}\cdot\frac{P}{Q}} = \frac{1}{\varepsilon_d}}\right)$$

$$= P\left(1 + \frac{1}{\varepsilon_D}\right)$$ ← memorize!



Q_2 elasticity mid point ↑ $\varepsilon = -1$ produce ~~here~~ depends on MC

$0 > \varepsilon_d < -1$ inelastic MR is (−) so monopolist will never produce here

Q_1

$MR = 0$

Monopoly output in this range

(5)

b) Whats socially optimal P, Q

$MC = P$

total welfare maximized

$Q^* = 15$

$P^* = 15$

DWL due to monopolist behavior

- since 0 at socially optimal level

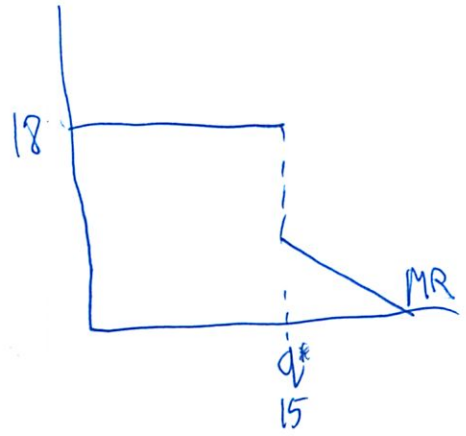
PS still = π since still no fixed cost = 150

CS = 50

$DWL = \frac{10 \cdot 5}{2} = 25$

---

c) Price Ceiling



Always MR > MC

$\pi = PQ - C(Q)$

$= 18 \cdot 12 - \frac{1}{2}(12)^2$

profits are lower

DWL decreased

(6)

d) What price ceiling should it choose

15

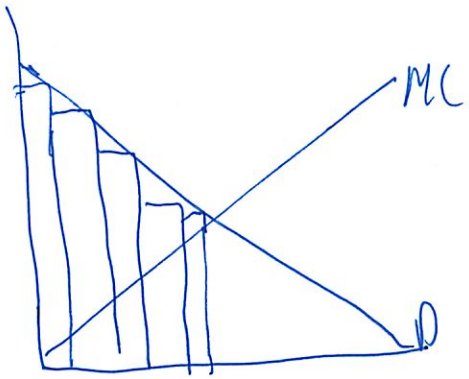
Makes DWL = 0

That was a uniform price monopolist

Can charge diff. people diff. prices

- price discrimination

Perfect Price Discrimination =



#2
P-set was 1 person
ohhhh

each person

0 CS

MR = Demand curve = AR

Produce MR = MC

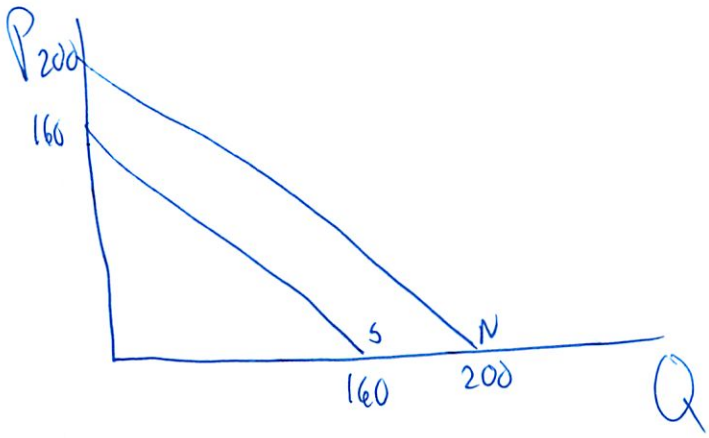
D = MC ∴ sells socially optimal/competive output level

(7)

#2 Graphically

$Q_S = 160 - P_S$

$Q_N = 200 - P_N$



Would sell socially optimall # of songs

S

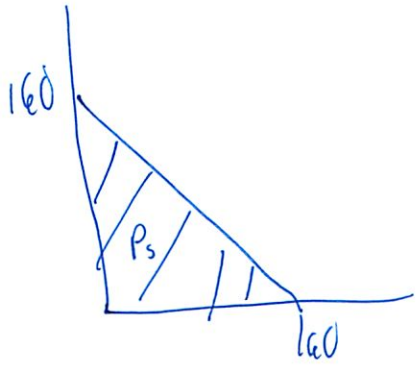
$q = 160$

p = for bundle

N

$q = 200$

↑ what fee for using 160 → their total WTP



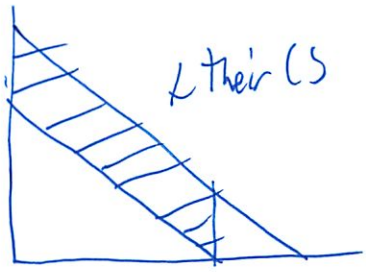
like cell phone bill

pay fixed fee for bucket of songs

2 Part Tarrif

(8)

If N buy this is their CS



Can charge

140 songs
- same reasoning

4. Was Oligopoly
- no math Oligopoly on midterm
- but concepts

So far have been doing continous + differential supply curves, etc

if
$Q=0 \quad C=0$
$Q=1 \quad C=2$
$Q=4 \quad C=4$

how would find optimal amt

(9) given constant price

max $\pi = TR - TC \Rightarrow MR = MC$

$P = MC$

Look at $\pi_0 = 0$

$\pi_1 = P - 2$

$\pi_4 = 4p - 4$

Check inequalities

Where is profit highest?

(No $P = MC$)

For given price - how much output to produce

gives you inverse supply

11/5

Topic Review

14.01: Section 9 - Midterm 2 Review
November 5, 2010

1 Production and Costs (Chapters 6 and 7)

- Lecture 8: Production

  I. Production Functions
  - $Q = f(L, K)$;

  II. Short Run Production
  - there is a fixed factor of production, usually capital (plant size is fixed in SR);

  III. Long Run Production
  - all factors are variable;

- Lecture 9 - Production & Costs

  I. Productivity

  II. Costs
  - Fixed cost = cost on fixed factor;
  - Variable cost = cost on variable factor;
  - Total cost = Fixed cost + Variable Cost;
  - Marginal cost = additional cost of producing one more unit, $MC = \frac{\triangle TC}{\triangle Q}$. If total cost function is differentiable, then $MC = \frac{dTC}{dQ}$.
  - Average cost = cost per unit of output;

  III. Long Run Cost Curves
  - all factors variable, factor input demand is such that $MRTS = \frac{w}{r}$, tangency between isoquant and isocost curve determines optimal mix of inputs and minimum cost of production;
  - Marginal cost and Average cost defined in the same way;
  - LRAC is the lower envelope of SRAC for different plant sizes, i.e. LR cost of production lower than SR cost of production.
  - LRAC=SRAC implies SRMC=LRMC.
  - economies of scale and scope.

2 Competition (Chapter 8)

- Lecture 10 - Competition

  I. Perfect Competition
  - firms and consumers are price takes;
  - symmetric information;
  - no transaction costs;

- free entry and exit in the long run;

II. Short Run Profit Maximization

- firm maximizes profits by producing output where $MR = MC$;
- competitive firm faces a perfectly elastic demand curve, $MR = P$. Hence, for a perfectly competitive firm, $P = MC$;
- in short run firms use short run cost curves (SRMC, ATC, AVC) to make profit maximization and shut down decisions;
- firm shuts down if $P < \min AVC$;
- derive individual firm short run supply curve using $P = MC$ and $Q = 0$ (shut down) for $P < \min AVC$.
- SR market supply curve is horizontal sum of individual firm SR supply curves.
- industry profits can be positive or negative in SR.

- Lecture 11 - Competition II

I. Competition in the Long Run

- in LR free entry and exit drives economic profits to 0, i.e. $P = MC = AC$. Hence, LR industry supply curve is perfectly elastic at $P = \min AC$ and each firm produces at $q = \arg\min AC$;
- with barriers to entry, problem is as in the SR only firms use their LR cost curves; LR individual supply curve with barriers to entry is LRMC curve above minimum of AC and 0 below.
- SR supply less elastic than LR supply with entry barriers, which is less elastic than LR supply with free entry.
- Increasing input prices can lead to an upward sloping LR supply curve even with free entry;

- Lecture 12 - Competition III

I. Do Firms Maximize Profits?

- agency problem when manager of firm does not own full stake in the firm;
- allign incentives by using stock options and other payment schemes - can lead to excessive risk taking and short term behavior;

3 Welfare Economics (Chapter 9)

- Lecture 13 - Welfare Economics

I. Consumer Surplus

- demand curve represents marginal willingness to pay for good;
- area under demand curve and above the price is the value from consuming the good in monetary terms - consumer surplus;

II. Producer Surplus

- supply curve comes from marginal cost of production;
- area above supply curve and below price is net benefit to producers - producer surplus;

III. Competition Maximizes Welfare

- total welfare (CS+PS) maximized when demand=supply, i.e. at perferctly competitive output level;
- any other output level leads to a deadweight loss (gains from trade that are left unexploited);
- government policies done for redistributive reasons or to raise tax revenues;

IV. Government policies

- price controls (price ceiling);
- price support/minimum wage (price floor);
- import tariffs/quotas;
- unit tax/subsidy;

4 Monopoly (Chapter 11)

- Lecture 14 - Monopoly I

I. Monopoly Profit Maximization

- total revenue is $TR = P(Q) \cdot Q$;
- average revenue for a firm is given by demand curve, $AR = P(Q)$;
- marginal revenue is additional revenue from selling one more unit, $MR = \frac{\triangle TR}{\triangle Q}$ or if revenue function is differentiable, $MR = \frac{dTR}{dQ}$.
- perfectly competitive firm faces a perfectly elastic demand curve, $P(Q) = P$ and hence, $MR = P = AR$.
- monopoly faces downward sloping demand curve and hence $MR = P(Q) + Q \cdot \frac{dP}{dQ} < P(Q)$ since $\frac{dP}{dQ} < 0$.
- monopolist has to decrease price on all units sold in order to sell one additional unit. Not the case with a perfectly competitive firm, which cannot influence the price at which it sells.
- MR curve for monopolist is below AR curve (the demand curve).
- $MR = P(Q) + Q \cdot \frac{dP}{dQ} = P(Q)(1 + \frac{Q}{P(Q)}\frac{dP}{dQ}) = P \cdot (1 + \frac{1}{\epsilon_D})$. For $|\epsilon_D| < 1$, $MR < 0$ and so a monopoly never produces at the inelastic part of the demand curve.
- Profit maximization $\implies MR = MC$. Hence, $P \cdot (1 + \frac{1}{\epsilon_D}) = MC$ or $\frac{P-MC}{P} = -\frac{1}{\epsilon_D}$: mark-up, measure of monopoly power.
- Shut down decision is like that of a competitive firm.

II. Welfare Effects of Monopoly

- Because $MR < AR$, monopolist would supply less than the socially optimal (welfare maximizing) level of output, which leads to a deadweight loss;

- Lecture 15 - Monopoly II

  I. Price Discrimination
  - above analysis is for a uniform pricing monopoly - the monopolist sets the same price for every unit sold or for every consumer type.
  - monopolist can price discriminate - set different prices for different units, charge different uniform prices for different consumer groups, use two part tariffs, etc.
  - perfect price discrimination/1st degree price discrimination - monopolist charges each consumer their willingness to pay for the good, and hence extracts all the consumer surplus. MR curve is now the AR curve, i.e. the demand curve. Set output where new MR curve equals MC, i.e. where demand intersects MC.
  - hence, a perfectly price discriminating monopolist produces the socially optimal output level.

  II. How do Monopolies Arise?
  - cost advantages - natural monopoly, for any output produce at lower AC than any other firm can (AC is declining);
  - barriers to entry - fixed costs, patents;

  III. Regulating Monopolies
  - Government regulation of monopoly, through a price ceiling can improve welfare. Setting a price ceiling at the competitive price leads to zero DWL.
  - Effect of a unit tax on the price of good - price of good can increase by less than 1 for 1 with the tax or by more - difference with perfectly competitive market.

  IV. Contestable Markets
  - threat of entry "disciplines" monopolist and they charge a price close to the perfectly competitive price.

5 Other Market Structures (Chapter 13)

- Lecture 16 - Other Market Structures

  I. Oligopoly
  - small number of firms that interact strategically (not price takers but have to take into account other firms' decisions when making their own decisions);
  - duopoly - narket with two firms;

  II. Game Theory
  - study of the outcome of strategic interactions;
  - player's objective is to maximize payoffs given actions of others;
  - non-cooperative games - players cannot enforce mutually beneficial strategies;
  - strategies - possible actions that players choose from to maximized payoffs;
  - dominant strategy - strategy that maximizes a player's payoff no matter what the other player does;
  - Nash equilibrium - each player is doing the best it can (maximized payoff) given the actions of its opponents;

III. Cournot Model of Noncooperative Equilibrium

- Cournot doupoly - two firms compete by setting **output** levels **simultaneously**. Each firm treats the output of its competitor as fixed;
- Reaction curve - relationship between firm's profit maximizing output and output it thinks its competitor will produce;
- Cournot equilibrium - Nash equilibrium of Cournot duopoly game. Output levels for which reaction curves intersect.

Econ OH

11/5

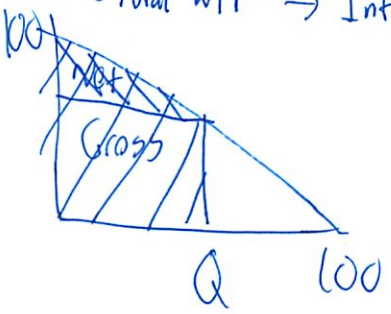
~~New vs Total~~

~~vs~~ vs ~~Gross~~

P-set calls it

Gross vs Net

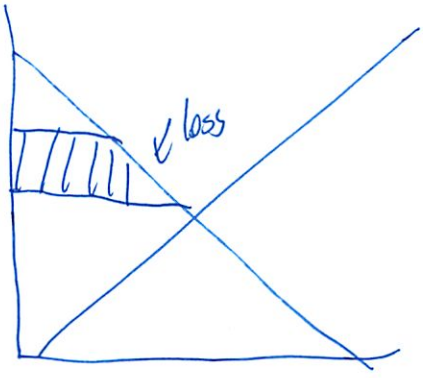
↳ Total WTP → Integral under demand



$Q = 100 - P$

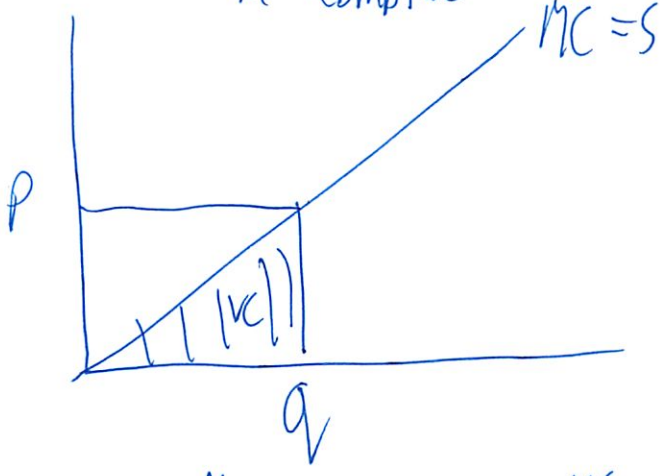
I was thinking "New" CS as delta in CS

- like if gov does price floor
- trapizod is lost CS



(2)

Producer surplus in Comptive market

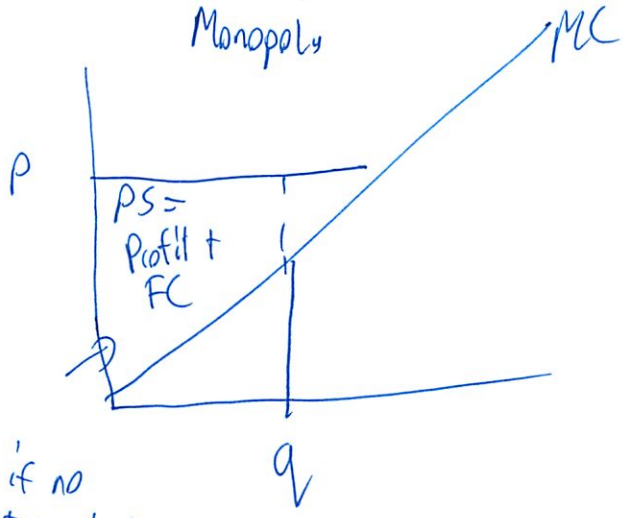


monopoly have supply point

$$MC = \frac{dTC}{dq} = \frac{dVC}{dq}$$

since $\frac{dFC}{dq} = 0$

Monopoly

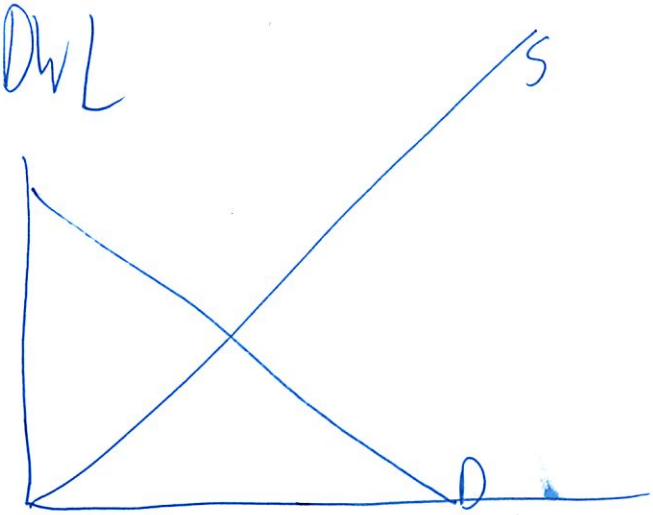


if no FC, just profit

$PS = \Pi + FC$

↙ usually look at LR where nothing fixed so usually no FC but in SR, monopoly inc. FC

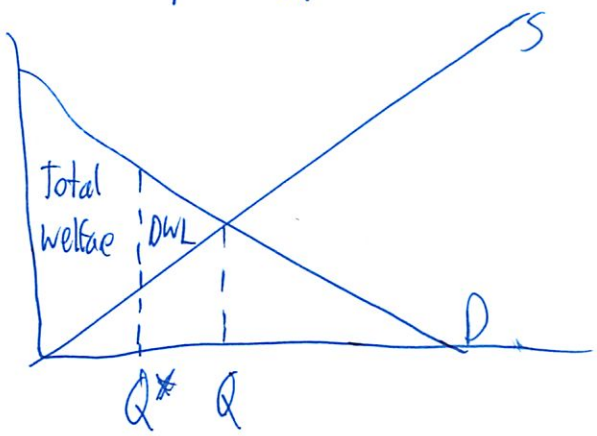
(3) DWL



Competive market
no DWL,
unless gov intervention

What Q maximizes CS + PS = total welfare
when S=D

But output Q*

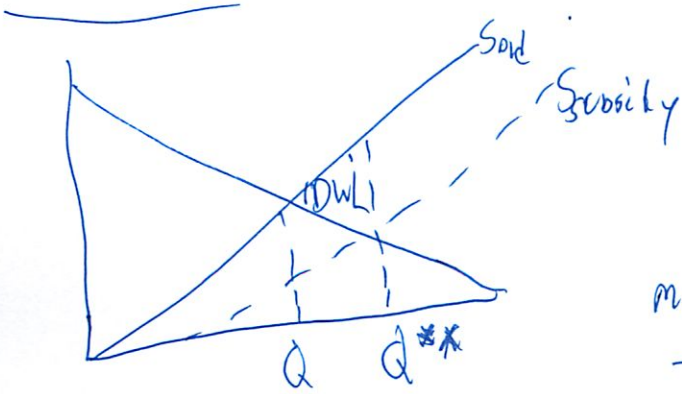


Consumers are willing to pay that price above MC

gains from trade that are left unexploited

?
gov fixes output

- bad for social welfare



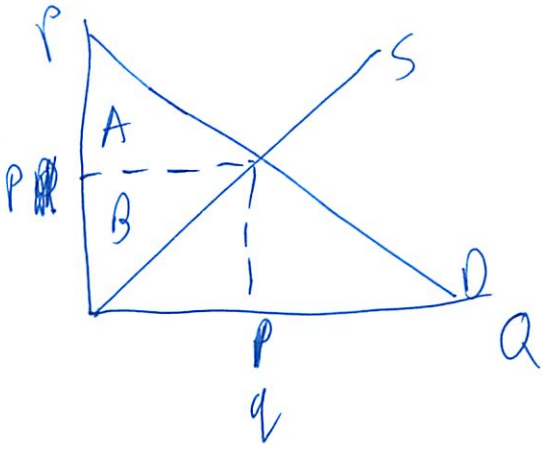
who is paying
must consider subsidys
- this is a waste

4

↓ Gruber said

DWL → below price, above supply curve

only in some situations

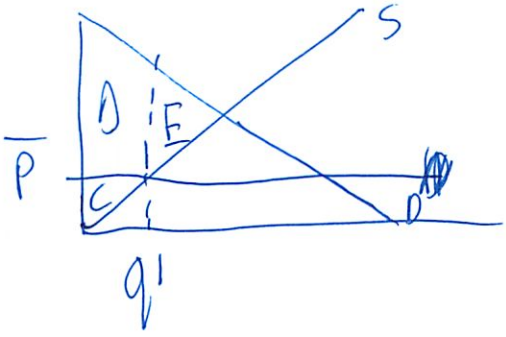


Price ceiling / price control

old

CS = A

PS = B



Consumers can only buy what is supplied

new

CS = D

PS = C

DWL = E = loss of consumers + loss of producers

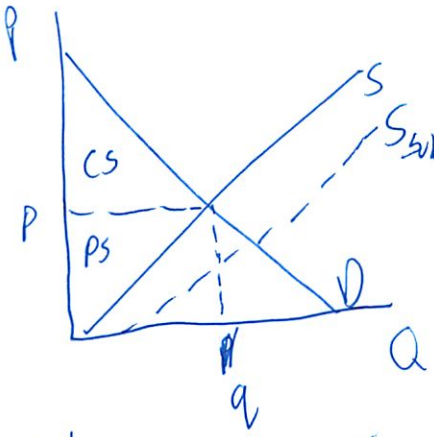
tries to redistribute surplus from producers → consumers

consumers are better off

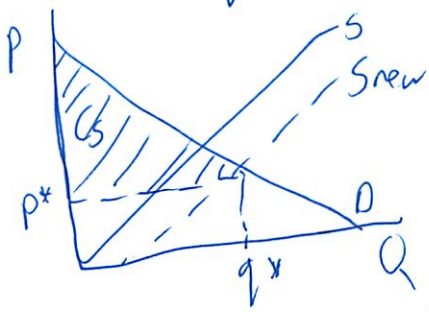
but worse to society in general

don't worry about producers being consumers, etc

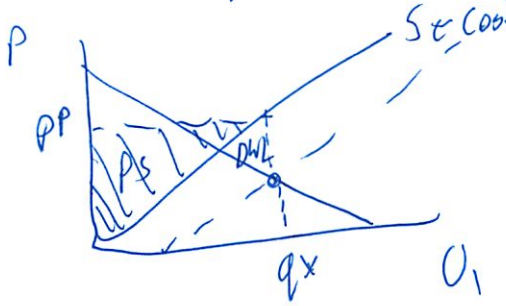
(5)



Subsidy is ↓ shift in supply curve
for given q producers supply more



Producers get the subsidy as well (P^*)



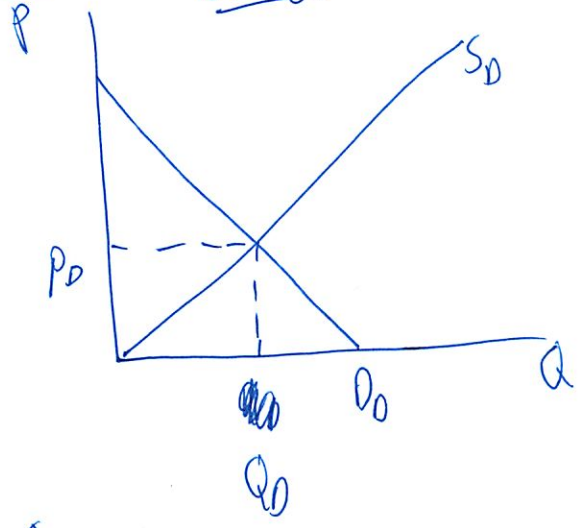
Why can CS, PS overlap?
Gov paying (aka other tax payers)
↓ gov puts out

Part of subsidy goes to Consumers + producers

(6)

Trade Closed

D_0 = Domestic



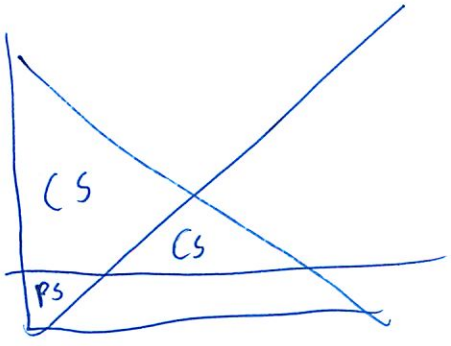
Open

P_W = world price

domestic producers compete at this world price

~~export~~ domestic | international imports

both charge P_W



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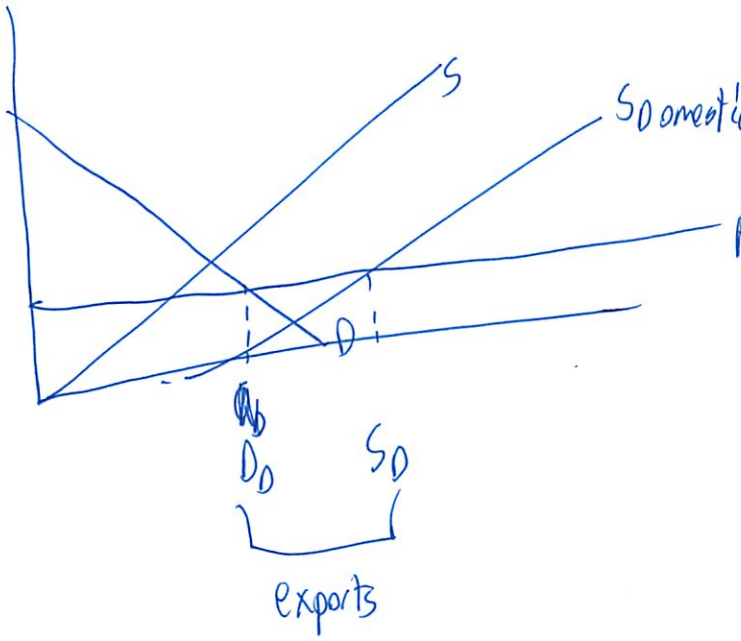


a lot more efficient or export subsidies

don't get into retaliation.

"moderate plenty" = small shift in supply curve

Non Cooperative

Figure 16-3: American and United's best response curves

Monopoly

$P = 339 - Q$

$MC = 147 = AC$

$MR = MC$

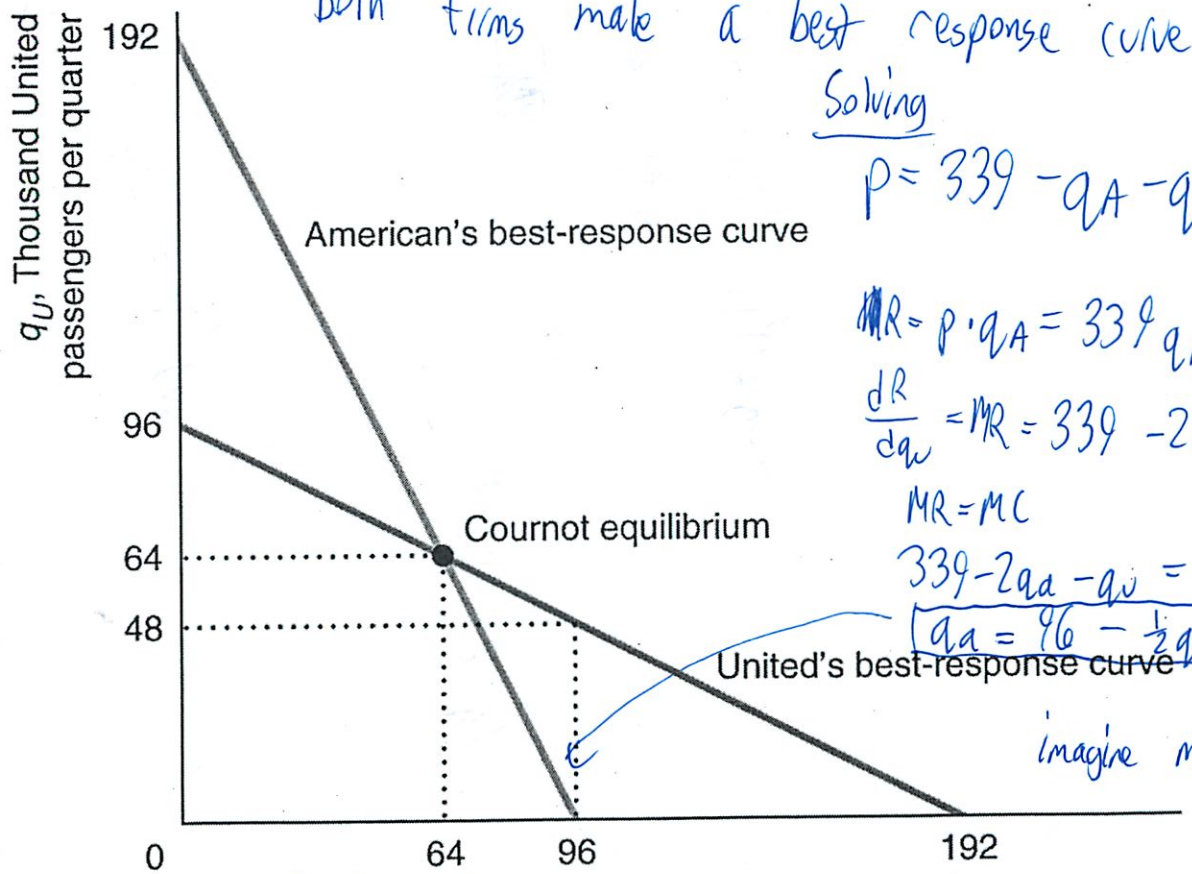
$339 - 2Q = 147$

$Q_m = 96 \quad P_m = 243$

$q_A = Q - q_U$

given what other firm is doing

both firms make a best response curve



Solving

$P = 339 - q_A - q_U$ outside given factor

$MR = P \cdot q_A = 339 q_A - q_A^2 - q_U q_A$

$\frac{dR}{dq_U} = MR = 339 - 2q_A - q_U$

$MR = MC$

$339 - 2q_A - q_U = 147$

$q_A = 96 - \frac{1}{2} q_U$

imagine monopoly except worry about other guy

don't really think about prisoners dilema parallel

Cournot equilibrium

$q_A = q_U$

$q_A = q_U = 64$

$P = 339 - q_A - q_U = 211$

$q_U = 96 - \frac{1}{2} q_A$ since symetrical

don't have to be symetrical

Lecture 7

8/11

Cooperative 

$Q_m = 96$ ← monopoly q

$P_m = 243$

$\pi = 48(243 - 147) = 4,608$

↑ split q in half

$q_{each} = \frac{Q_m}{2} = \frac{96}{2} = 48$

Uncooperative 

$q = 64$ ← more flights

$\pi = 64(211 - 147) = 4,096$

) profits up by $\frac{1}{8}$

Lecture 17 - Oligopoly Cont

11/8

fig 16-3 - uncooperative

Cooperative equalibium

- trust each other + form a cartel

* pretend that they are 1 firm (monopoly)

then split the profits

~~Q = 96 when they are monopoly~~

fig back page

better off as cortel

2 reasons why not

1. Fundamental instable - any 1 firm has an incentive to cheat

$q_A = 48 \rightarrow 50$

$Q = 96 \rightarrow 98$

$P = 243 \rightarrow 241$ lowered price

$\pi_A = 50 \cdot (241 - 147) = 4,700 \in 4608$

so burned profits

$\pi_B = 48(241 - 147) = 4,512 \in 4608$

screwd partner

it gets all the benefits of a monopoly but poisoning effect is shared w/ United

monopolist would not cheat itself - would feel entire pain of cheating

(2)

Then the game intuition: I think other will cheat, so I will cheat first. Remember only if ∞ game.

2. Illegal - (economists always puts 2nd)

1900s ~~the~~ trusts were very popular

still many ways to cartalize

- backroom deals

anti trust division prosecutes these cases

Sometime gov promotes cartels

- Voluntery export restrictions in ~~19~~ 1980s
- Japan produced much better cars
- could impose quota - but Reagan could not do politically
- backdoor quota
- why did they agree?
  - 1. thought quota was coming
  - 2. gov just formed a cartel of us
    - in a way that would be hard to break
    - some way to monitor cheating
  - raise prices + hurt American consumers
  - raised Japanese' income

(3)

3 different market firms
- perfect Competitive
- monopoly
- (non competitive) oligopoly

for United American example

type	Q	Π/firm	Social welfare
Monopoly	96	4608	low
Oligopoly	128	4096	middle
Perfect Competition $p=mc$	192	0	high

↑ look at Q
DWL = trades that are not made

Does # of firms determine welfare?
- in Cournot - the more firms there are the closer you are to PC

$$\frac{P-MC}{P} = \frac{1}{n\varepsilon}$$ | markup inversly proportional to elasticity of demand

Should we ever allow # of firms to shrink? "merger"
by above logic - would be bad
why does gov always allow through

(4)

* economies of scale - both firms running a plant at half efficiency - merge and run 1 firm

kinda like how a patent could be a good or bad thing

Pro: ↓ MC

Con: ↓ # firms in market, ↑ pricing powe

DoJ decides which effect is larger is hard - data controlled by businesses

example: hospitals

- they argue very often under capacity
- most allowed through
- hospitals kept same capacity, but charged more
- fooled by theory of econ of scale
- just to have market power

Size of market Intuitively: the bigger the market the easier it is to enforce a cartel

hard to know who is cheating

OPEC - oil cartel

- hard to track
- efficency has varried over time

(5)

Cartel to sell mercury
- other countries entered, cartel fell down

Important in gov policy

Allowed China to control Rare Earth materials
- should US offer subsidies for American producers?

Cornot competion not only model out there

Bertrand / Price competition
- competition over q
- market gives p

- firms set price
- then produce whatever q is demanded
- Some MC
- How much do they compete down to MC
- 2 firms can fight it down to MC
- could have 2 firms at PC

Which model to use?
- don't know
- conditions under which q, p competion more likly

q

when capacity logs (airlines, cars)
hard to produce on demand

p

cereals at a supermark

(6)

What can firms do to avoid Bertrand competion?

- product differentiation
  - not perfect substitutes
  - price above MC
  - thats why so many type of details
    - "monopolistic competition"
  - different enough - to charge a higer price
  - if price too high, people will switch

- good or bad?

depends if consumers will pay more

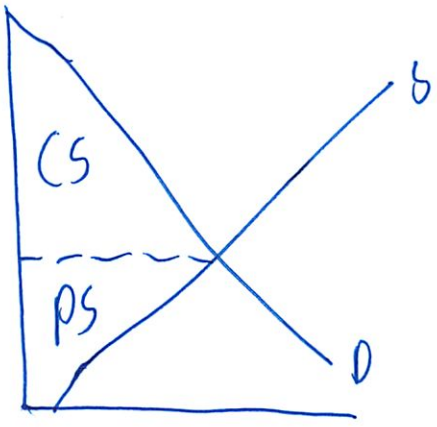
Can raise consumer welfare - if people want it

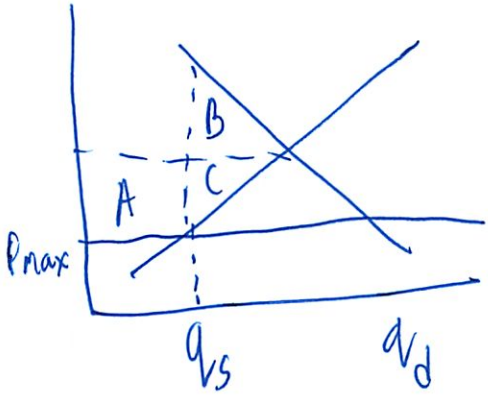
despite it being tool to charge a higher price

Chap 9 Competitive Markets

11/7

-going to keep this short





price cieling

oh did this before

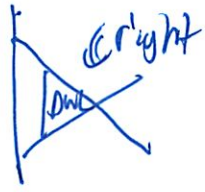
$\Delta CS = +A - B$

$\Delta PS = -A - C$

$DWL = \Delta CS + \Delta PS$

↑ oh never realized this!

$= (A - B) + (-A - C) = -B - C$



So many ways to think about!

Market failures

- externalities
- lack of info

price supports (gov buys extra)

$\Delta CS = -A - B$

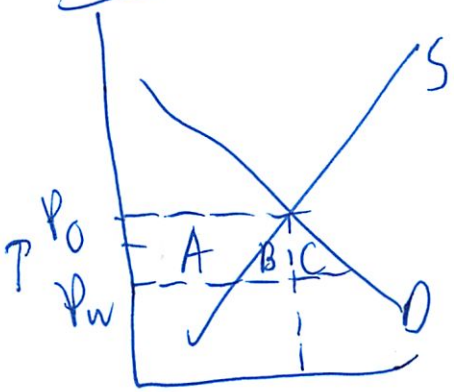
$\Delta PS = A + B + D$

So $DWL = D$

I like this way of thinking about it

(2)

Quota

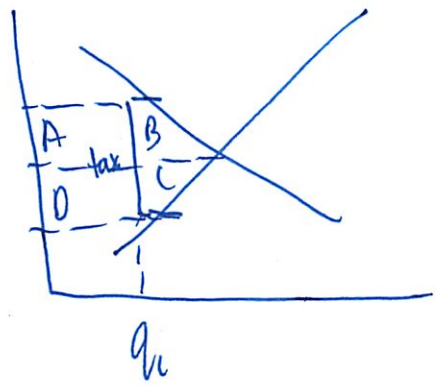


$\Delta CS = -A - B - C$

$\Delta PS = A$

$DWL = B + C$

Tax



$\Delta CS = -A - B$

$\Delta PS = -C - D$

$Gov = A + D$ ← who pays tax is split

$DWL = B + C$

*look where p, q go

Subsidy

- negitive tax
- benefit split
- book does not go into cost to gov

Econ Exam 2 Review

11/8

Producer theorm

$f(k, \ell)$

↑ fixed in SR

$MRTS = \frac{\Delta k}{\Delta L}\Big|_{\bar{q}}$

returns to scale → if ↑ all inputs proportionally
what hapens to output
constant → dable inputs = double output

$\Pi = R - C$

$MC = \frac{\Delta \text{ cost}}{\Delta \text{ output}}$ $AC = \frac{\text{cost}}{\text{output}}$

$C = f(wL + rk)$

↑

isocost lines slowe $= -\frac{w}{r}$

$MRTS = \frac{MP_L}{MP_c}$ ← marginal product $= \frac{w}{r}$

law of diminishing marginal returns

isoquant ← each line = same output quantity MRTS convex

(2)

III perfect substitutes

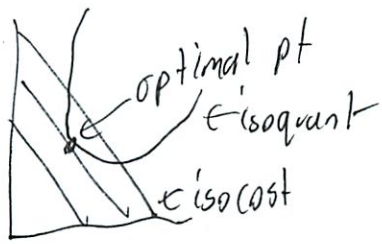
IIb fixed proportions

~~returns to scale~~ Covered already

Cost → economic cost (ie w/ opportunity cost)

$MC = \frac{\Delta TC}{\Delta q} = \frac{\Delta VC}{\Delta q}$

rental rate of capital
- what we work w/



expansion path = long run cost curve

* straight line = constant economies of scale
- avg cost declines to a point but only up to a point
= doubling of output for ~~less~~ same cost
(note slight diff w/ returns' to scale → double input q → double output.)

economies of scope - different type of outputs
product transformation curve

(3)

Learning curve - over time

Perfect competition

1. Identical products
2. consumers need full info on all prices
3. Low/no transaction/shopping costs → Peter Diamond's search cost
4. Free entry + exit of market for firms

firm vs market demand
- each firm's demand is elastic
  does not imply demand of market is elastic

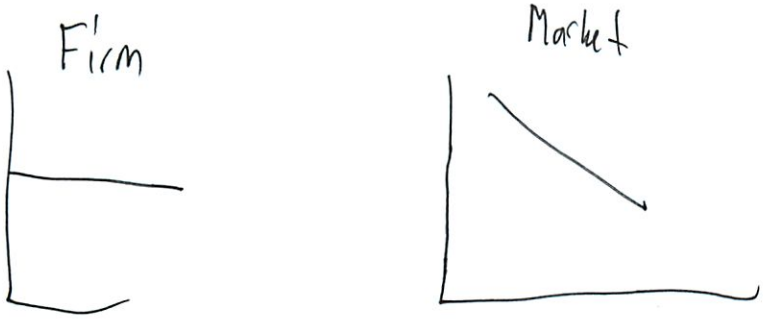
all about profit maximization
MR = price
so p = MC

* in long term must always check shut down condition
(be able to think through a tax)
in long run no profits as firms enter + exit
(do math later - when going over exam)

---

also need to decide what level of output
- consumers have this info handed to them
(keep each piece seperate in your mind)
large firm incentive problem w/ managers
PC firms: where MC = 0
- thought was where MC = MR

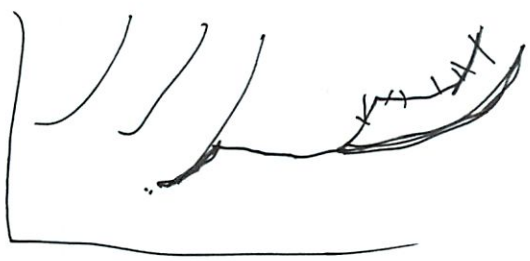
(4)



firms supply curve → MC curve above shut down condition

when input changes MC curve shifts - new q

SR Market curve



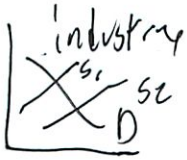
sum of all 3 curves

$$\epsilon_s = \frac{\Delta Q}{\Delta P}$$

Producer surplus

* sum of area above producer supply curve
  related, but ≠ profit

Long Run - may exit industry



no economic profit - can sell advantage to another firm

industry long run supply curve hard to draw
- depends if ↑ or — constant cost industry

(5)

the more producers in the market, the more elastic the supply is

each firm makes = q

~~So how much each firm makes at P~~

1. Get each firm's supply curve
2. Add up for market
3. Find market price → → ~~divide for q (each firm)~~
4. Find how many each firm will produce

in long term → add shutdown condition

and market entry

so no profit

LRAS upward sloping upward sloping in reality

(flat theoretically) - but can't find - seems upward sloping as well

---

Pick Q to max Π

$MR = MC$ $\Pi = P \cdot Q$

Welfare = well being

Price (non discriminating) is to marginal consumer

Price ↑ ability depends on elasticity

DWL - trade that don't happen that would make both parties happy

PC = $\frac{1}{2}$ibium = 0 DWL

(6)

Monopoly (remember the best

$MR = MC$

$MR \neq p$ since no "poisoning effect"

$MR = p\left(1 + \frac{1}{\epsilon}\right)$

↳ so when perfectly elastic, $MR = 0$

↳ ah! like that question

Shut down rule applies here too!

market power - ability to charge > MC

Markup $= -\frac{1}{\epsilon}$ ✱ study

- does not look familiar

But even better when can price discriminate

Sources 1. Cost advantages

- telco, water co

2. Gov actions - patents

Contestable market - is a natural monopoly but someone could come in + compete

---

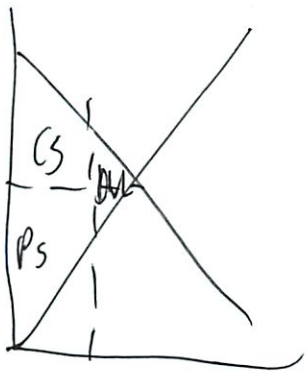
Oligopoly

- game theory
- noncooperative

(7) Another way to do CS

CS = $\int$ under demand curve $-\int$ total actual expenditures

$PS = \frac{dVC}{dQ}$



q fixed - somehow...

Perfect price discrimination actually <u>good</u> for society

Review Session

Plamen

11/8

~5 min late

Costs

$\pi = TR - TC$

$= TR(Q) - TC(Q)$

- or minimize costs

1. SR
   - capital can not vary
   - can only change labor

$TC = rk + wL$

economic costs, not accounting costs

expenses (no opp cost) accountants ~~use~~ count - economists don't

$TC = \underbrace{rk}_{FC} + \underbrace{wL}_{VC}$

(this I am mostly good on - want more #'s / math)

$f(k, L) = L \cdot k$

So if $\bar{k} = 10$ $r = 1$ $w = 5$

$TC(q) = 10 \cdot 1 + l5$

need to change this - w/ what?

(2) ah $Q = L \cdot 10$ ← production function?

$$L = \frac{Q}{10}$$

$$TC = 10 + \frac{Q}{10} \cdot 5$$

$$TC(Q) = 10 + \frac{Q}{2}$$

$$MC = \frac{1}{2} = \frac{\Delta TC}{\Delta Q} = \frac{dTC}{dQ}$$

? constant

$$ATC = \frac{10 + \frac{Q}{2}}{Q} = \frac{10}{Q} + \frac{1}{2}$$

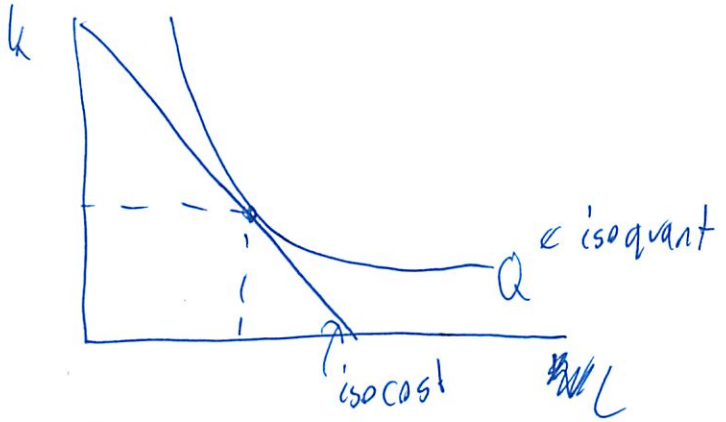
$$= AVC + AFC$$

$$= \frac{VC}{Q} + \frac{FC}{Q}$$

(3)

LR=

- firm flexible, all factors of production can vary
- choose k, L to minimize
  so $Q = f(L, k)$



slope isoquant = MRTS = $\frac{dk}{dL} = \frac{MP_L}{MP_k}$

slope isocost = $\frac{w}{r}$ = ratio input prices

tangency where slopes =

$$\frac{dk}{dL} = \frac{w}{r}$$ fixed quantity

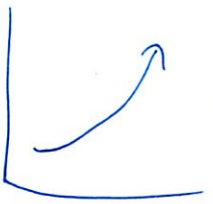
such that cost minimized for that specific Q

the optimal k, L will be functions of Q

so TC(Q)

(I think I am confused w/ what variables to leave in)

But what if have diff. output levels

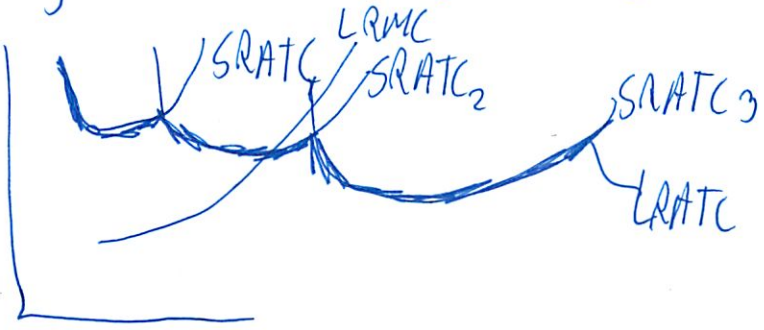


LR expansion path

(did we ever do any math here?)

(4)

Long run costs are always lower

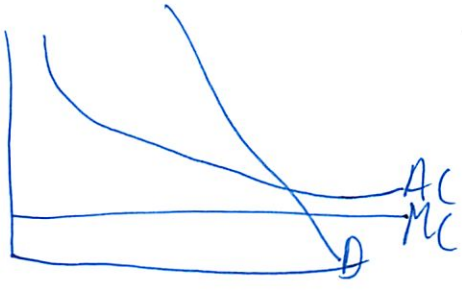


economies of scale –

$$C(2Q) < 2C(Q)$$

(I Think I just don't see in my head how all the # fit together - w/ everything in 14.01)
- well graphs kinda
- but using their # - not which is what did in HW5

$AC(Q) \downarrow$



good candidate for a natural monopoly
allow it to exist + tax its profits

diseconomies of scale

$AC(Q) \uparrow$

optimal to split production to other firms

(5)

Economies of scope - different goods

supply curve

perfect competition - firms are price takers

free entry + exit

no transaction costs / "frictions"

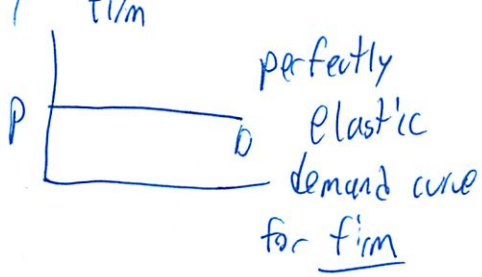
SR profit maximization

$\Pi = TR - TC$

- chooses output level to maxize profits (ah! here where it finds Q
- remember each "step"

want Q that maximizes Π

$MR = MC$



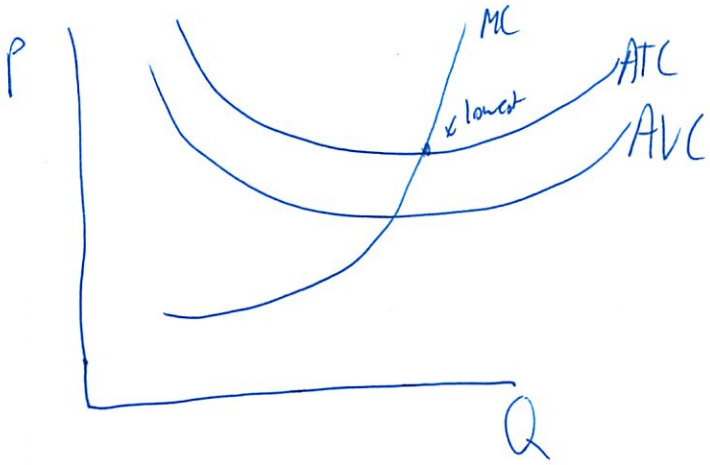
$TR = P(Q) \cdot Q$

$AR = \frac{P(Q)\,Q}{Q} = P(Q) = P$ ← price always same

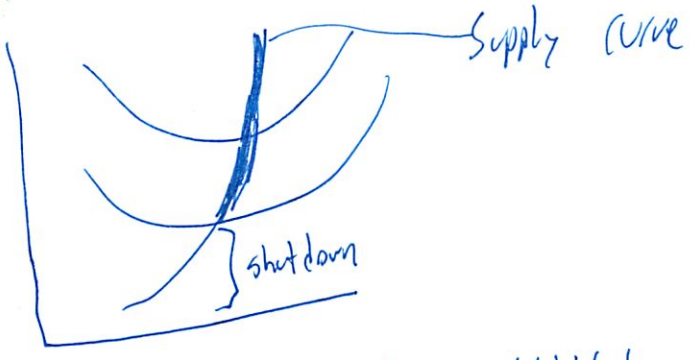
$P = AR = \frac{MR}{Q} = MC$

(6)

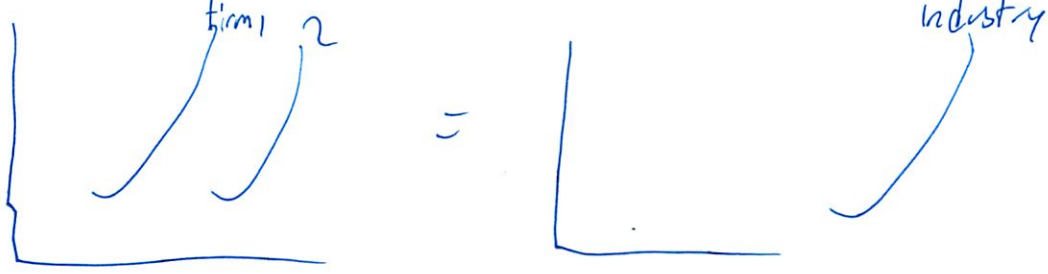
In LR need to check shut down condition



ok here is where get LRS - not from expansion curve



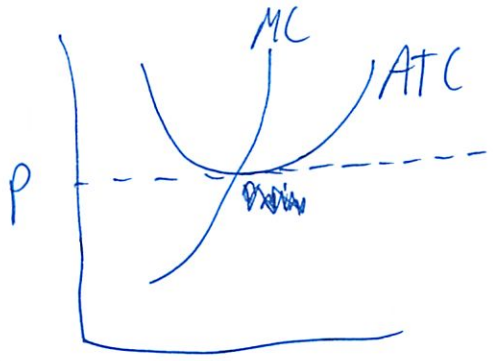
industry horizontal addition



in short run can be making loss
in long run always 0 profits
as firms enter + leave industry

(7)

Long run industry supply curve



so price will be where ATC = MC
- where slope ATC = 0

$\pi = TR - TC$

$= P \cdot Q - ATC \cdot Q$

$= (P - ATC) Q$

$P = MC$

$P = ATC$

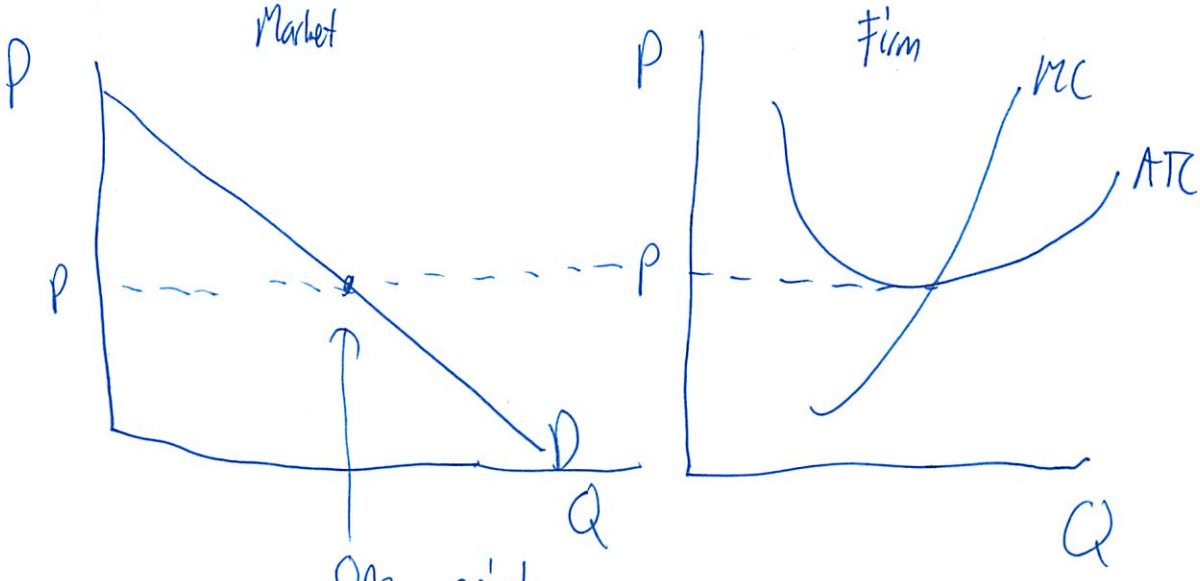
(can you have situation where short term equalibrium price < LR equalibrium price

- if too many firms and they are making losses

(8)

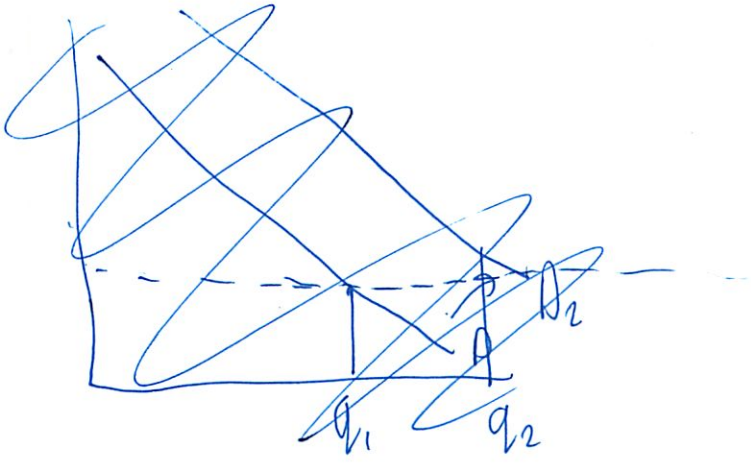
But Market supply curve is not flat in LR
- its upward sloping
- run out of efficency
- must go to less efficent producers

~~ATC shifts up~~

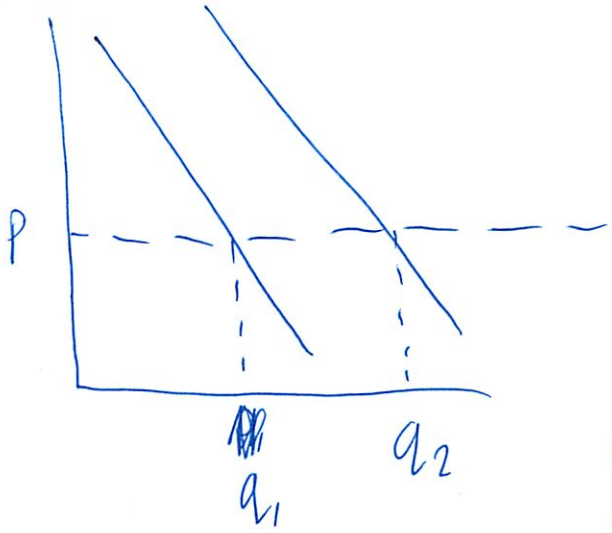


One point
- no firm makes profit

Say demand ↑



(9)

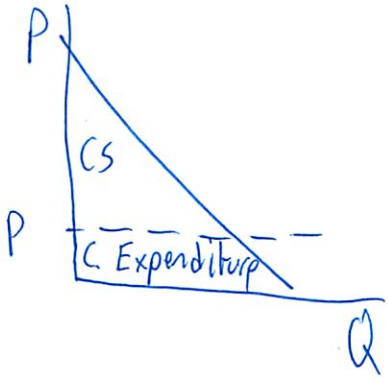


← assuming cost of inputs same but likely not to happen so ATC ↑ and new equilibrium prices

(I thought this was accounted for already

Corp finance → why firms do not maximize profits
- agency problem

Welfare Economics

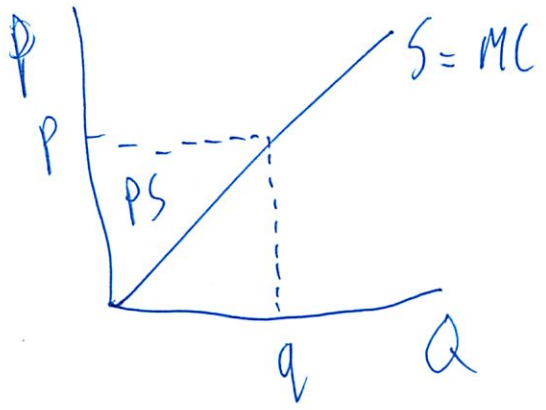


$P = 100 - Q$

represents marginal WTP

(Oh! - just look at this!)
- makes it clearer when less stuff on graph

(10)

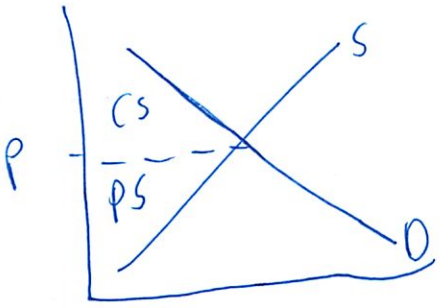


again just look at this graph!

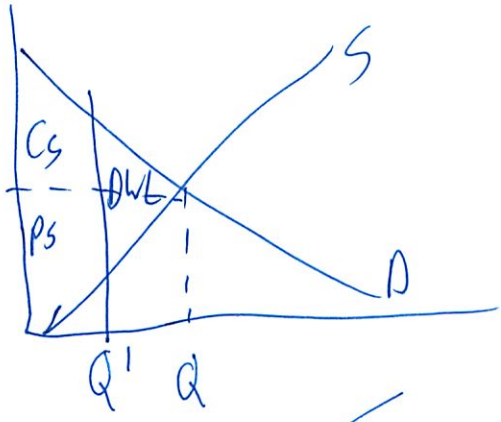
$DWL = \Delta CS + \Delta PS$ ← this is about the change
- keep seperate!

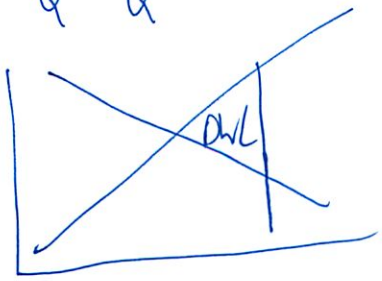
if no fixed cost $PS = \Pi$

otherwise $PS = \Pi + FC$



Total welfare = $CS + PS$





higher cost than marginal willingness to pay

(11)

Why would gov interfere

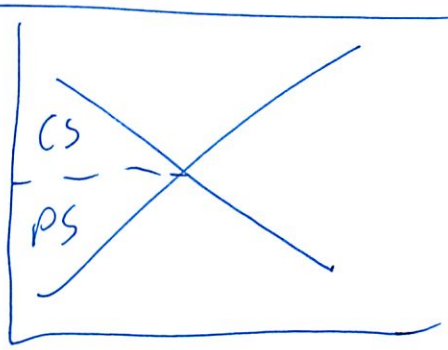
- raise $
- thinks market not competive
- redistribute from producers → consumers

note must add gov to total welfare

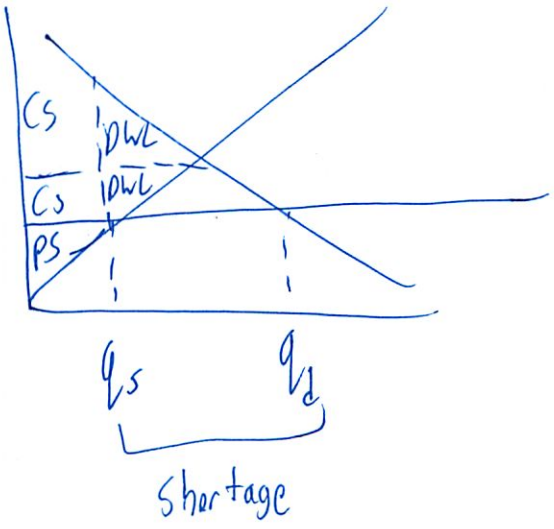
TW = CS + PS + gov revenue/expenditure

Price control/price ceiling

- not price support (buy extra goods)



Old

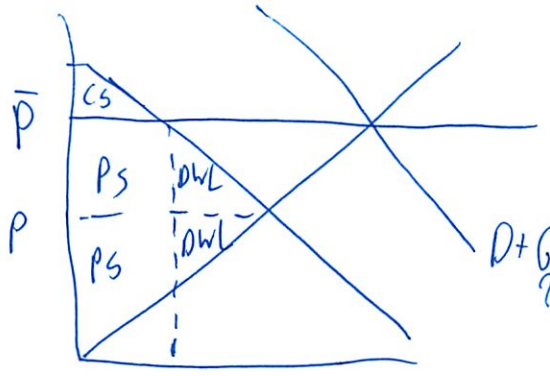


so I was right before

Consumers better off
producers worse off
) net Society worse off

(12)

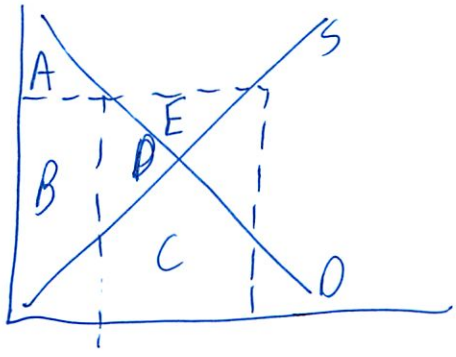
Price Support / price floor



↑ implemented w/ gov buying rest # 2 below

1. Producers produce Q_S + no one buys $Q_S - Q_D$
2. Producer produce Q_D only
3. Gov buys excess from 1

1. $PS = B - C$ $CS = A$ $DWL = D + C$
2. $PS = B$ $CS = A$ $DWL = D$
3. $PS = B + D + E$ $CS = A$ $DWL = D + C$ $Gov = -D - C - E$

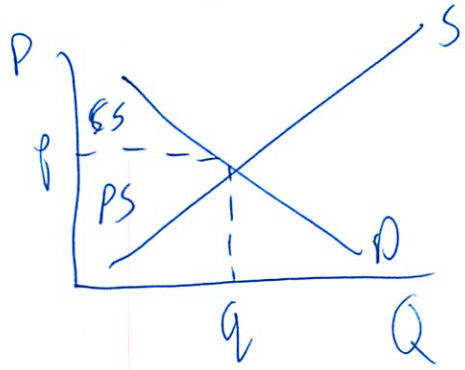


Total welfare initial = A + B + D

(13)

Import tariffs / quotas

Domestic market

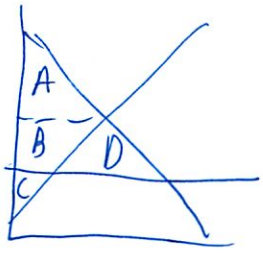


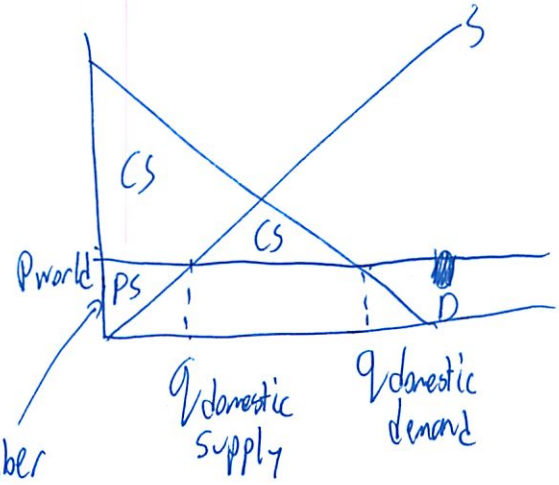
~~P~~ ~~Q~~ = ~~0~~

Q, P = autarik equalibrium

CS = A

PS = B + C





remember this is total/new!

big change/ reduction!

elastic supply curve

new CS = A + B + D

new PS = C

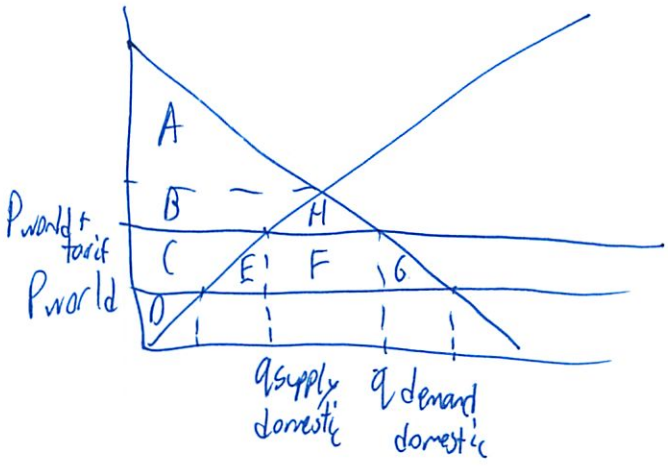
total welfare higher by D

- no DWL
- international gain

(14)

Tarrif

- tax on international producers



PS ↑
CS ↓
) change

F = Gov tax revenue

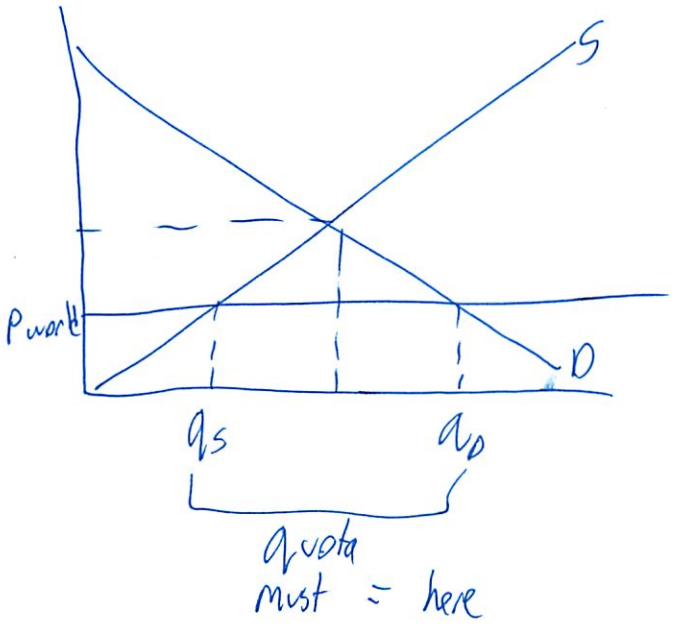
E + G = DWL

New Cs = A + B + H

New PS = C + D

still better than ~~Tarif~~ no free trade

Quota



quota

$q = Q_D - Q_S$

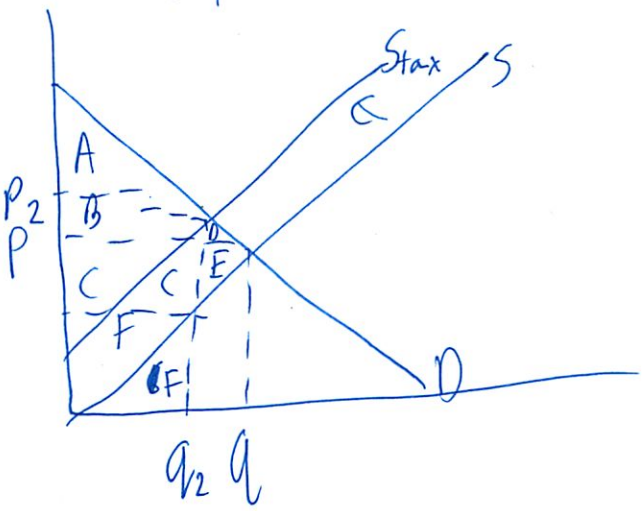
Or shift domestic supply to right by quota

↑ tool to find

(15)

Tax

- on PC firm - shifts all of the cost curves up
- unit tax



New CS = A

New PS = C + F

Gov = B + C

DWL = E + D

B = Part to people

C = Part producers pay

old CS = A + D + B

old PS = D + C + F

---

exam not cumulative