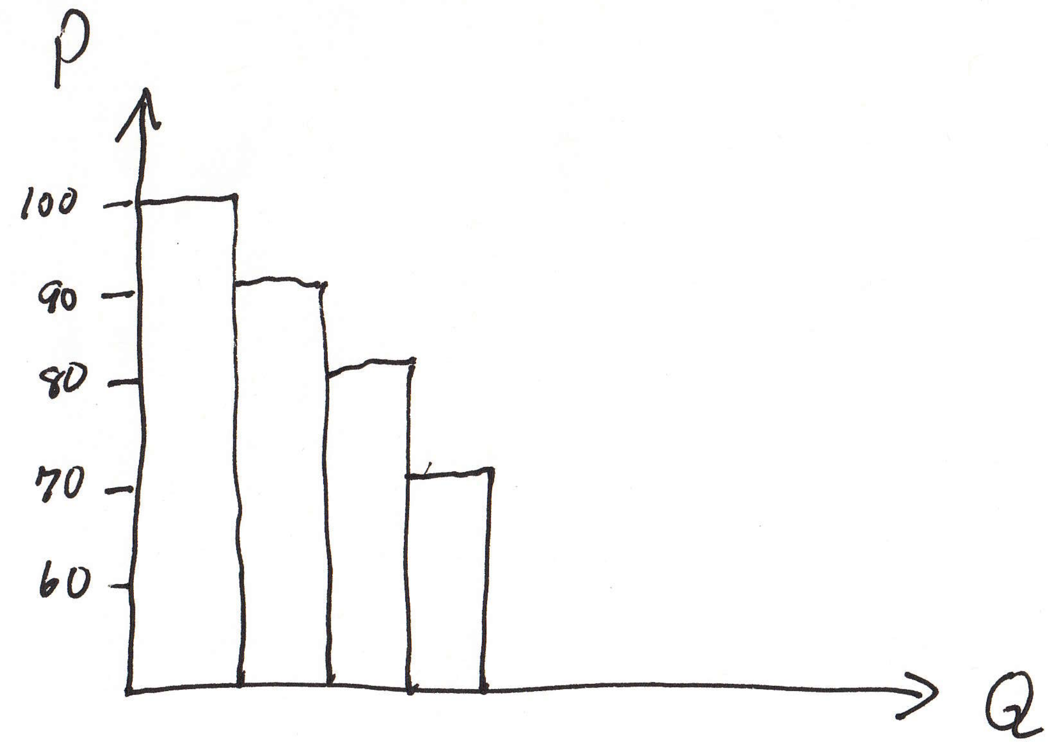
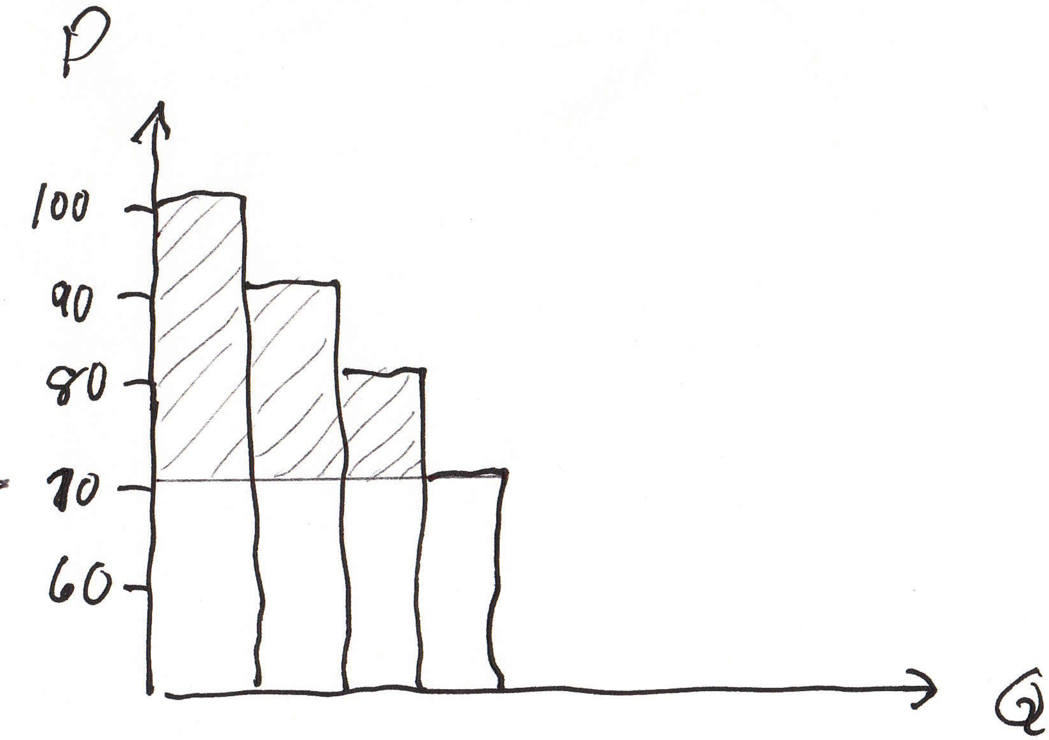
Demand: Four individuals, one object

Ind	Willingness to pay
1	100
2	90
3	80
4	70



Consumer surplus: Four individuals, one object

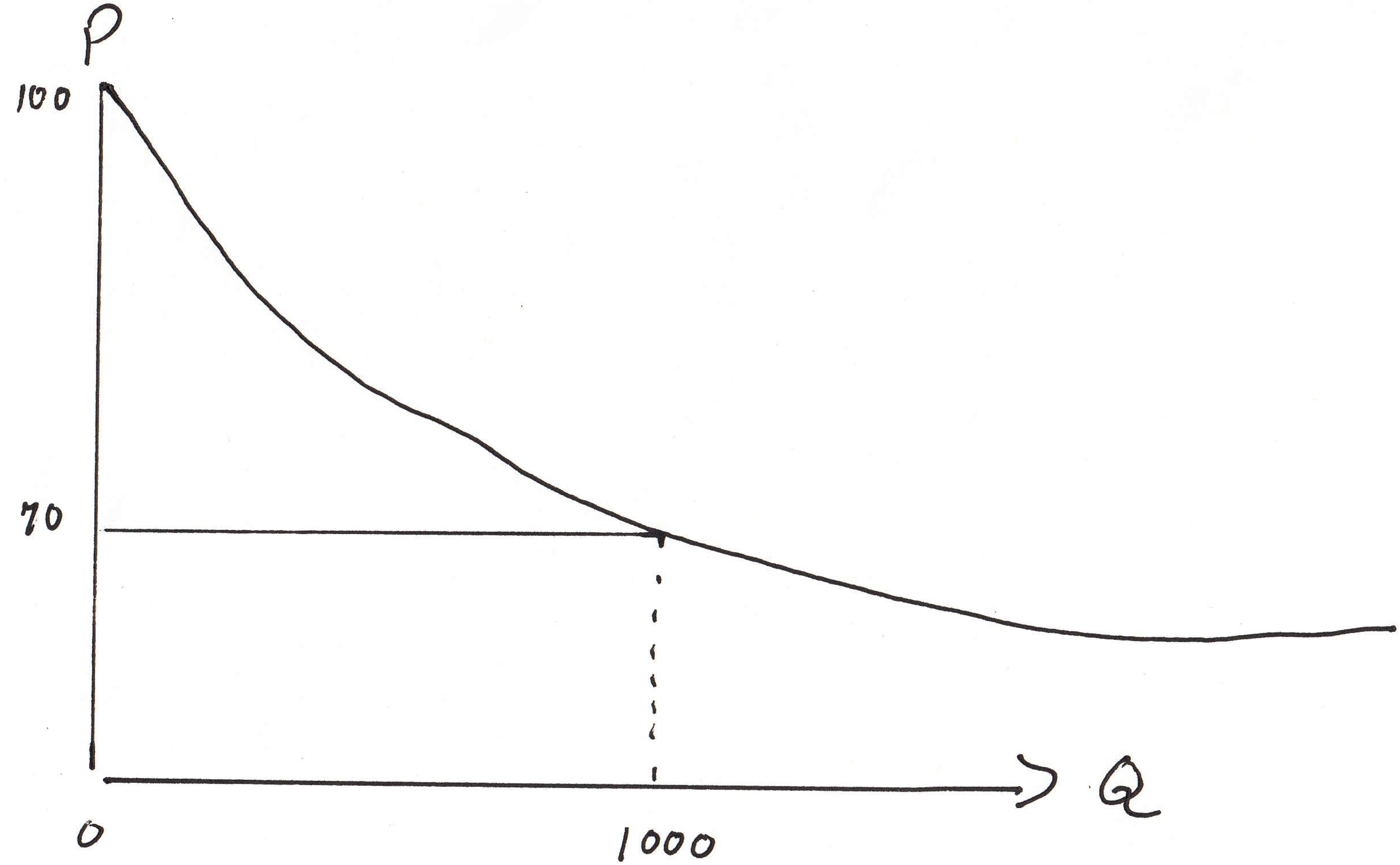
selling price



Ind	WTP	Surplus
1	100	30
2	90	20
3	80	10
4	70	0
		60

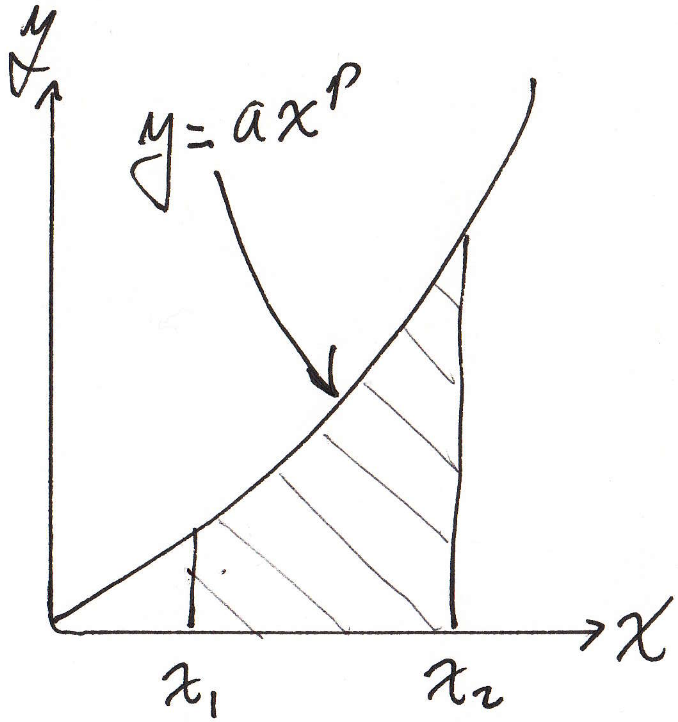
Consumer surplus is the area

Demand: Many idividuals; The jagged line becomes smooth



Area is approximately $(100-70) \times 1000 \times \frac{1}{2} = 15{,}000$

Computing the area under a curve



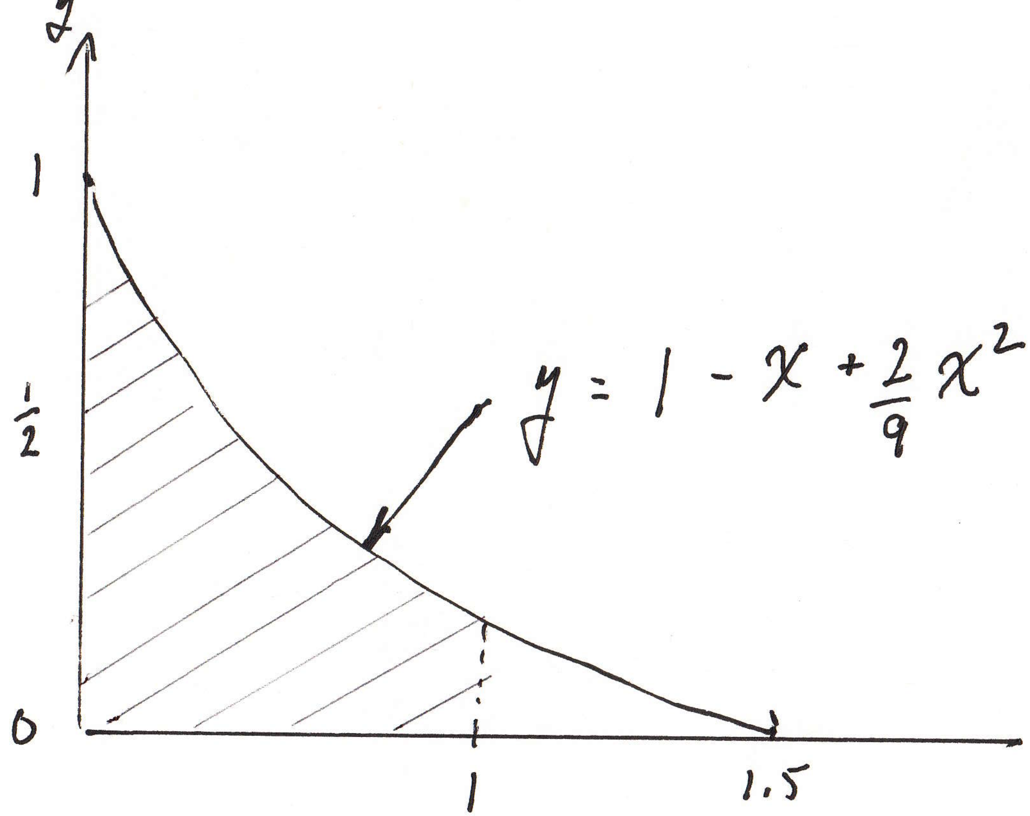
$$\text{Area} = a\left[\frac{x_2^{p+1}}{p+1} - \frac{x_1^{p+1}}{p+1}\right]$$

Area for more complicated curves

$$y = a + bx + cx^2$$

Compute the area for each piece and then add them up.

Example



$x = 0 \quad y = 1$

$x = 1 \quad y = 2/9$

$x = 3/2 \quad y = 0$

Area under curve from 0 to 1

$$1\left[\frac{x_2^1}{1} - \frac{x_1^1}{1}\right] = 1\,[1-0] = 1$$

$$-1\left[\frac{x_2^2}{2} - \frac{x_1^2}{2}\right] = -1\left[\tfrac{1}{2} - 0\right] = -\frac{1}{2}$$

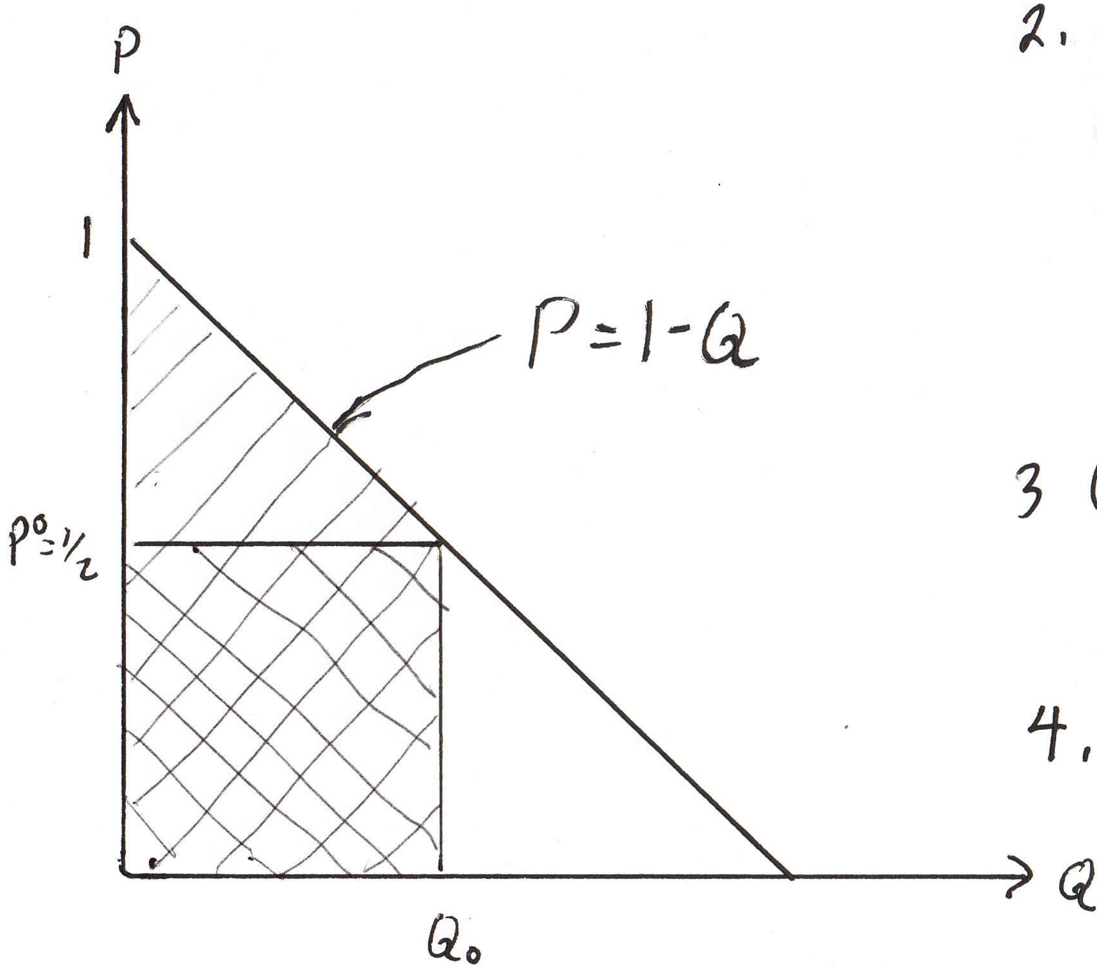
$$\frac{2}{9}\left[\frac{x_2^3}{3} - \frac{x_1^3}{3}\right] = \frac{2}{9}\left[\tfrac{1}{3} - 0\right] = \frac{2}{27}$$

Sum $1 - \frac{1}{2} + \frac{2}{27} = \cancel{.507}$ .574

Consumer surplus if

Demand: $P = 1 - Q$

Selling price: $P_0 = 1/2$



Solution

1. Find Q_0

$$P_0 = 1/2 = 1 - Q \Rightarrow Q_0 = 1/2$$

2. Compute total willingness to pay, which is area under demand curve from 0 to Q_0

$$1\left[1 - \tfrac{1}{2}\right] - 1\left[\tfrac{1}{4} - \tfrac{1}{8}\right] = \tfrac{1}{2} - \tfrac{1}{8} = 3/8$$

3 Compute total cost, which is

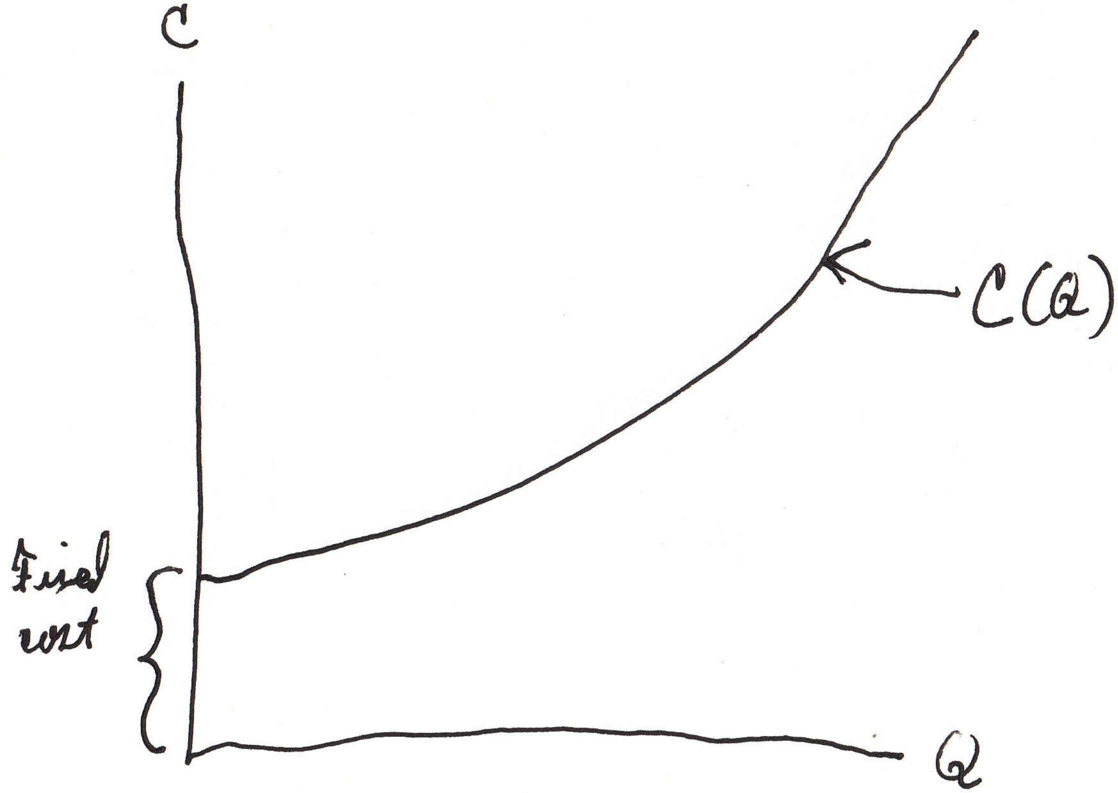
$$P_0 \times Q_0 = \frac{1}{2} * \frac{1}{2} = 1/4$$

4. Consumer surplus is

$$\frac{3}{8} - \frac{1}{4} = \frac{1}{8}$$

Supply is determined by the firm's cost function

Most cost functions plot like this



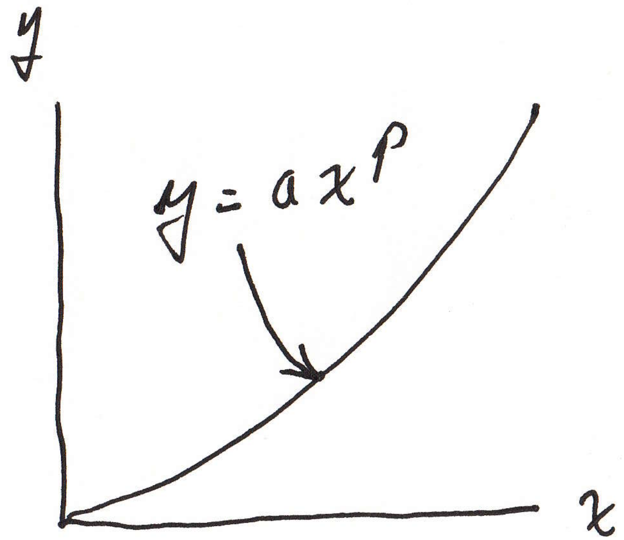
More useful than the cost function is the marginal cost function

$$MC(Q) = \frac{\Delta C}{\Delta Q} = \frac{C(Q_1) - C(Q_0)}{Q_1 - Q_0}$$

which gives the incremental cost of producing Q_1 when the firm is already producing Q_0. I.e. the extra cost of one more unit of output

also written as $MC(Q) = C'(Q) = \dfrac{dC(Q)}{dQ}$

Computing $\frac{\Delta y}{\Delta x}$ for



$$\frac{\Delta y}{\Delta x} = a p x^{p-1} \qquad p \neq 0$$

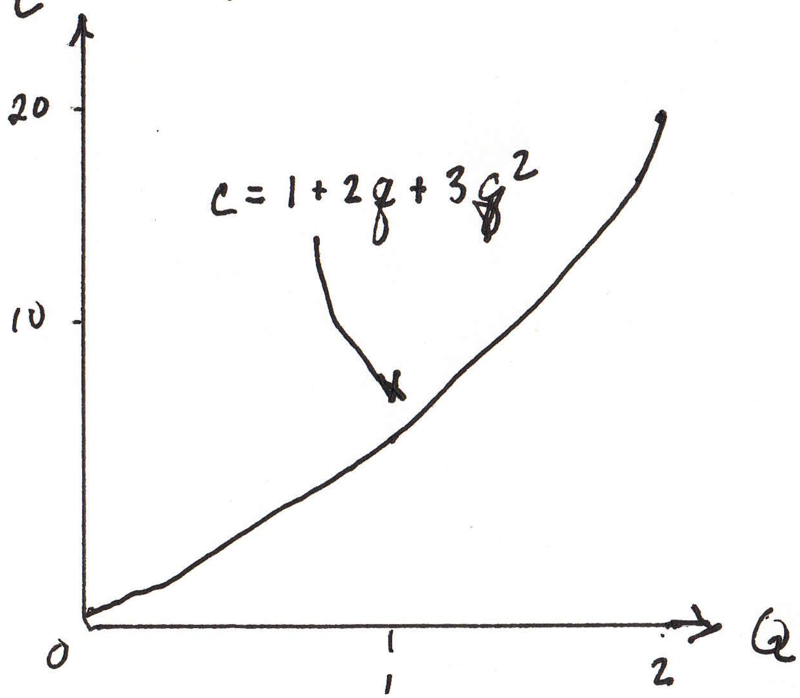
$$\frac{\Delta y}{\Delta x} = 0 \qquad p = 0$$

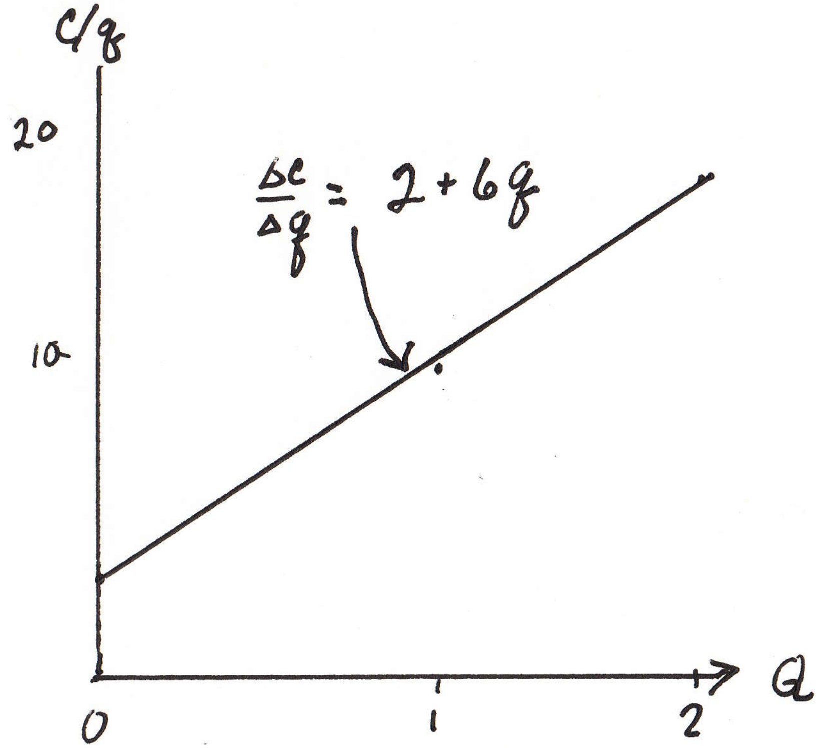
$\frac{\Delta y}{\Delta x}$ for more complicated curves

$$y = a + bx + cx^2$$

Compute $\frac{\Delta y}{\Delta x}$ for each piece then add them up

Example





$q = 0 \quad c = 1$

$q = 1 \quad c = \cancel{5}\ 6$

$q = 2 \quad c = 17$

$q = 0 \quad \frac{\Delta C}{\Delta Q} = 2$

$q = 1 \quad \frac{\Delta C}{\Delta Q} = 8$

$q = 2 \quad \frac{\Delta C}{\Delta Q} = 14$

What Q does a firm decide to produce?

If there are so many firms that each firm's output has ~~an~~ no effect on price (competition) then the firm's profit is

$$\Pi(Q) = P \cdot Q - C(Q)$$

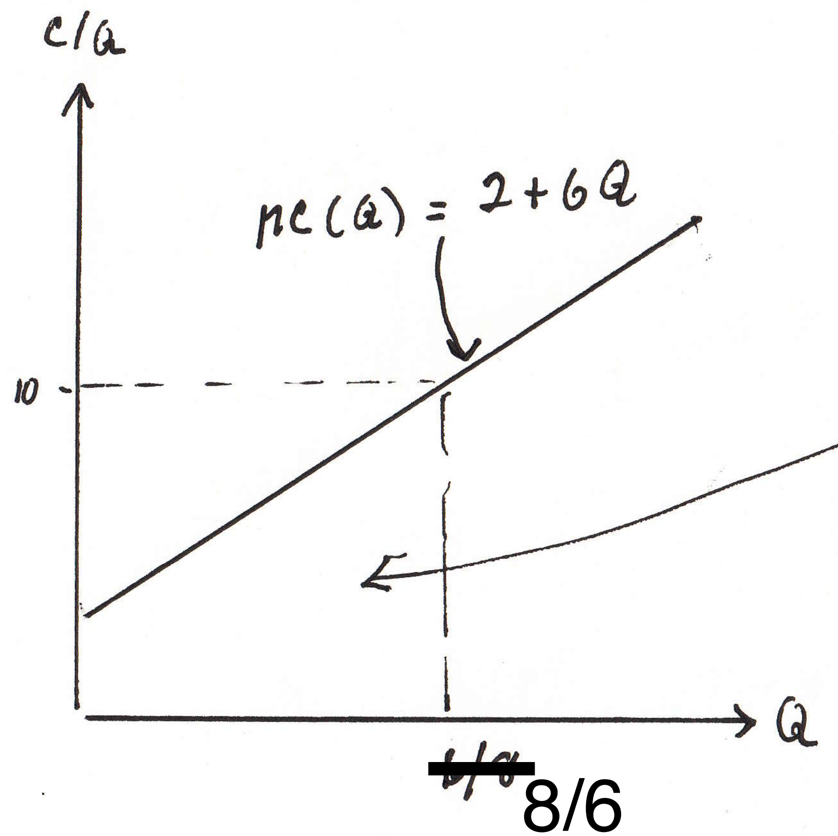
The firm will increase output until $\frac{\Delta \Pi}{\Delta Q} = 0$

$$0 = \frac{\Delta \Pi}{\Delta Q} = P - MC(Q)$$

That is

$$MC(Q) = P$$

Example



This area is total variable cost at $Q = \cancel{6/8}$ 8/6

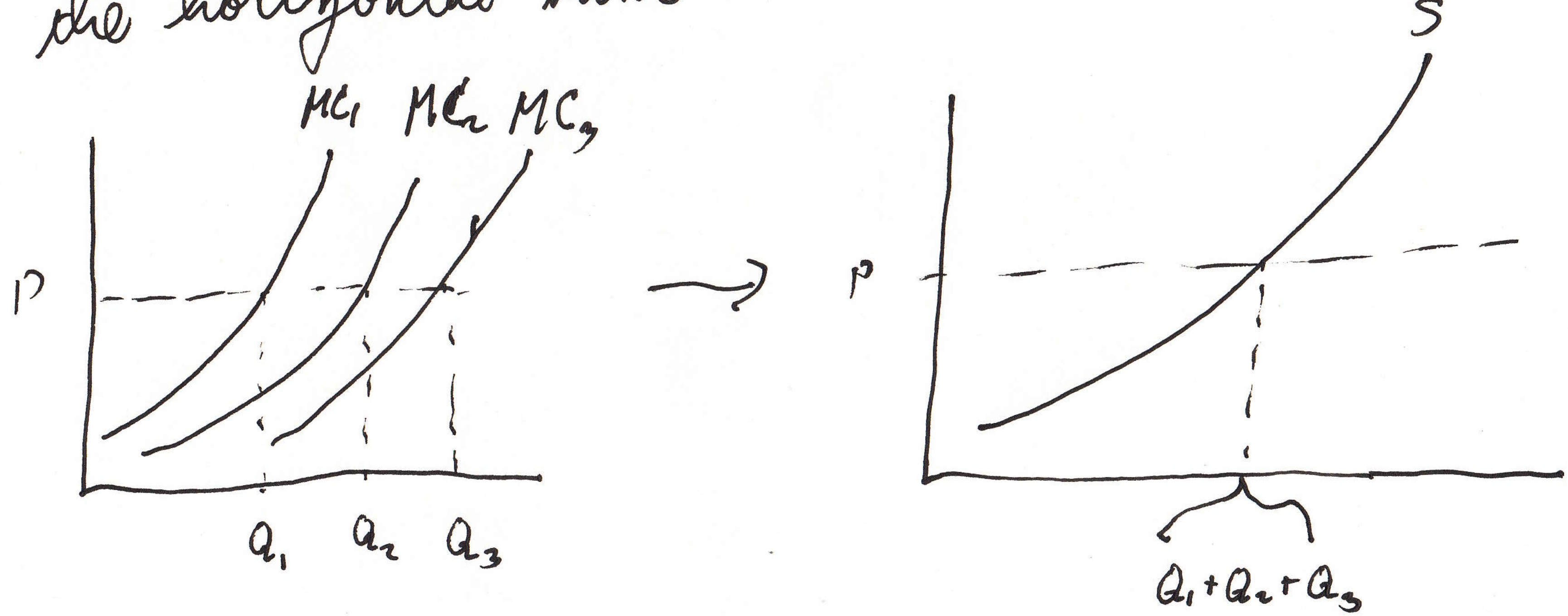
I.e. $2Q + 3Q^2$

The information about fixed costs gets lost.

$10 = 2 + 6Q$

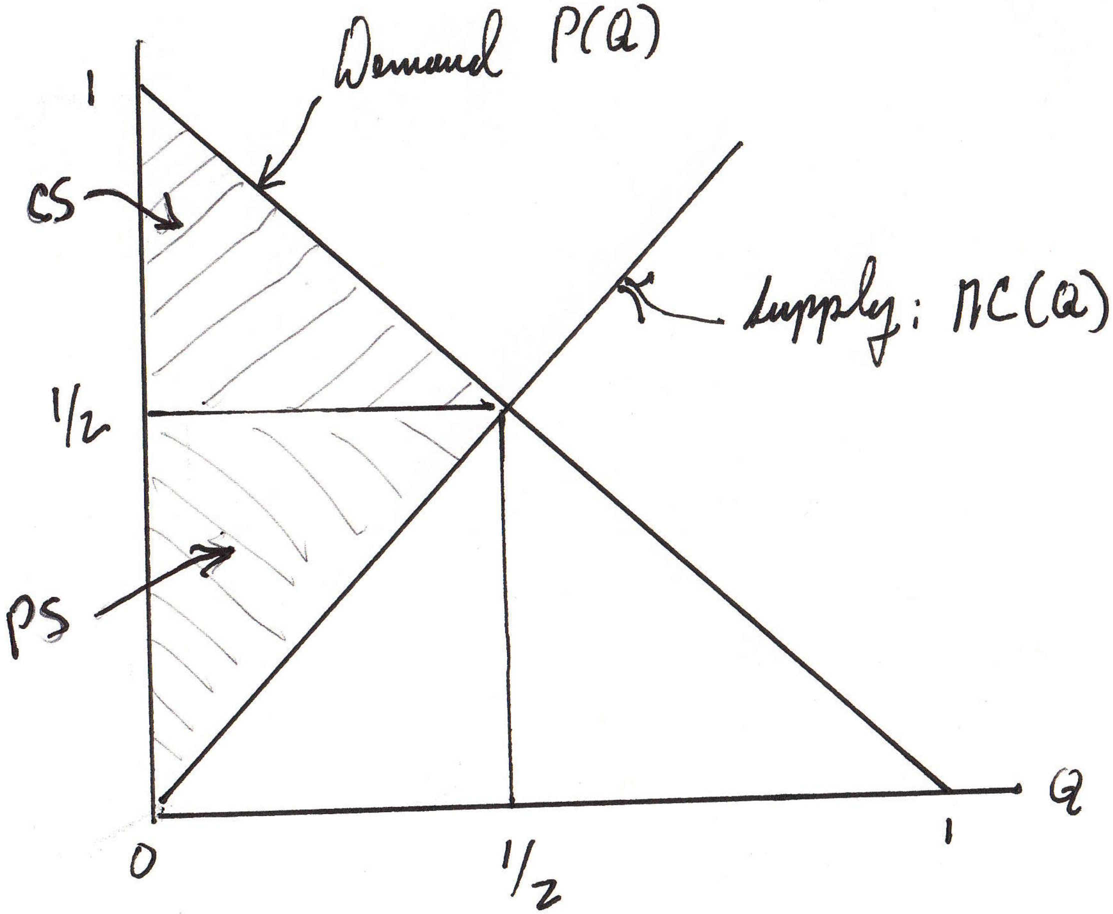
$Q^* = \cancel{6/8}$ 8/6

To get the industry's supply curve, take the horizontal sum



I.e. at each price P, the industry output is the sum of the outputs of each firm

Equilibrium occurs where the demand and supply curves intersect



$$P(Q) = 1 - Q$$

$$MC(Q) = Q$$

$P = MC$ equilibrium

$$1 - Q = Q$$

$$Q^c = 1/2$$

$$P^c = 1 - 1/2 = 1/2$$

What does a firm decide to produce?

If there is only one firm (monopoly) then the firm must take the effect of Q on P into account (demand)

$$\Pi(Q) = \underbrace{P(Q)\,Q}_{\text{Revenue}} - C(Q)$$

$$= R(Q) - C(Q)$$

The firm will increase output until $\frac{\Delta \Pi}{\Delta Q} = 0$

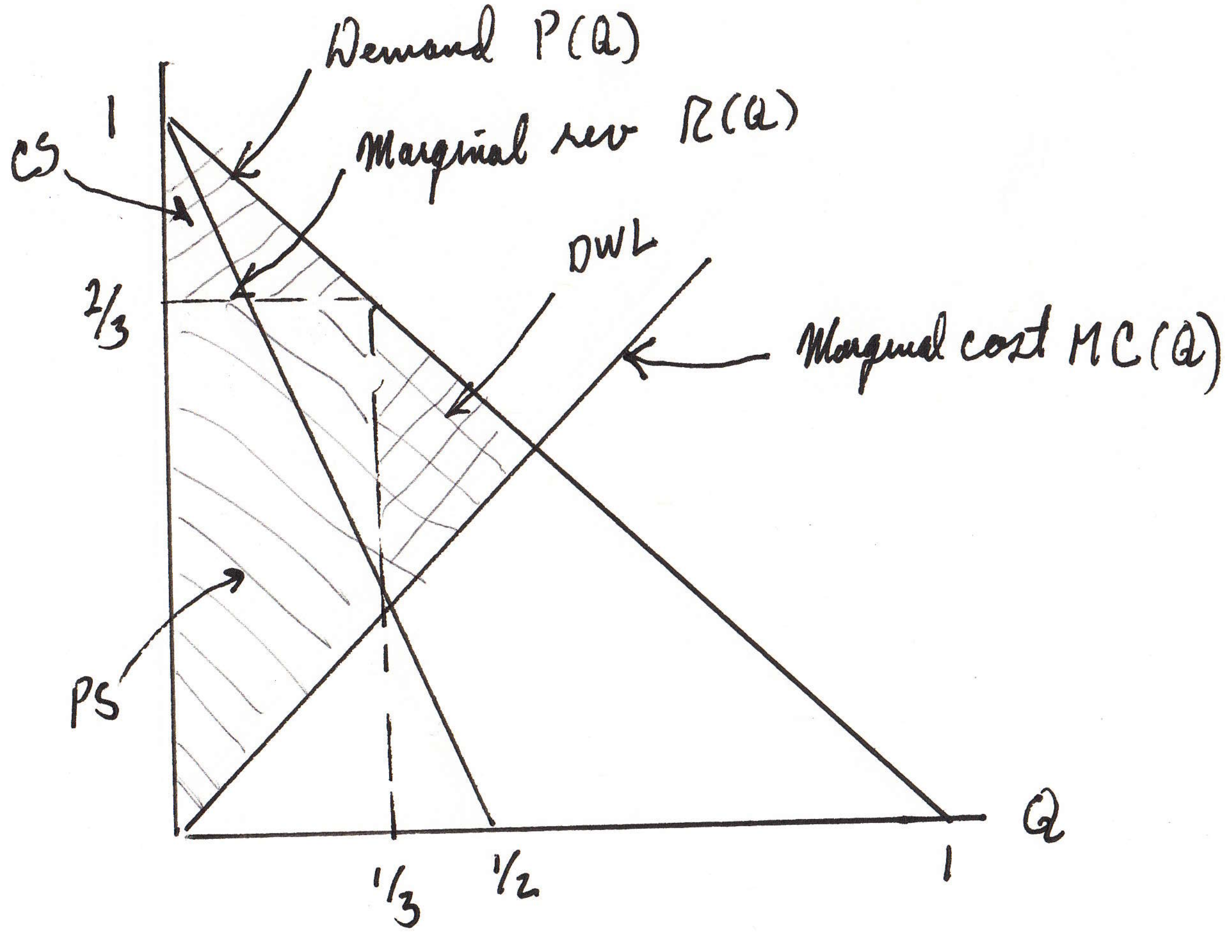
$$0 = \frac{\Delta \Pi}{\Delta Q} = \frac{\Delta R}{\Delta Q} - \frac{\Delta C}{\Delta Q}$$

That is

$$MC(Q) = MR(Q)$$

Marginal cost equals marginal revenue

Example



$$P(Q) = 1 - Q$$

$$R(Q) = (1-Q)Q = Q - Q^2$$

$$MR(Q) = 1 - 2Q$$

$$MC(Q) = Q$$

$MC = MR$ equilibrium

$$Q = 1 - 2Q$$

$$Q^M = 1/3$$

$$P^M = 1 - 1/3 = 2/3$$

Compare monopoly with competition