Output Decision

Optimal Q depends on producer's goals

Two main options:

1. Maximize *output* (without running a deficit)
2. Maximize *profits*

- Can do one or the other but not both simultaneously
- To implement, need to consider *revenue* and *profit*

Revenue equations:

Total revenue, TR:

Definition:

$$TR = P * Q$$

Average revenue, AR:

Definition:

$$AR = \frac{TR}{Q}$$

Simplifying:

$$AR = \frac{P * Q}{Q}$$

$AR = P$ Average revenue = P

Marginal revenue, MR:

Definition:

$$MR = \frac{\Delta TR}{\Delta Q}$$

Profits and Output Goals

Definition of profit:

Profit = Revenue - Cost

Will use π to represent profit in equations

(1) Total profit, $T\pi$:

Definition:

$T\pi = TR - TC$ Total profit = total revenue - total cost

(2) Average profit, AR:

Definition:

$$A\pi = \frac{T\pi}{Q}$$

Simplifying:

$$A\pi = \frac{TR - TC}{Q}$$

$$A\pi = \frac{TR}{Q} - \frac{TC}{Q}$$

$$A\pi = AR - AC$$

$A\pi = P - AC$ Average profit = price - AC

(3) Marginal profit, $M\pi$:

Definition:

$$M\pi = \frac{\Delta T\pi}{\Delta Q}$$

Simplifying:

$$M\pi = \frac{\Delta TR - \Delta TC}{\Delta Q}$$

$$M\pi = \frac{\Delta TR}{\Delta Q} - \frac{\Delta TC}{\Delta Q}$$

$M\pi = MR - MC$ Marginal profit = MR - MC

Can use profit equations to find **optimal Q**

Goal 1: maximizing output:

Raise Q as long as profit isn't negative:

1. *Increase* Q when: Profit > 0 or $A\pi(Q) > 0$, $P - AC > 0$, $P > AC$

2. *Stop* at Q where: Profit $= 0$ or $P = AC$

Goal 2: maximize profit:

Raise Q as long as doing so raises profit:

1. *Increase* Q when: Profit rising or $M\pi(Q) > 0$, $MR - MC > 0$, $MR > MC$

2. *Stop* at Q where: Profit maximum or $MR = MC$

Demand and Producer's Choice of Price

What should the producer charge for the good?

Depends on the *degree of competition* in the market

Often called the "market environment"

Four broad cases:

1. Monopoly
   No competitors

2. Perfect competition
   Many competitors
   Identical products

3. Monopolistic competition
   Many competitors
   Differentiated products

4. Oligopoly
   Small number of competitors
   Strategic behavior arises

This class focuses on 1 and 2

Key difference between cases:

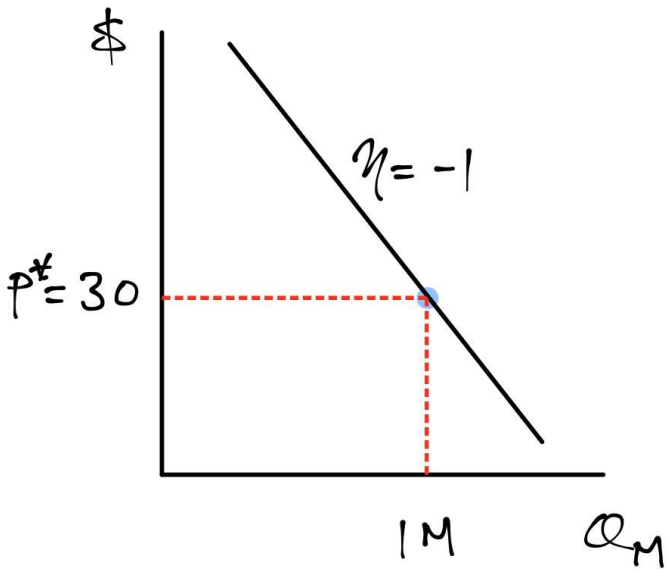
Elasticity of demand faced by the producer

Example: alpaca wool

Market P: $30

Market Q: 1M pounds

Elasticity: -1



Case 1: Monopoly

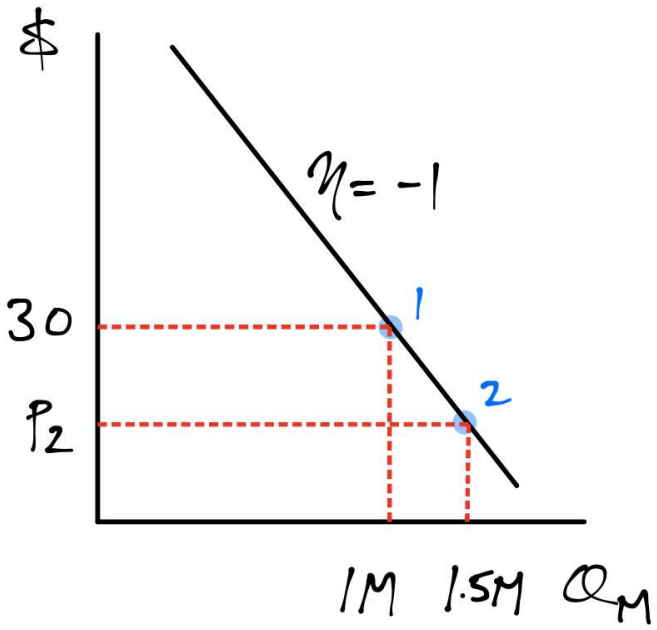
Producer sees the market demand:

$$WTP_M(Q) = P$$

Must adjust P when changing Q:

- Raising Q requires reducing P
- Raising P requires reducing Q

Example: suppose want to raise Q by 50% to 1.5M:



$$\eta = \frac{\%\Delta Q_M}{\%\Delta P_M}$$

$$\%\Delta P_M = \frac{50\%}{-1}$$

$$\%\Delta P_M = -50\%$$

$$P_2 = \$15$$

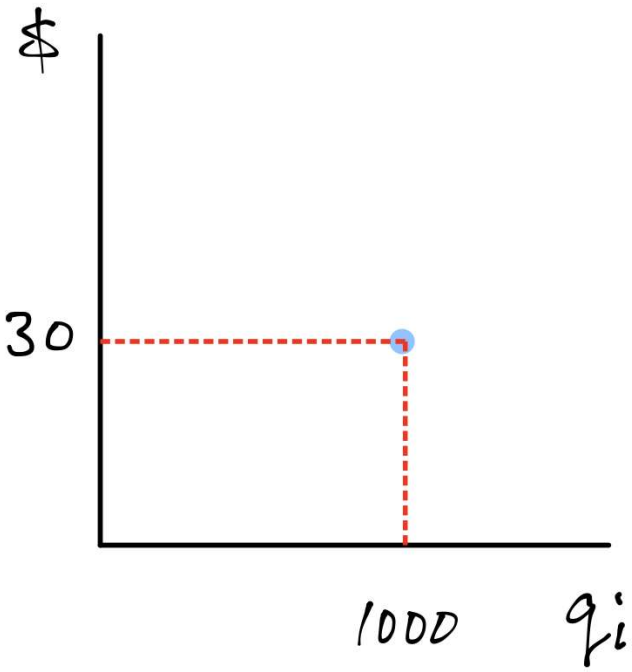
Case 2: Perfect competition

Individual producer sees **much** more elastic demand

Suppose:

- 1000 identical small producers
- Each produces $q_i = 1000$

Start with one point on each producer's apparent demand:



Producer considers raising q_i by 50%: 500 lbs

Impact on market price?

Small percent change for the market:

$$\%\Delta Q_M = \frac{500}{1M} = 0.05\%$$

Finding the price change:

$$\eta = \frac{\%\Delta Q_M}{\%\Delta P_M}$$

$$\%\Delta P_M = \frac{\%\Delta Q_M}{\eta} = \frac{0.05\%}{-1} = -0.05\%$$

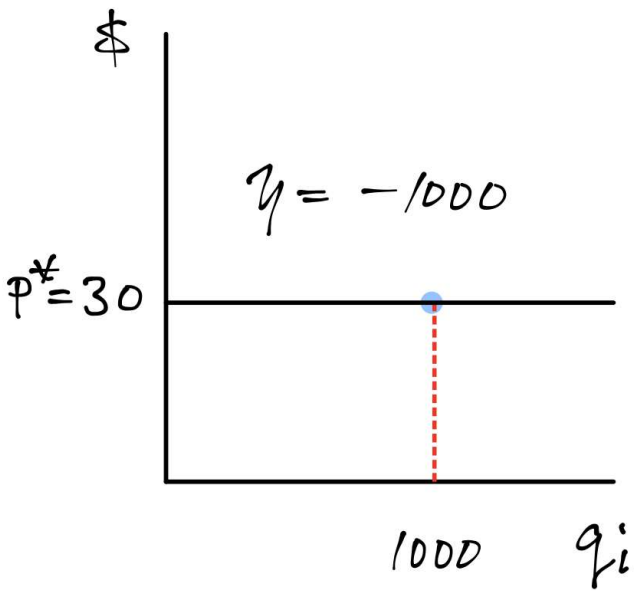
$$\Delta P_M = (-0.0005)(\$30) = -\$0.015$$

$$\Delta P_M = -1.5\ ¢$$

Apparent elasticity to the producer:

$$\eta_i = \frac{\%\Delta q_i}{\%\Delta P_M} = \frac{+50\%}{-0.05\%} = -1000$$

Graphing:



Flat for all practical purposes:

Producers can act as though the price is fixed at P^*
Known as *price taking* behavior

Output Decision Example

Can now find optimal output for four cases:

		Market type	
		Competitive	Monopoly
Goal		$P = P^*$	$P = WTP_M$
Output max	Q where $P = AC$	Case 1	Case 3
Profit max	Q where $MR = MC$	Case 2	Case 4

Example: sailboat hulls

$$TC = 1800 + 72 * Q^2$$

Monopoly demand: $WTP = 4000 - 300Q$

Competitor's demand: $P^* = 1200$

Can find optimal Q with a spreadsheet with 5 columns:

1. Q
2. $P(Q)$
3. $TR = P * Q$
4. $TC = 1800 + 72 * Q^2$
5. $\Pi = TR - TC$

Example: competitive producer with P=1200

Q	P	TR	TC	Profit
0	1200	0	1800	-1800

1	1200	1200	1872	-672
2	1200	2400	2088	312
…				…

Spreadsheet on web site

Snapshots of Spreadsheets

Competitive case:

Output Decision
Short Run with Capital Stock Fixed

Linear Demand Curve: P = A - B*Q A = 1,200
Total Cost Equation: TC = 1800 + 72*Q^2 B = 0

	Q	Price	TR	TC	Profit	AC	AR	AR-AC	MC	MR	MR-MC
	0	1,200	0	1,800	-1,800	--	--		--	--	
	1	1,200	1,200	1,872	-672	1,872	1,200	-672	72	1,200	1,128
	2	1,200	2,400	2,088	312	1,044	1,200	156	216	1,200	984
	3	1,200	3,600	2,448	1,152	816	1,200	384	360	1,200	840
	4	1,200	4,800	2,952	1,848	738	1,200	462	504	1,200	696
	5	1,200	6,000	3,600	2,400	720	1,200	480	648	1,200	552
	6	1,200	7,200	4,392	2,808	732	1,200	468	792	1,200	408
	7	1,200	8,400	5,328	3,072	761	1,200	439	936	1,200	264
Profit max	8	1,200	9,600	6,408	3,192	801	1,200	399	1,080	1,200	120
	9	1,200	10,800	7,632	3,168	848	1,200	352	1,224	1,200	-24
	10	1,200	12,000	9,000	3,000	900	1,200	300	1,368	1,200	-168
	11	1,200	13,200	10,512	2,688	956	1,200	244	1,512	1,200	-312
	12	1,200	14,400	12,168	2,232	1,014	1,200	186	1,656	1,200	-456
	13	1,200	15,600	13,968	1,632	1,074	1,200	126	1,800	1,200	-600
	14	1,200	16,800	15,912	888	1,137	1,200	63	1,944	1,200	-744
Output max	15	1,200	18,000	18,000	0	1,200	1,200	0	2,088	1,200	-888
	16	1,200	19,200	20,232	-1,032	1,265	1,200	-65	2,232	1,200	-1,032
	17	1,200	20,400	22,608	-2,208	1,330	1,200	-130	2,376	1,200	-1,176
	18	1,200	21,600	25,128	-3,528	1,396	1,200	-196	2,520	1,200	-1,320
	19	1,200	22,800	27,792	-4,992	1,463	1,200	-263	2,664	1,200	-1,464
	20	1,200	24,000	30,600	-6,600	1,530	1,200	-330	2,808	1,200	-1,608
	21	1,200	25,200	33,552	-8,352	1,598	1,200	-398	2,952	1,200	-1,752
	22	1,200	26,400	36,648	-10,248	1,666	1,200	-466	3,096	1,200	-1,896
	23	1,200	27,600	39,888	-12,288	1,734	1,200	-534	3,240	1,200	-2,040

Monopoly cases:

Output Decision

Short Run with Capital Stock Fixed

Linear Demand Curve: P = A - B*Q	A	4,000
Total Cost Equation: TC = 1800 + 72*Q^2	B	300

	Q	Price	TR	TC	Profit	AC	AR	AR-AC	MC	MR	MR-MC
	0	4,000	0	1,800	-1,800	--	--		--	--	
	1	3,700	3,700	1,872	1,828	1,872	3,700	1,828	72	3,700	3,628
	2	3,400	6,800	2,088	4,712	1,044	3,400	2,356	216	3,100	2,884
	3	3,100	9,300	2,448	6,852	816	3,100	2,284	360	2,500	2,140
	4	2,800	11,200	2,952	8,248	738	2,800	2,062	504	1,900	1,396
Profit max	5	2,500	12,500	3,600	8,900	720	2,500	1,780	648	1,300	652
	6	2,200	13,200	4,392	8,808	732	2,200	1,468	792	700	-92
	7	1,900	13,300	5,328	7,972	761	1,900	1,139	936	100	-836
	8	1,600	12,800	6,408	6,392	801	1,600	799	1,080	-500	-1,580
	9	1,300	11,700	7,632	4,068	848	1,300	452	1,224	-1,100	-2,324
Output max	10	1,000	10,000	9,000	1,000	900	1,000	100	1,368	-1,700	-3,068
	11	700	7,700	10,512	-2,812	956	700	-256	1,512	-2,300	-3,812
	12	400	4,800	12,168	-7,368	1,014	400	-614	1,656	-2,900	-4,556
	13	100	1,300	13,968	-12,668	1,074	100	-974	1,800	-3,500	-5,300
	14	-200	-2,800	15,912	-18,712	1,137	-200	-1,337	1,944	-4,100	-6,044
	15	-500	-7,500	18,000	-25,500	1,200	-500	-1,700	2,088	-4,700	-6,788
	16	-800	-12,800	20,232	-33,032	1,265	-800	-2,065	2,232	-5,300	-7,532
	17	-1,100	-18,700	22,608	-41,308	1,330	-1,100	-2,430	2,376	-5,900	-8,276
	18	-1,400	-25,200	25,128	-50,328	1,396	-1,400	-2,796	2,520	-6,500	-9,020
	19	-1,700	-32,300	27,792	-60,092	1,463	-1,700	-3,163	2,664	-7,100	-9,764
	20	-2,000	-40,000	30,600	-70,600	1,530	-2,000	-3,530	2,808	-7,700	-10,508
	21	-2,300	-48,300	33,552	-81,852	1,598	-2,300	-3,898	2,952	-8,300	-11,252
	22	-2,600	-57,200	36,648	-93,848	1,666	-2,600	-4,266	3,096	-8,900	-11,996
	23	-2,900	-66,700	39,888	-106,588	1,734	-2,900	-4,634	3,240	-9,500	-12,740