Chapter 14

Firms in Perfectly Competitive Markets

Perfect Competition

Recall: A perfectly competitive market has the following characteristics:

- There are many buyers and sellers in the market.
- The goods offered by the various sellers are homogeneous (identical).
- Firms can freely enter or exit the market.
- There are no barriers to entry such as patents, exclusive rights to a key input to production, etc.

Because the perfectly competitive market has so many buyers and sellers:

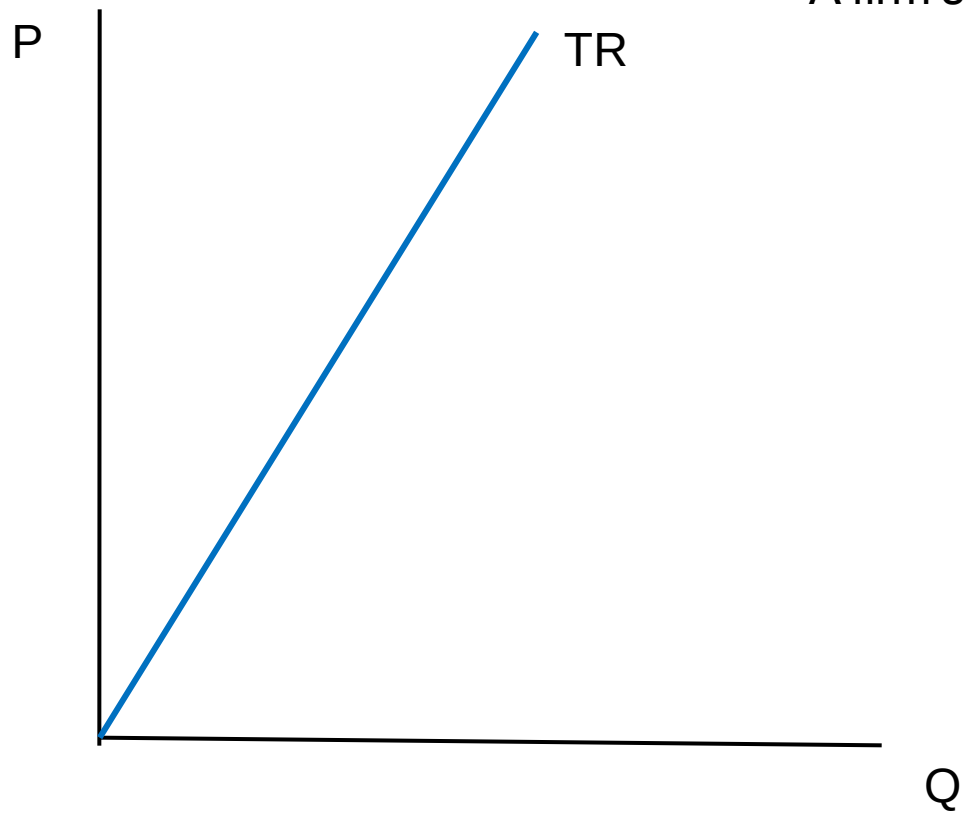
- The actions of any single buyer or seller in the market have a negligible impact on the market price.
- No one firm has any market power – no firm is big and powerful enough to control price.
- Market demand and supply determine price and every firm takes the market price as given – they are **price takers**.

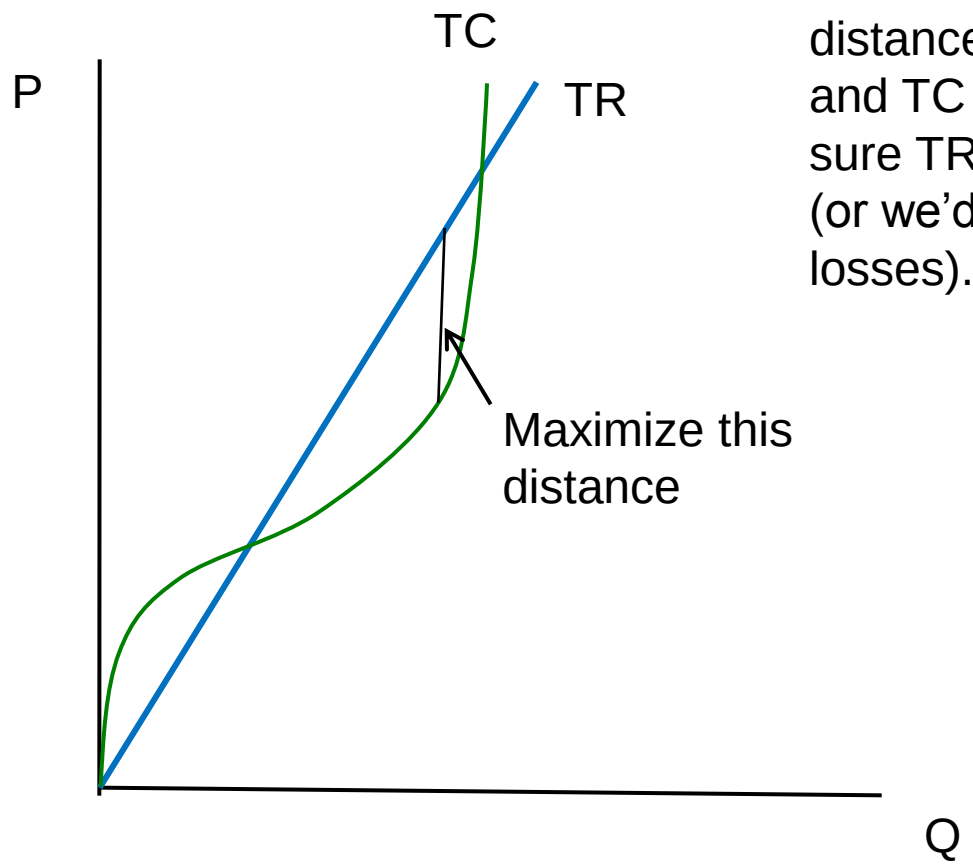
- When we examined a firm's cost structure, we looked at MC and Average Costs.
- These concepts are useful to apply to a firm's revenue:

- First, how much revenue does a firm receive for a typical good it sells?

- Recall:
- Total revenue for a firm is the selling price times the quantity sold.
- $$TR = (P \times Q)$$
- Since P is given, the TR curve is a linear function of Q.

A firm's TR curve





Since Π = TR –TC, we want to maximize the distance between the TR and TC curves, making sure TR is not less than TC (or we'd be making losses).

Average Revenue

- Average revenue, AR, tells us how much revenue a firm receives for the typical unit sold.
- Average revenue is total revenue divided by the quantity sold.

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

Marginal Revenue

- Now, how much additional revenue does a firm receive if it increases production by one more good?

We define:

Marginal revenue = the change in total revenue from an additional unit sold.

$$\mathbf{MR = \Delta TR / \Delta Q}$$

MR is the slope of the total revenue function.

- Since TR = PQ and P is given (because firms are price takers), if we increase Q by 1 unit, TR will increase by the P of the good. Therefore,

MR = P for a perfectly competitive firm

*This is true only for competitive firms that are price takers.

- EXAMPLE:
- J&H Dairy Farms produces and sells milk in a perfectly competitive market.
- The market price for milk is $6 per gallon.
- The firm's TR, AR and MR for various quantities of milk are:

Revenues for J&H Dairy Farms

Quantity	Price	Total Revenue	Average Revenue	Marginal Revenue
(*Q*)	(*P*)	($TR = P \times Q$)	($AR = TR/Q$)	($MR = \Delta TR/\Delta Q$)
1 gallon	$6	$ 6	$6	
				$6
2	6	12	6	
				6
3	6	18	6	
				6
4	6	24	6	
				6
5	6	30	6	
				6
6	6	36	6	
				6
7	6	42	6	
				6
8	6	48	6	

- Notice that P = AR = MR

- Now, suppose we know the firm's TC of producing at each of the previous quantity levels.
- We can easily calculate its profit Π = TR-TC.
- Plus, since we know TC, we can also calculate the firm's MC.

Quantity	Total Revenue	Total Cost	Profit	Marginal Revenue	Marginal Cost
(*Q*)	(*TR*)	(*TC*)	(*TR* – *TC*)	(*MR* = $\Delta TR/\Delta Q$)	(*MC* = $\Delta TC/\Delta Q$)
0 gallons	$ 0	$ 3	−$3		
				$6	$2
1	6	5	1		
				6	3
2	12	8	4		
				6	4
3	18	12	6		
				6	5
4	24	17	7		
				6	6
5	30	23	7		
				6	7
6	36	30	6		
				6	8
7	42	38	4		
				6	9
8	48	47	1		

- As long as producing one more gallon of milk adds more to revenue than it does to total costs (that is, MR exceeds MC), it makes sense for J&H to produce that additional gallon.
- They make more from the sale of that gallon than it costs them to produce it.

- As long as MR > MC, the firm should produce that gallon.

- If the addition to total cost of producing an additional gallon (MC) is greater than the addition to total revenue (MR), the firm should not produce that gallon.
- It would cost more than it brought in and the firm would lose money on that gallon.

- If MR < MC, the firm should produce less milk.

- So, we have a golden rule for a profit-maximizing firm:

A profit-maximizing firm will produce a quantity of output at the point where

MR = MC

Quantity	Total Revenue	Total Cost	Profit	Marginal Revenue	Marginal Cost
(*Q*)	(*TR*)	(*TC*)	(*TR* – *TC*)	(*MR* = Δ*TR*/Δ*Q*)	(*MC* = Δ*TC*/Δ*Q*)
0 gallons	$ 0	$ 3	−$3		
				$6	$2
1	6	5	1		
				6	3
2	12	8	4		
				6	4
3	18	12	6		
				6	5
4	24	17	7		
				6	6
5	30	23	7		
				6	7
6	36	30	6		
				6	8
7	42	38	4		
				6	9
8	48	47	1		

- J&H will produce where **MR = MC**

- This is the point where Q = 5 gallons.
- Total profit = $7.

- Now, you'll ask "why not produce 4 gallons? The profit is $7 – the maximum – the same as if they produced 5 gallons."
- Well, a smart firm wants to keep a presence in the business community and serve as many customers as it can (looks good), so it will always produce and sell the greater amount.
- We prove this mathematically in second-year micro, but at the end of these notes I have included the proof for anyone who is interested.

This is important:

- In perfect competition, we've seen that price equals marginal revenue (P= MR), so

IN PERFECT COMPETITION, A FIRM WILL PRODUCE WHERE

P = MR = MC

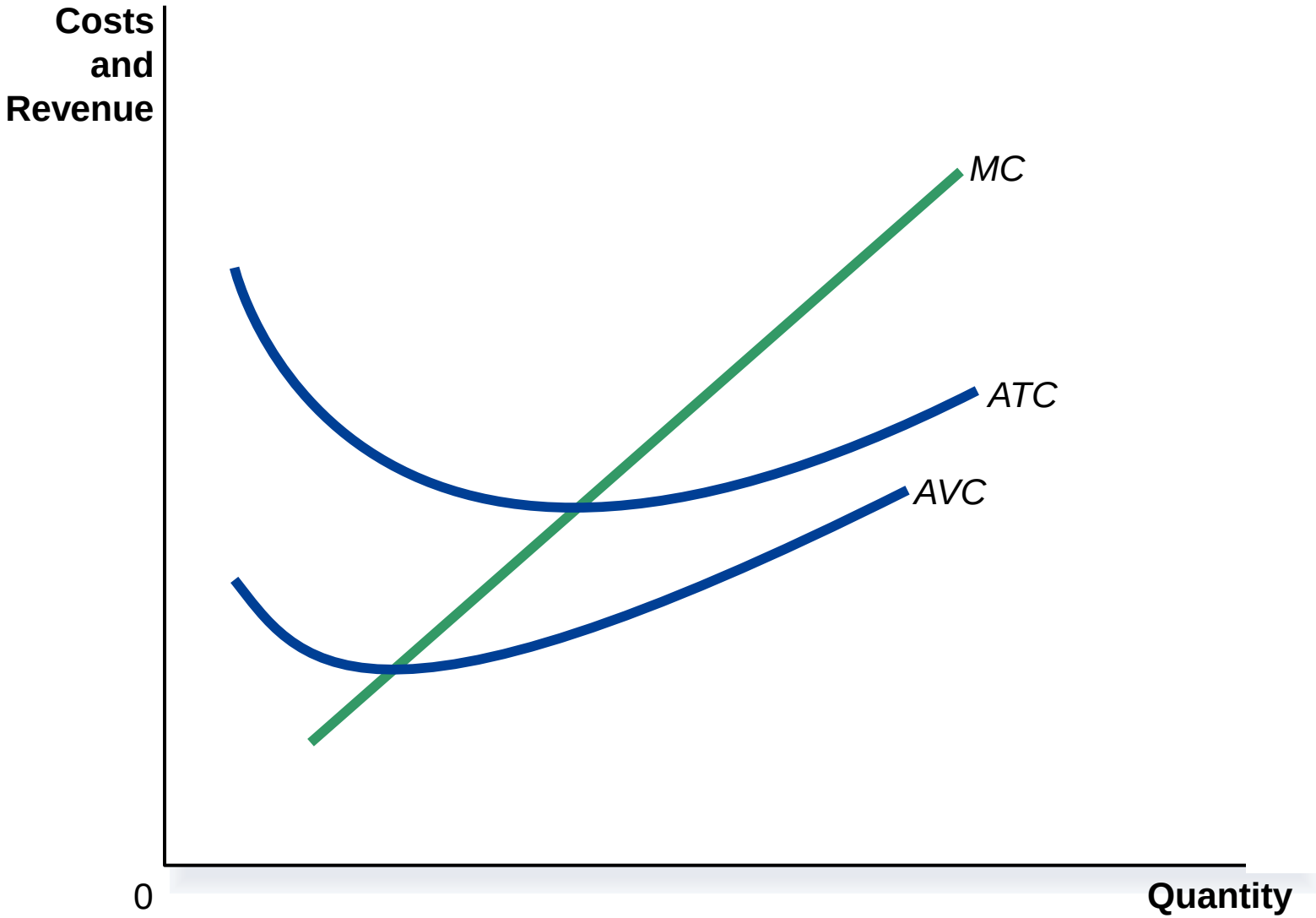
that is, where

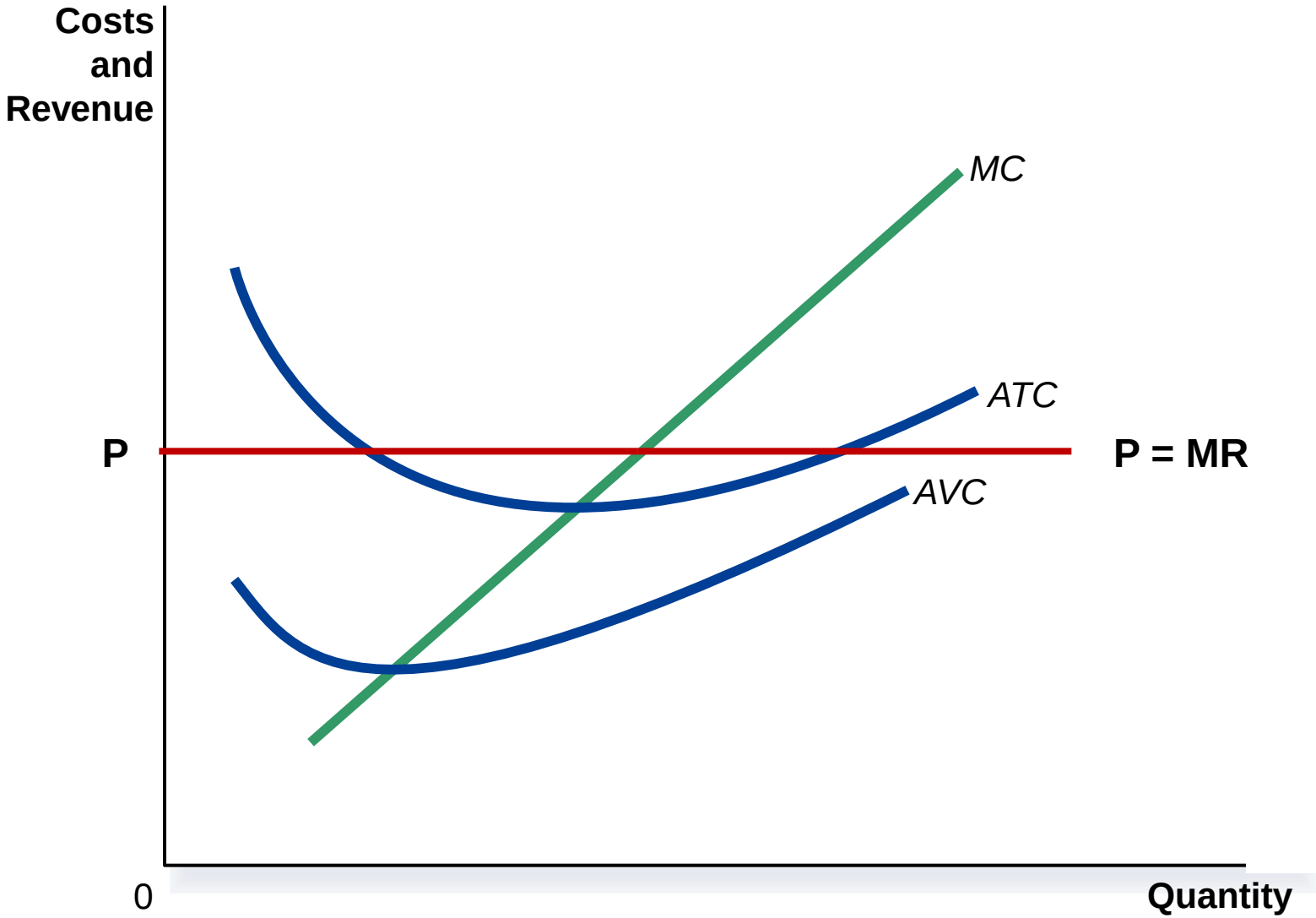
P = MC

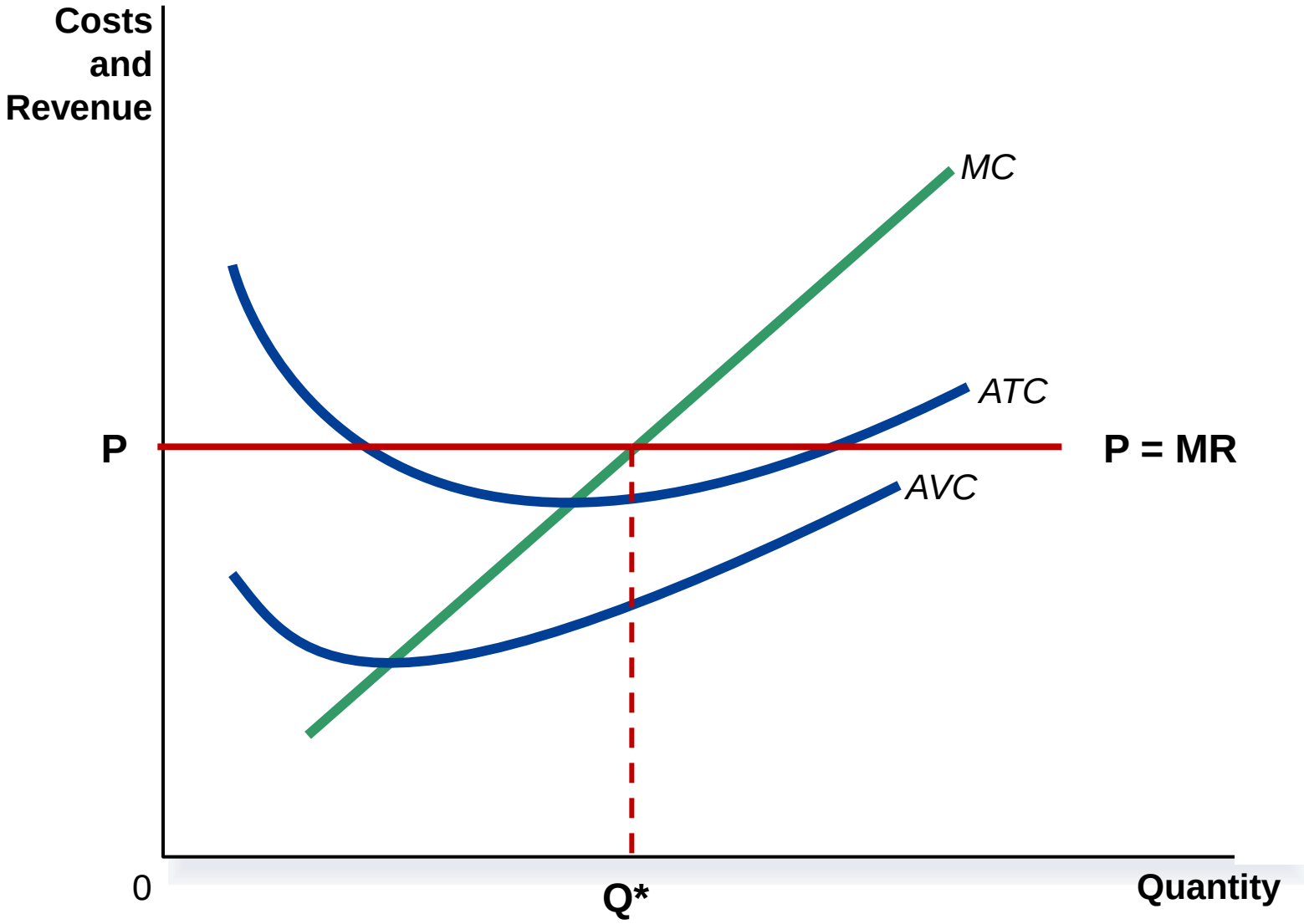
- We can now use our SR cost curves to illustrate a competitive firm's SR profit-maximizing choice of output level, Q

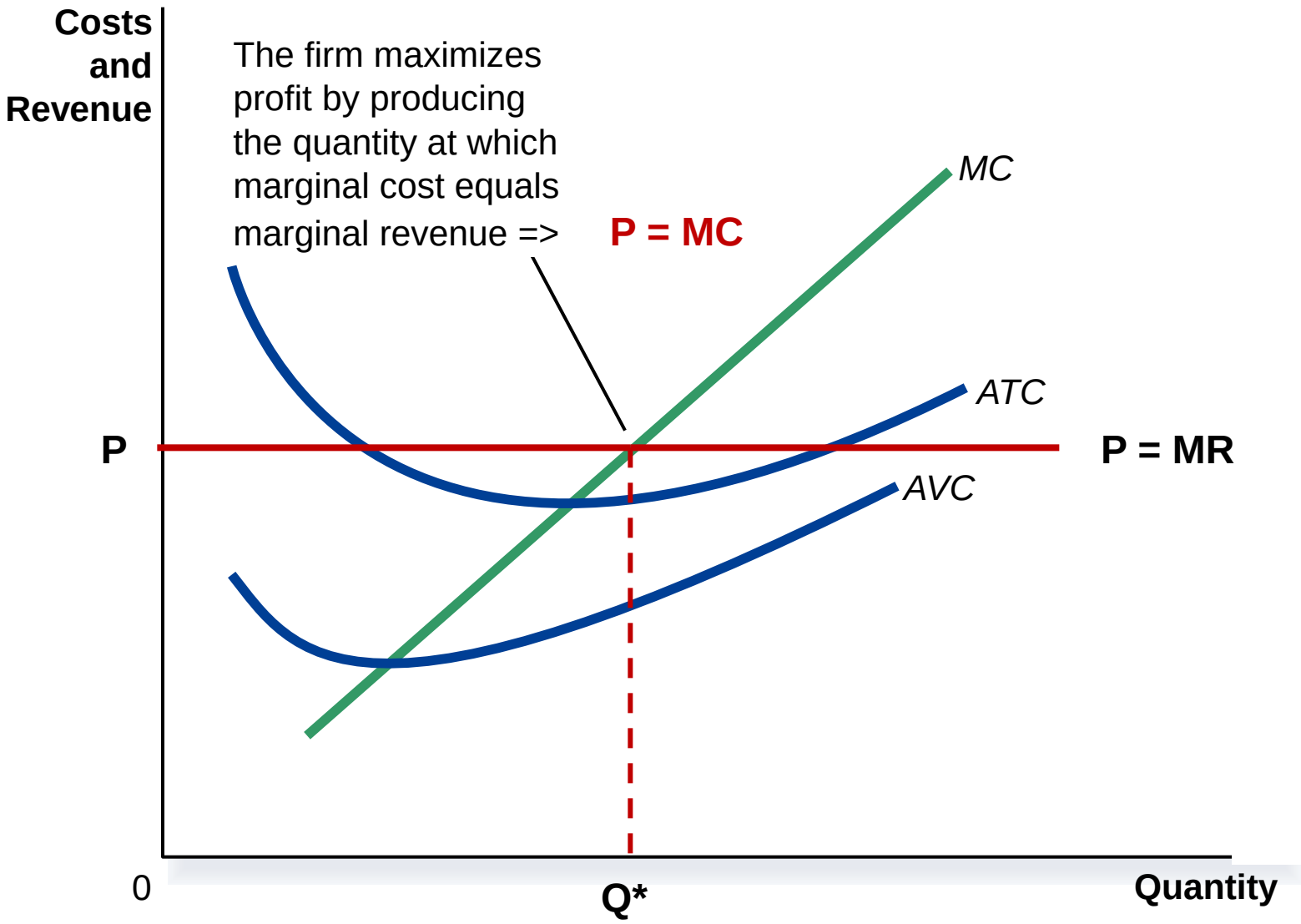
- Remember, a firm chooses Q so that
  P = MR = MC

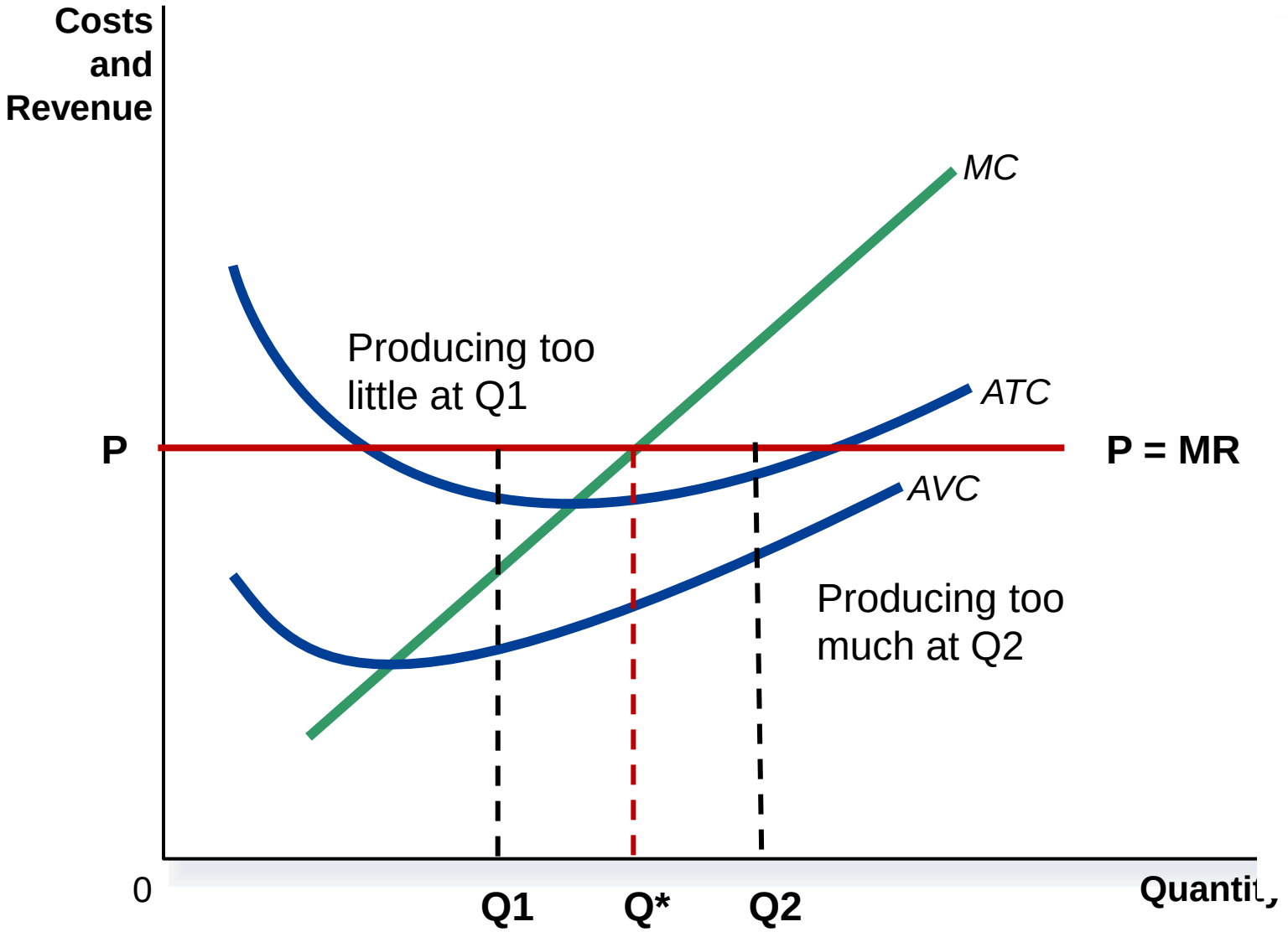
Profit Maximization for a Competitive Firm




Costs and Revenue
MC
ATC
P
P = MR
AVC
0
Quantity


Costs and Revenue
MC
ATC
P
P = MR
AVC
0
Q*
Quantity


Costs and Revenue
The firm maximizes profit by producing the quantity at which marginal cost equals marginal revenue =>
P = MC
MC
ATC
AVC
P
P = MR
0
Q*
Quantity


Costs and Revenue
MC
Producing too little at Q1
ATC
P
P = MR
AVC
Producing too much at Q2
0
Q1
Q*
Q2

- When MR > MC, the firm should increase Q (producing one more good will add more to TR than to TC: at Q_1).
- When MR < MC, the firm should decrease Q (producing that good adds more to TC than to TR : at Q_2).
- When MR = MC, profit is maximized (at Q*).

- Because the firm will always produce where P = MC, it is actually the MC curve that determines Q.
- In other words,

  The firm's supply curve is its MC curve (so far – we'll qualify this in a minute).

SR Shutdown Decision

- Sometimes a firm will choose to not produce anything at all.
- It may choose to temporarily shut down in the SR because of market conditions (for example, a temporary decrease in demand means that the price in the market of the firm's good has fallen).

- If a firm shuts down, it makes no revenue at all.
- But, it still has to pay its fixed costs (like lease, insurance, security guards, etc.).
- It does save by not having to pay any variable costs (no wages, no raw materials, etc.) because it's not producing anything.

- As long as a firm can cover its variable costs, it pays for the firm to stay open and keep producing (shutting down, even for a short time, could mean a big loss in customers).
- If the firm couldn't even bring in enough revenue to cover variable costs (wages, its bills for raw materials, etc.), it might as well shut down and cut its losses (only be stuck with its fixed costs).

- So, a firm will shut down in the SR if the revenue it would earn wouldn't be enough to cover its variable costs.

- Mathematically, the firm would shut down if

$$TR < TVC$$

$$\text{i.e., } PQ < TVC$$

- If we divide both sides of the equation by Q:

$$\frac{PQ}{Q} < \frac{TVC}{Q}$$

But, TVC/Q is AVC

So,

$$P < AVC$$

- That is,

A firm will shut down in the SR if
$P < AVC$

- Note that a firm doesn't consider its sunk costs when deciding whether to shut down.

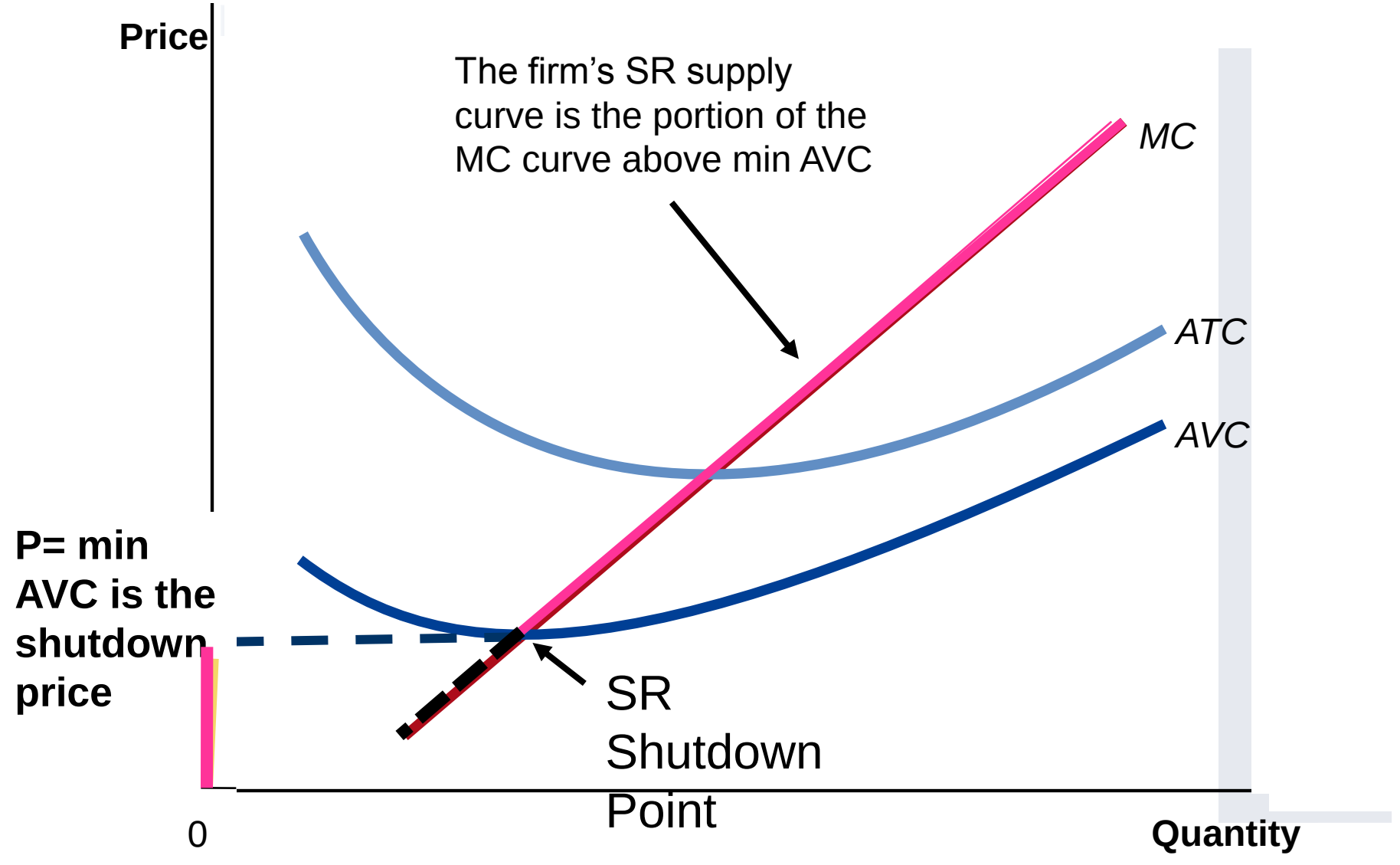
- Sunk costs are costs that have already been committed and cannot be recovered.
- The money's been spent and that's that.

A Competitive Firm's SR Supply Curve

- If a firm won't produce anything if P < AVC, we can specify what the firm's SR supply curve is:

The competitive firm's SR supply curve is the portion of the MC curve that lies above min AVC.

The Competitive Firm's SR Supply Curve



- If the price was exactly equal to min AVC, a firm would be indifferent between shutting down or staying open and producing.
- However, if the firm expects market conditions to improve, it should probably keep producing so that it doesn't lose customers.

A Competitive Firm's Demand Curve

- Notice that P is the ultimate factor in a firm's production decision.

- It chooses Q where P = MC.
- If it tried to charge a P > market P, people would stop buying from it completely. Therefore,

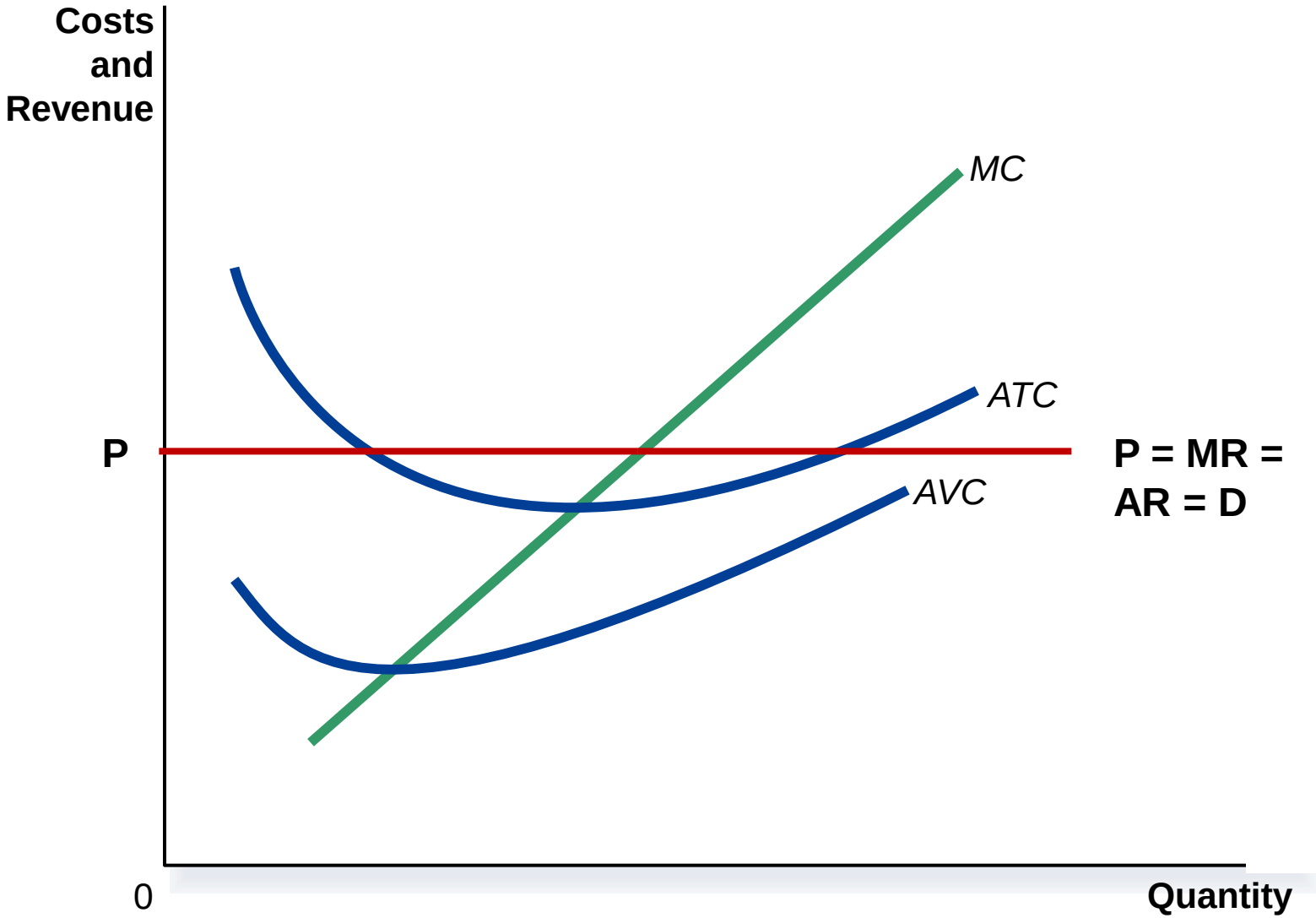
  The firm's demand curve is perfectly elastic.

In fact,

- The individual firm's demand curve in a perfectly competitive market is precisely the price level!

- So, in perfect competition, for a firm:

P = AR = MR = D


Costs and Revenue
MC
ATC
P
P = MR = AR = D
AVC
0
Quantity

A Competitive Firm's SR Profit

- Recall: A firm's profit is

  $\Pi = TR - TC$

- We can rewrite this equation as

$$\Pi = (TR/Q - TC/Q)Q$$

(all we did was divide TR and TC by Q and multiply by Q so the identity is preserved)

- But, TR/Q = P and TC/Q = ATC, so

$$\Pi = (P - ATC)Q$$

Profit in Economics

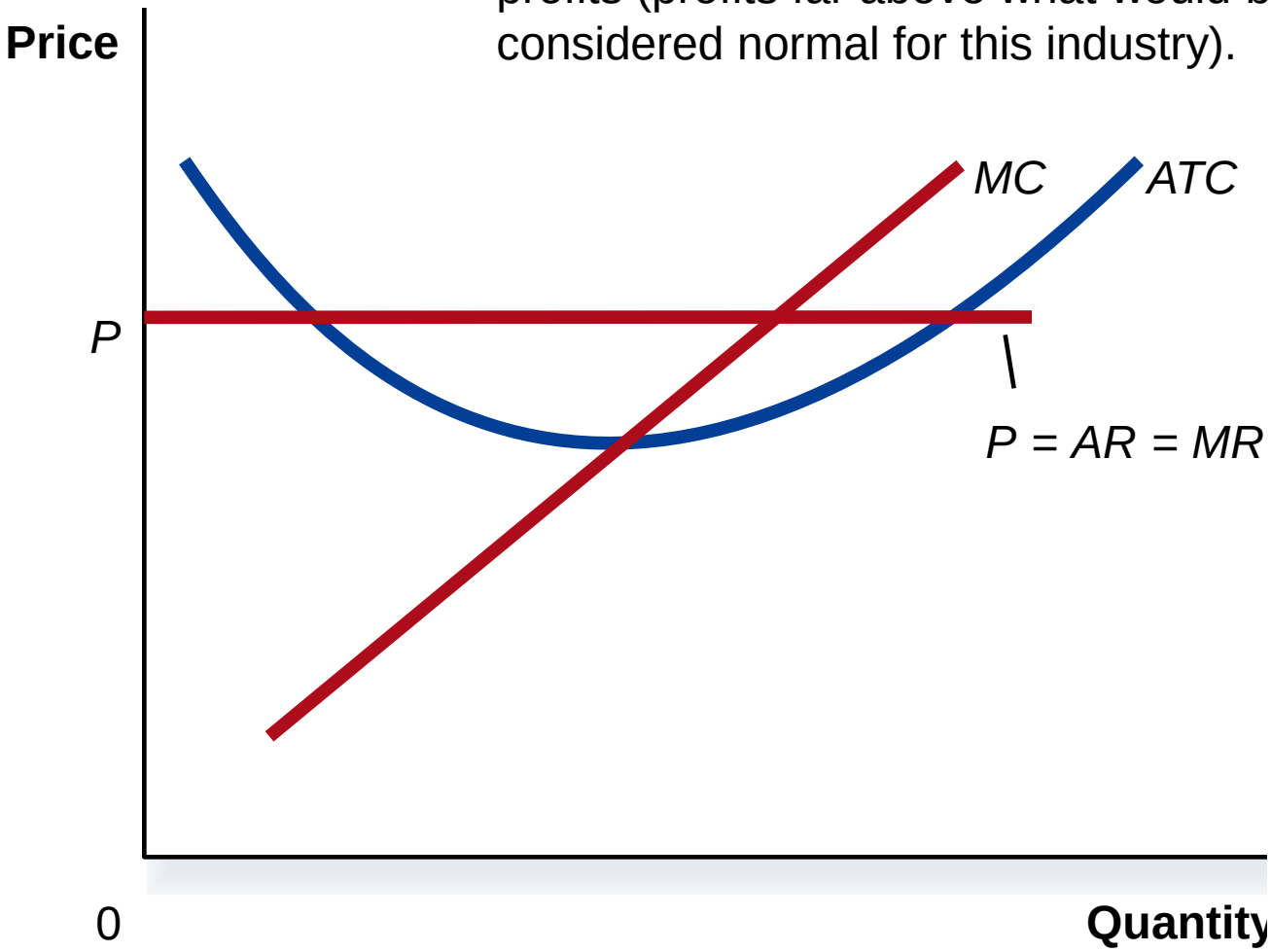
- When P > ATC, a firm makes positive economic profit.
- These are profits far above what you'd expect a firm to typically make in that industry.

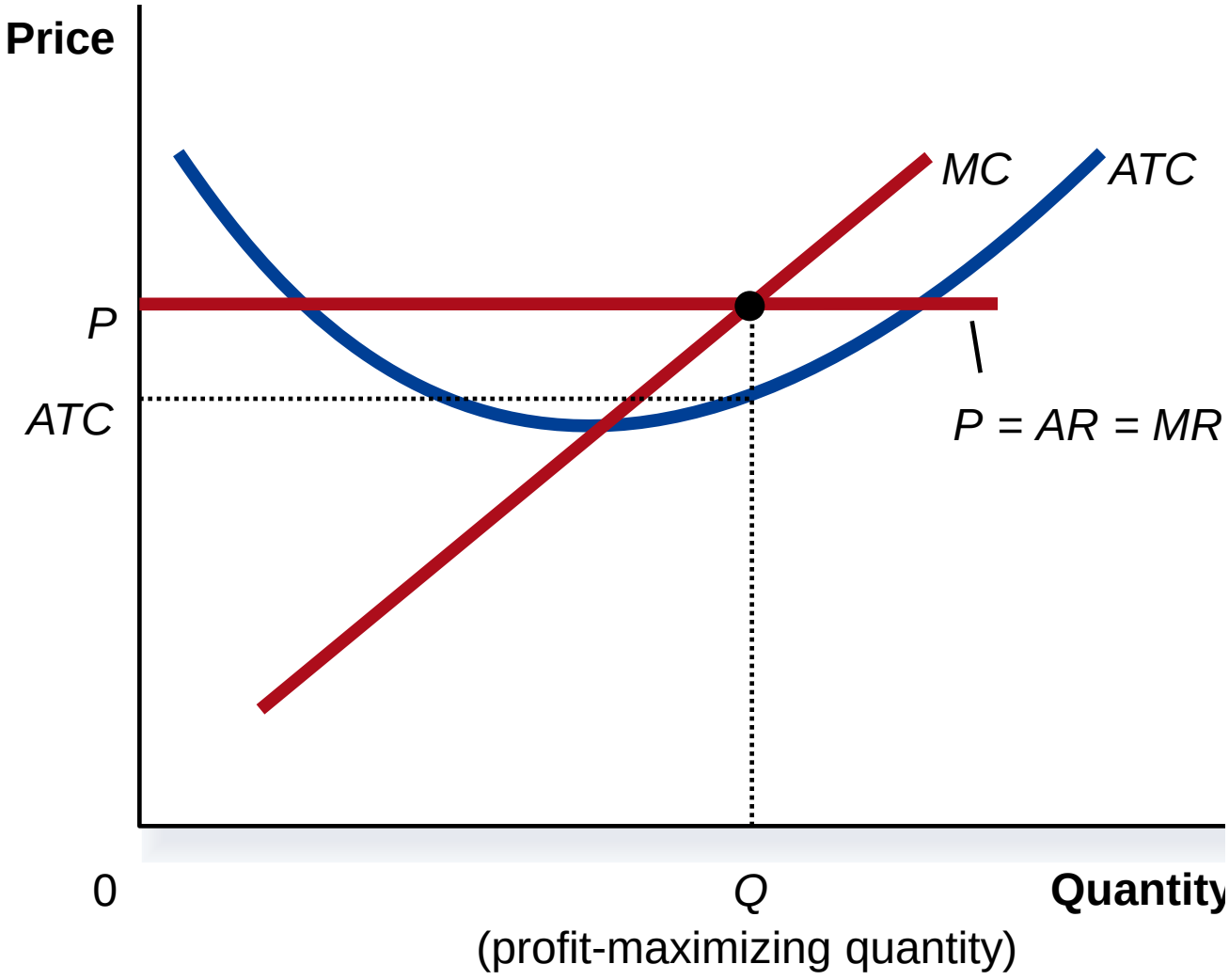
- When P < ATC, a firm makes negative economic profit, a loss.

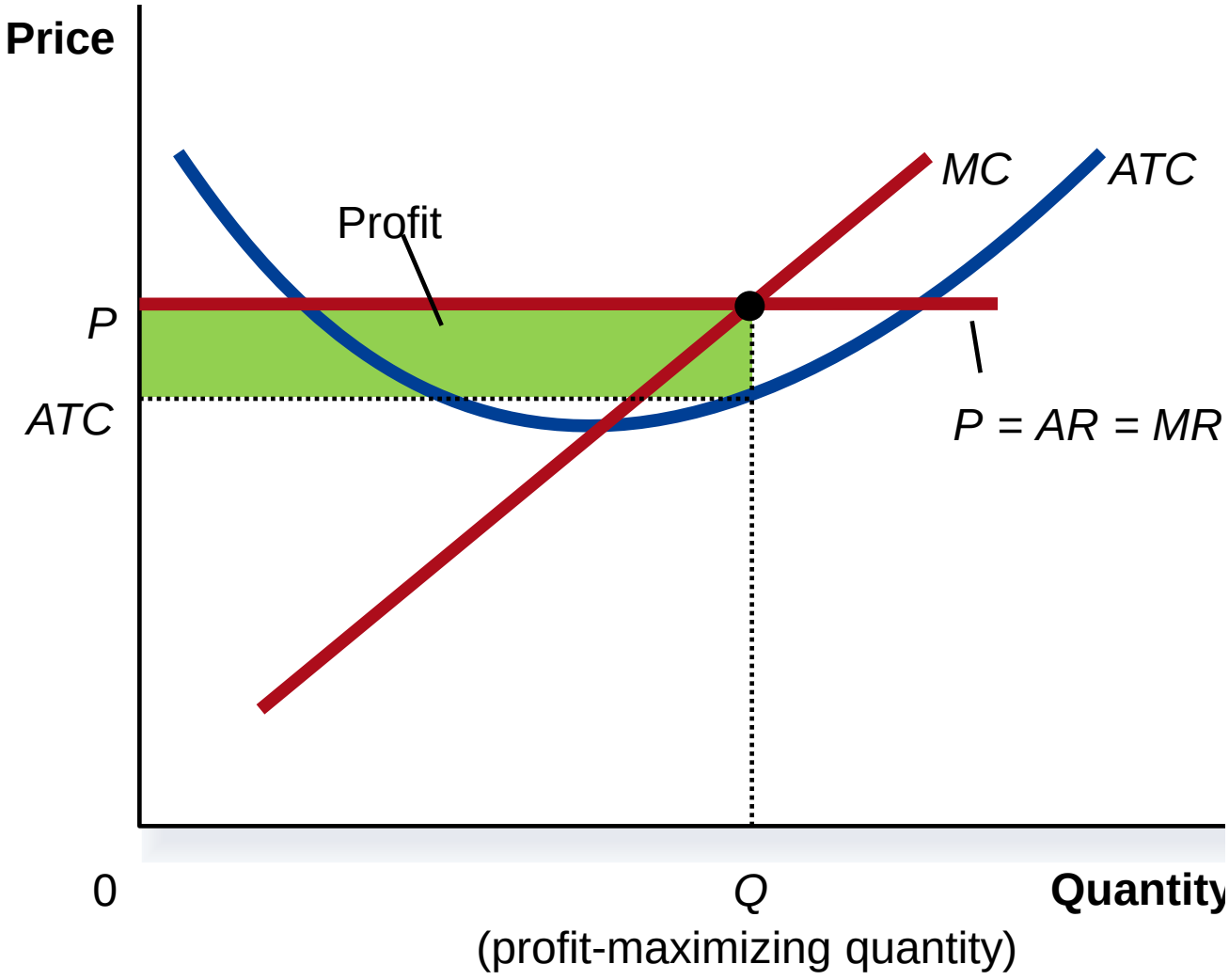
- When P = ATC, a firm makes zero economic profit.
- This is considered normal economic profit.
- It means a firm is earning a decent return in the industry.
- The firm is still making money, just not atypical profits.
- You'd still be making an accounting profit.

A Firm Making Economic Profit: P > ATC

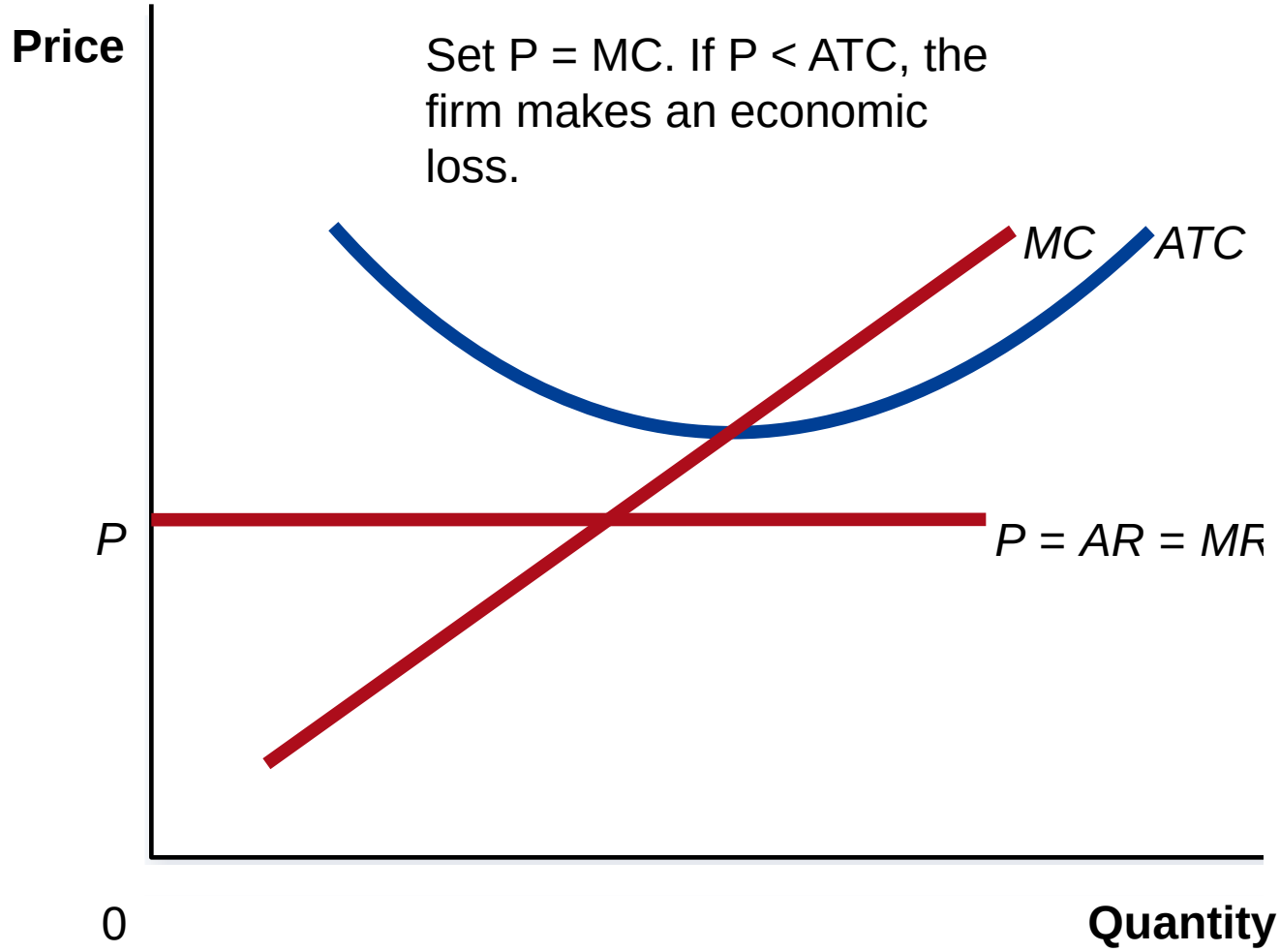
Set P = MC. If P > ATC, Profit will be > 0, so the firm will be earning positive economic profits (profits far above what would be considered normal for this industry).

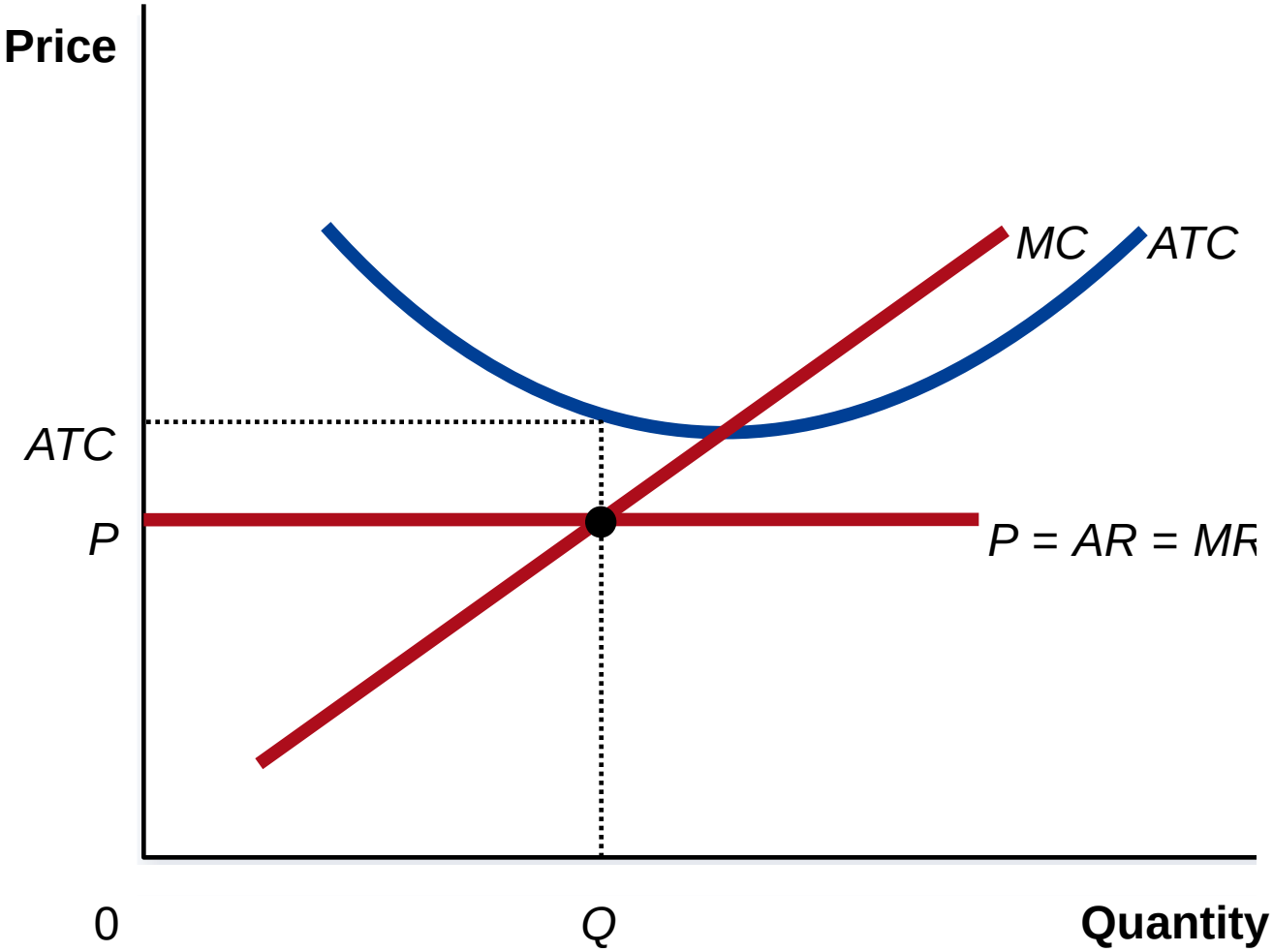


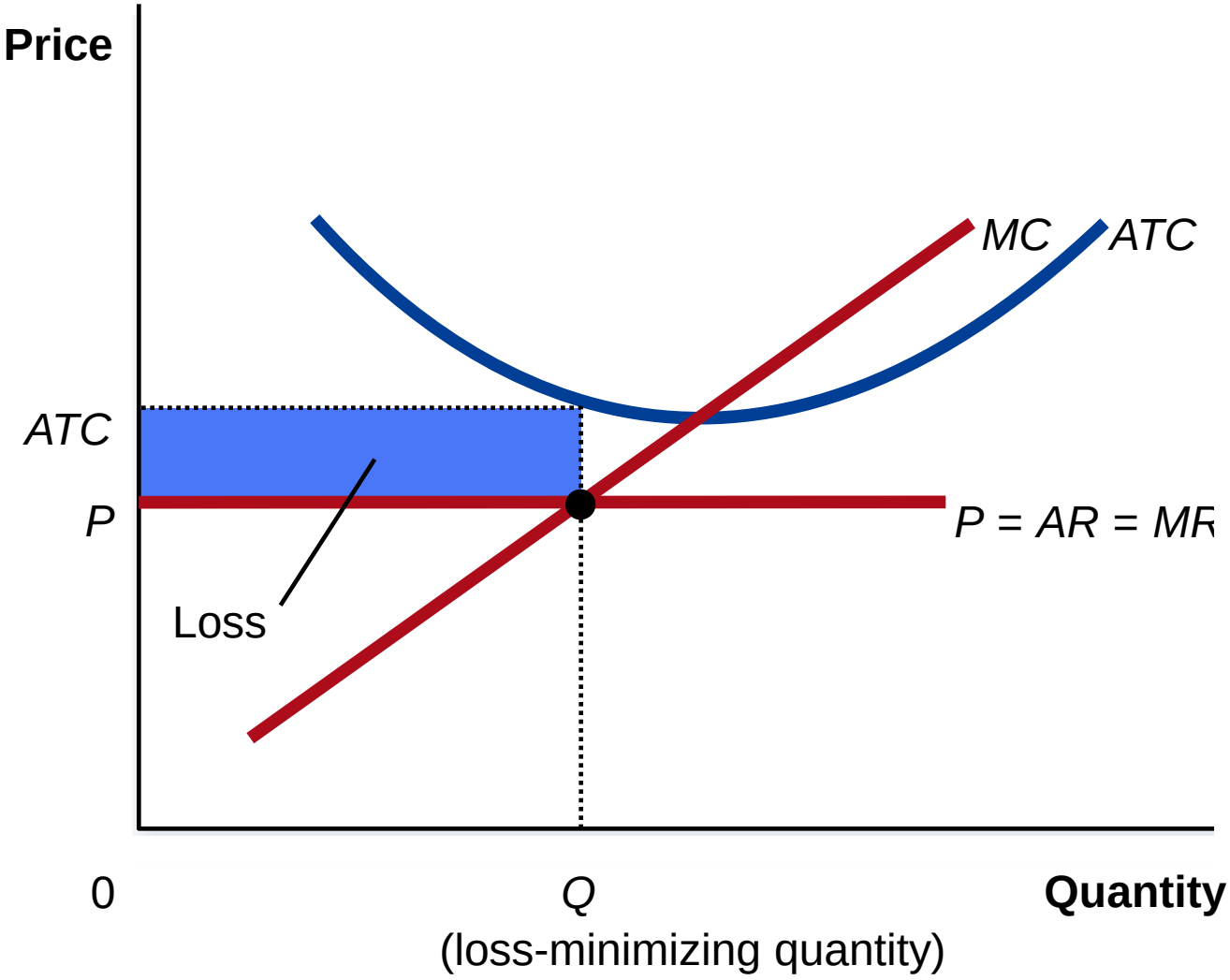

Price
MC
ATC
P
ATC
P = AR = MR
0
Q
Quantity
(profit-maximizing quantity)


Price
MC
ATC
Profit
P
ATC
P = AR = MR
0
Q
Quantity
(profit-maximizing quantity)

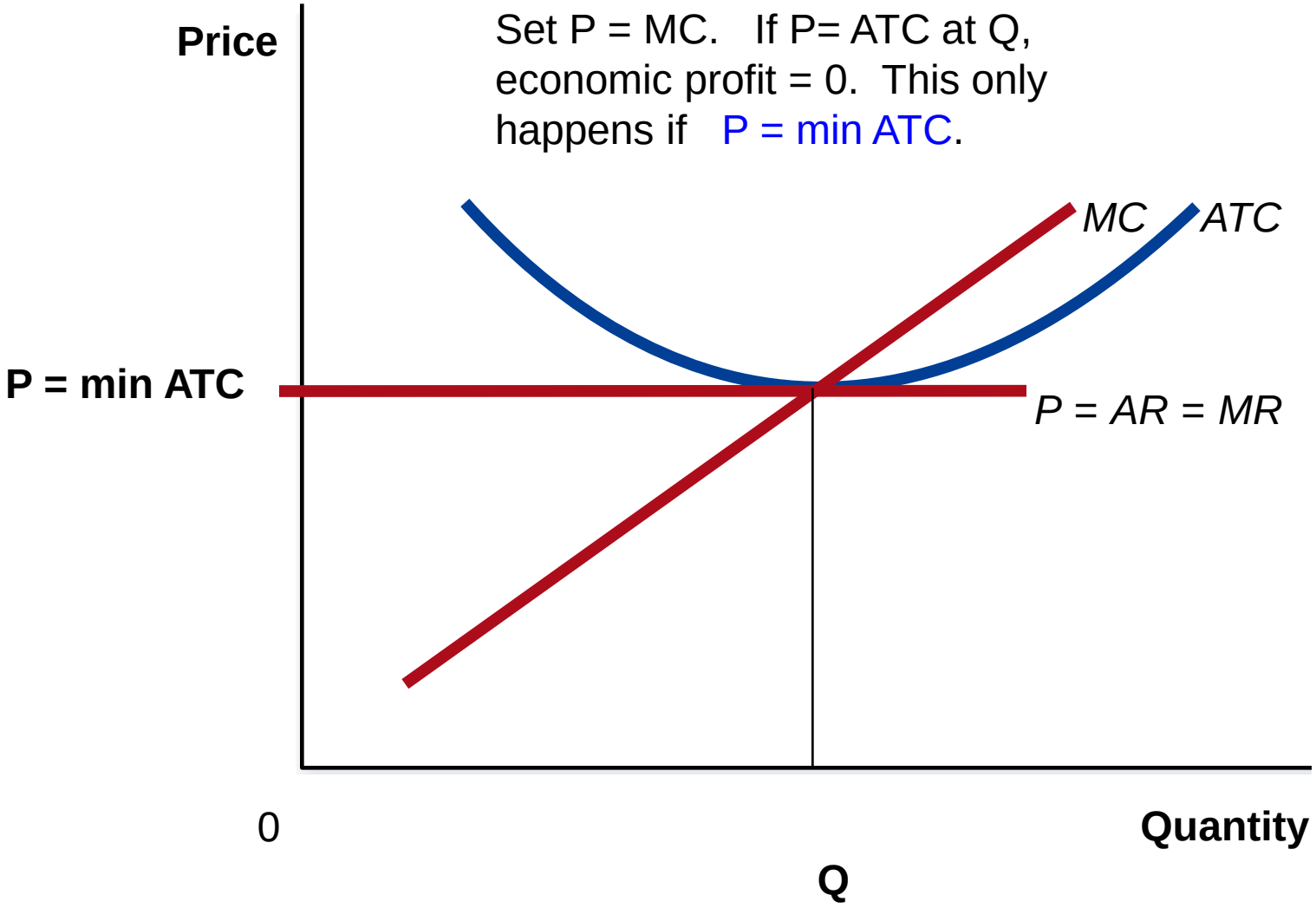
A Firm Making an Economic Loss: P < ATC




Price
MC
ATC
ATC
P
P = AR = MR
0
Q
Quantity


Price
MC
ATC
ATC
P
P = AR = MR
Loss
0
Q
Quantity
(loss-minimizing quantity)

Firm Making Normal Economic Profit = 0 and = min ATC

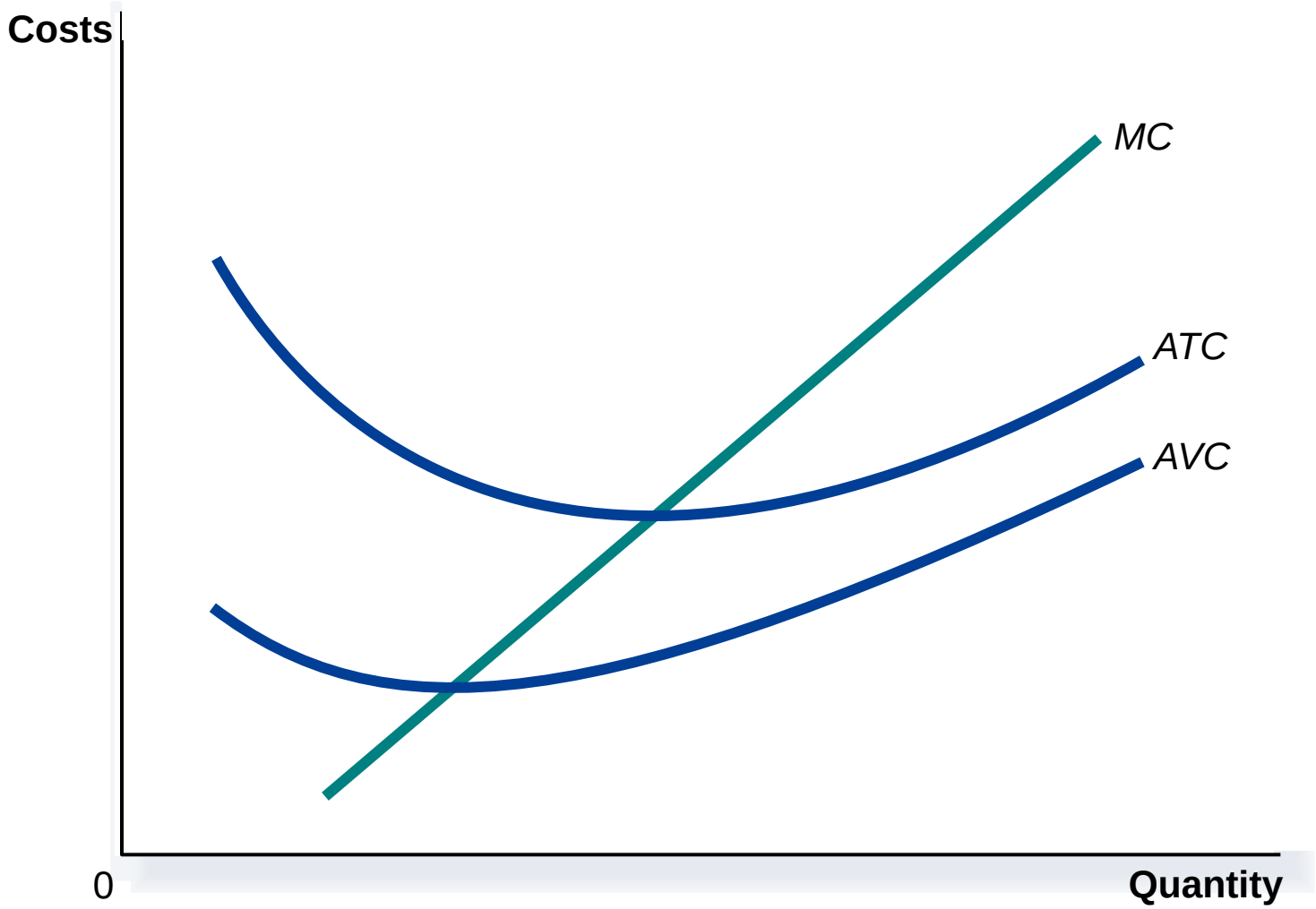


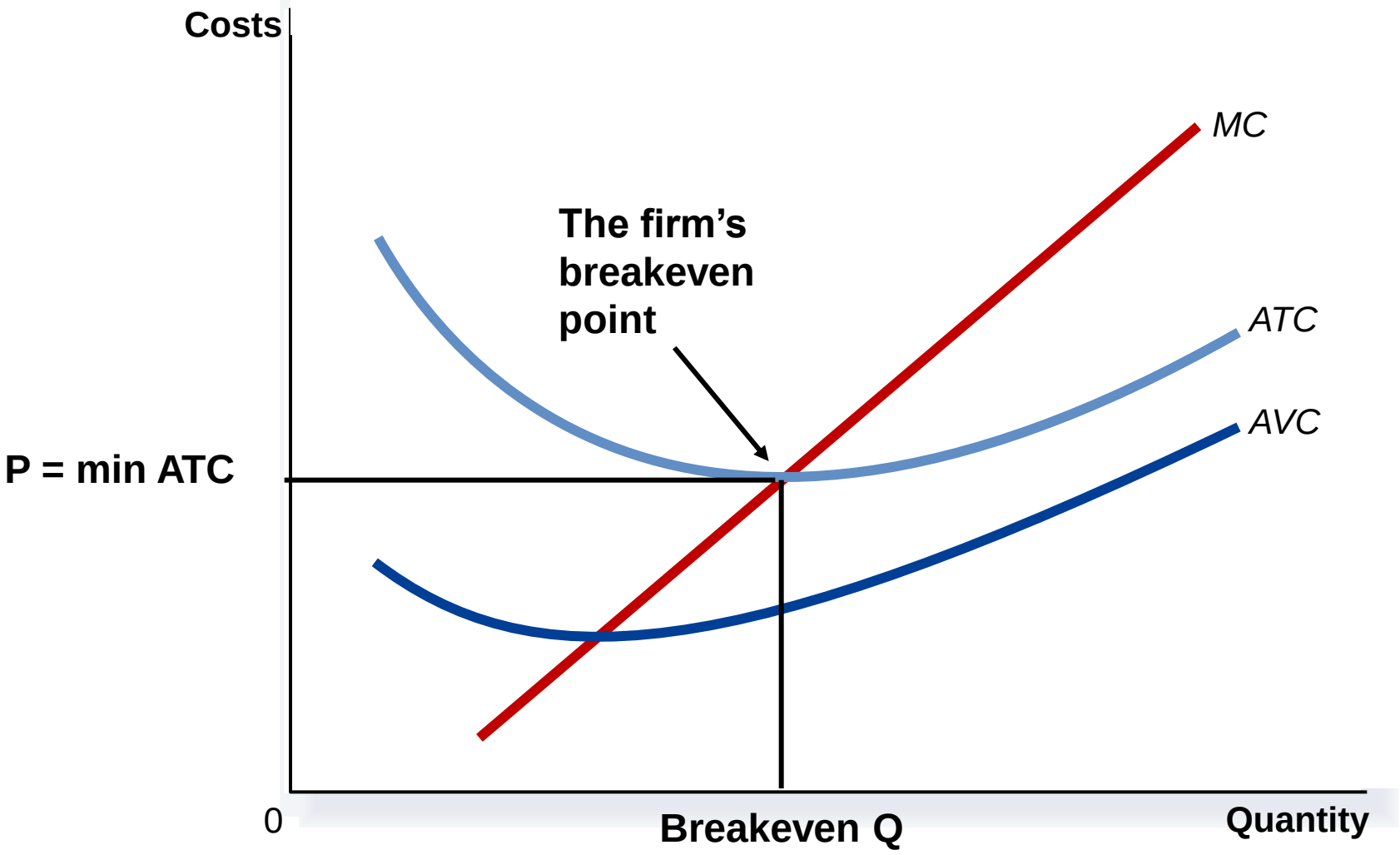
- When the firm earns zero economic profit, the firm is just breaking even (no profits, no losses)

The breakeven point for a firm occurs where

P = min ATC

A Firm's Breakeven Point




Costs
MC
The firm's breakeven point
ATC
AVC
P = min ATC
0
Breakeven Q
Quantity

Long Run Exit and Entry

- We've talked about a firm temporarily shutting down in the SR. What about in the LR?
- In the LR, all costs are variable, so it's average total costs (including any SR fixed costs) that come into play.
- A firm will want to exit an industry completely if the revenue it earns is consistently less than its costs.

- Mathematically, a firm will exit if
  TR < TC
- Dividing both sides by Q, exit if
  TR/Q < TC/Q that is, exit if
  P < ATC

So,

A firm will exit an industry if P < min ATC

- If P is consistently above ATC, firms in the industry are making positive economic profits that are exceptionally high for the industry.
- Potential entrants will see these profits as very attractive, and new firms will enter the industry.

So,

A firm will enter an industry if P > min ATC

- When P = min ATC, firms are earning zero economic profits.
- They're just earning profits that are normal.
- These are the profits one would expect a firm in that industry to earn – nothing special.
- When economic profit is zero, there is no reason for existing firms to exit (no losses) or for any new firms to enter (nothing special about this industry's profits).

When P = min ATC, there is no entry into or exit out of the industry:

This is LR equilibrium in the industry

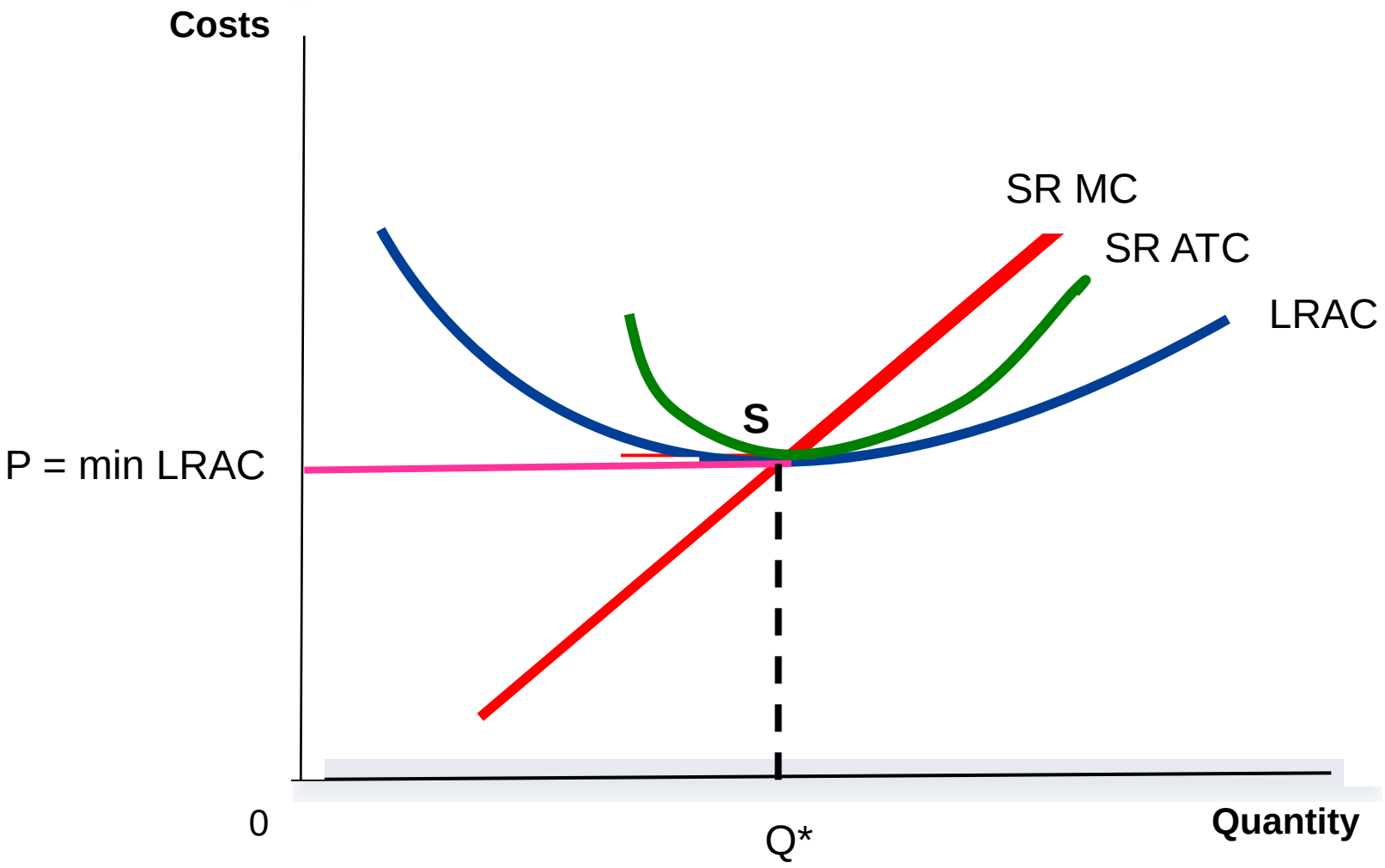
- The industry/market is in LR equilibrium when SR P = min ATC = SR MC
- But, in the LR, price must also be such that there is no entry or exit, nor any incentive for existing firms to change the Q they produce.
- That is, it must be that P = min LRAC.

- Now we can summarize LR equilibrium:

In LR eqm,

- Firms maximize SR profits such that
  P = SR MC
- Profit = 0 so there's no entry or exit, so
  P = min SR ATC
- LRAC is at a minimum, so P = min LRAC
- Firms produce at efficient scale

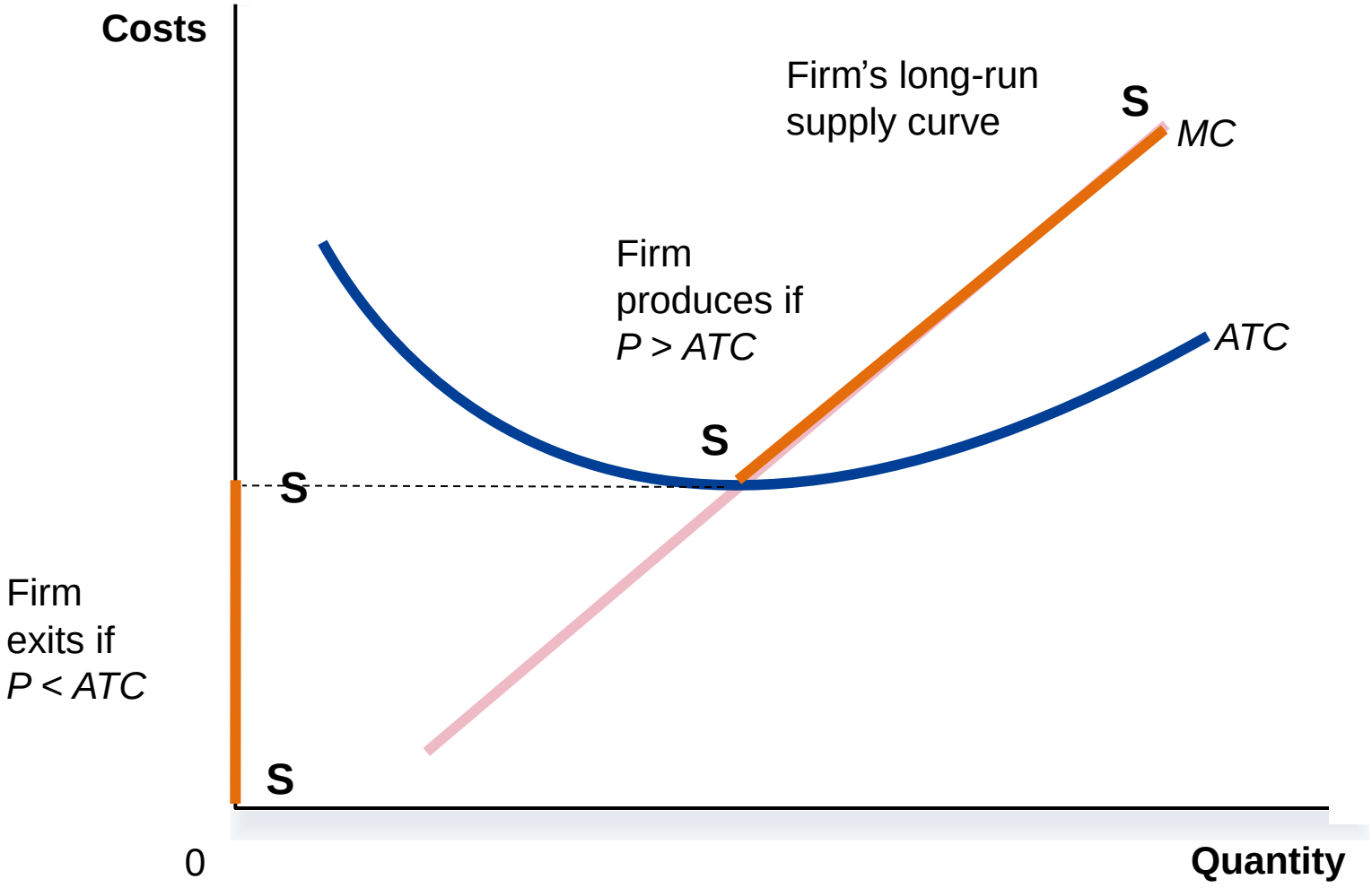
The Competitive Firm's LR Equilibrium



Long Run Supply

- We can now derive a firm's LR supply curve:
- It produces Q based on P = MC when
  P > min ATC
- It exits and produces 0 when P < min ATC

The Firm's LR Supply Curve



Market Supply

- Market supply equals the sum of the quantities supplied by the individual firms in the market.

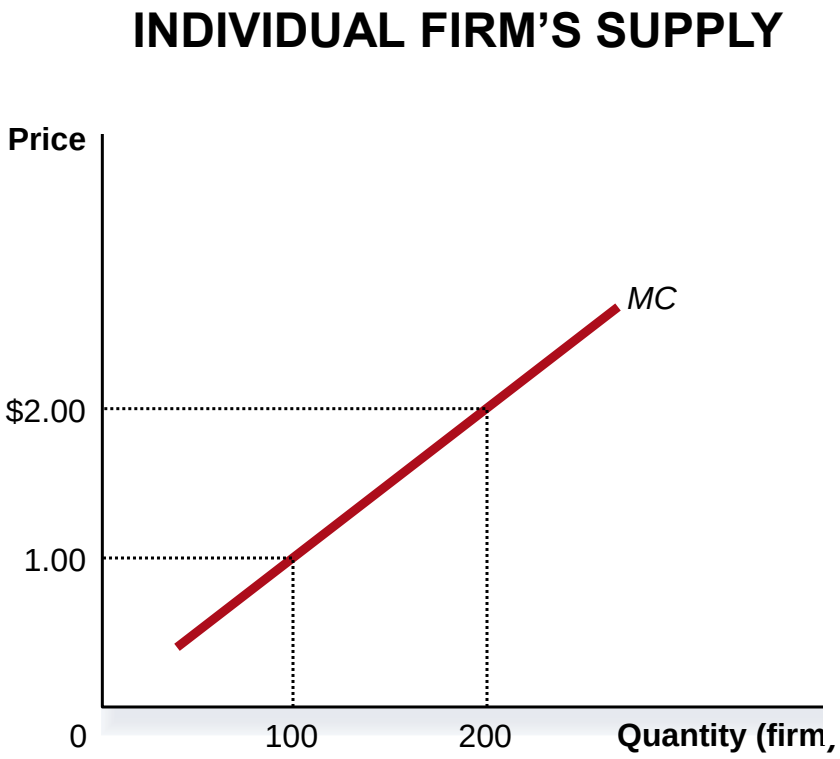
- Recall: we add up all the quantities every firm would supply at various prices.

- For any given price, each firm supplies a quantity of output so that its marginal cost equals price.
- The market supply curve reflects the individual firms' marginal cost curves.

- Example:

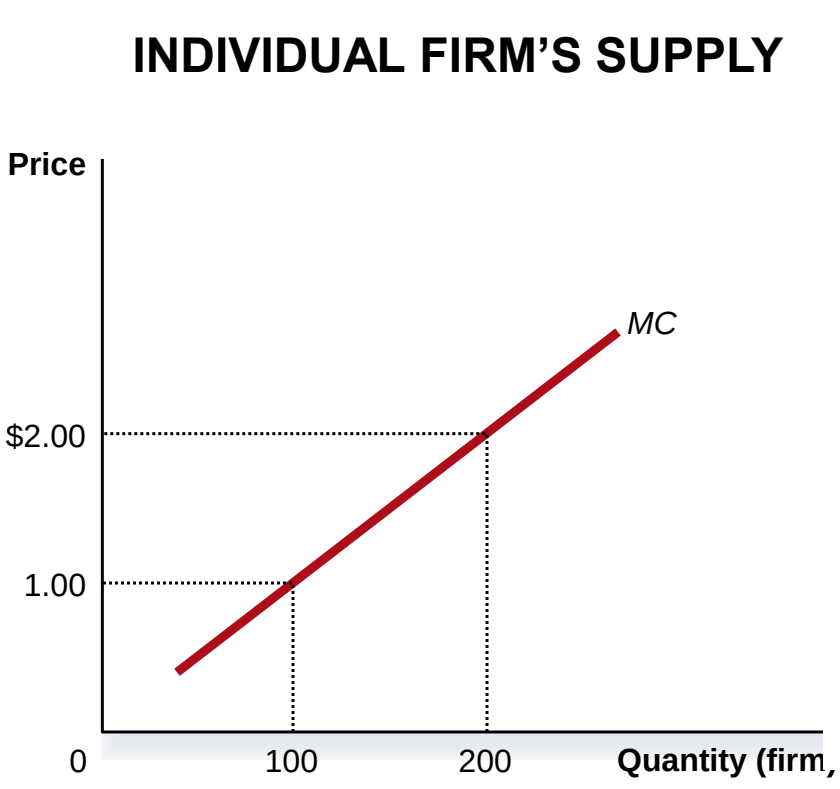
  Suppose there are 1000 firms in the market, each producing the same amount:

Market Supply with a Fixed Number of Firms

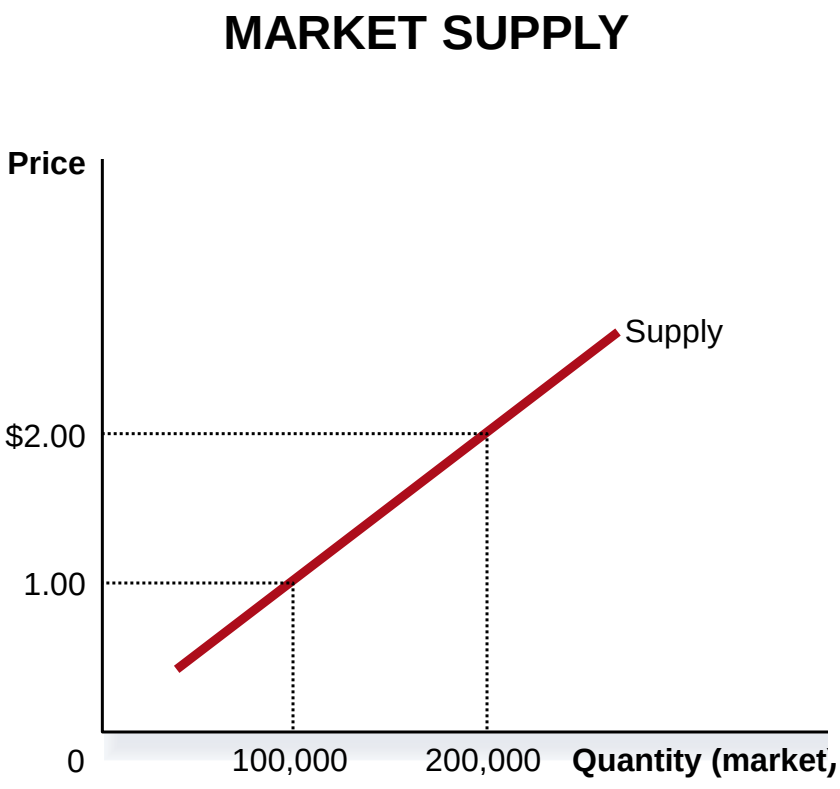


One firm supplies 200 at a price of $2.00

Market Supply with a Fixed Number of Firms



One firm supplies 200 at a price of $2.00



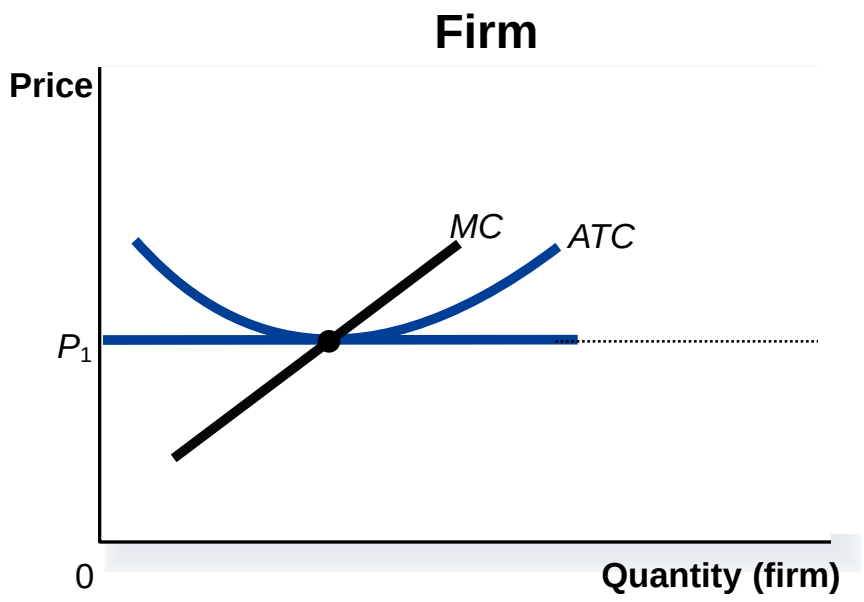
1000 firms supply 200 000 at a price of $2.00

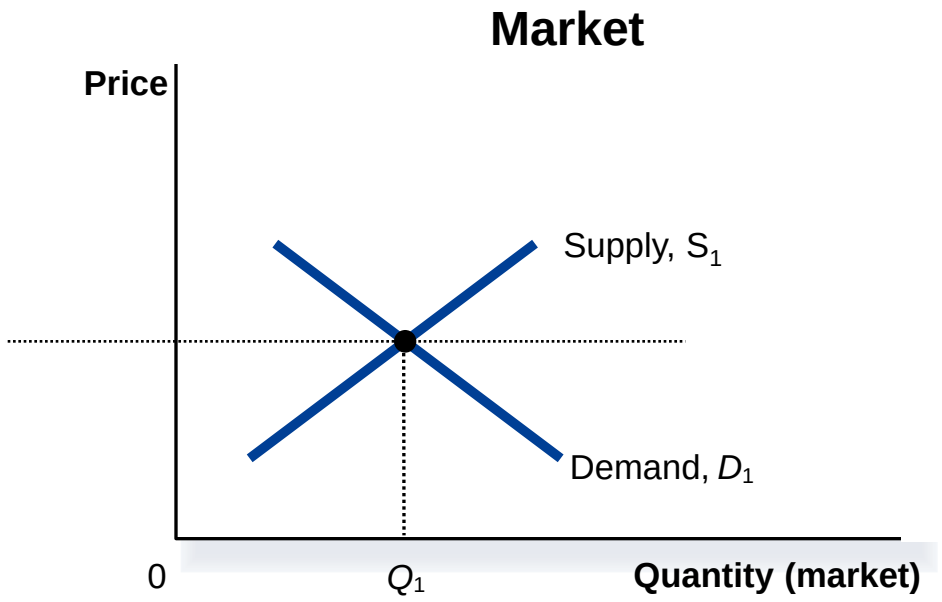
When Firms Enter an Industry: How We Get to LR Equilibrium

- Suppose that a market is initially in LR eqm, so that in the SR, P = MC = min ATC.

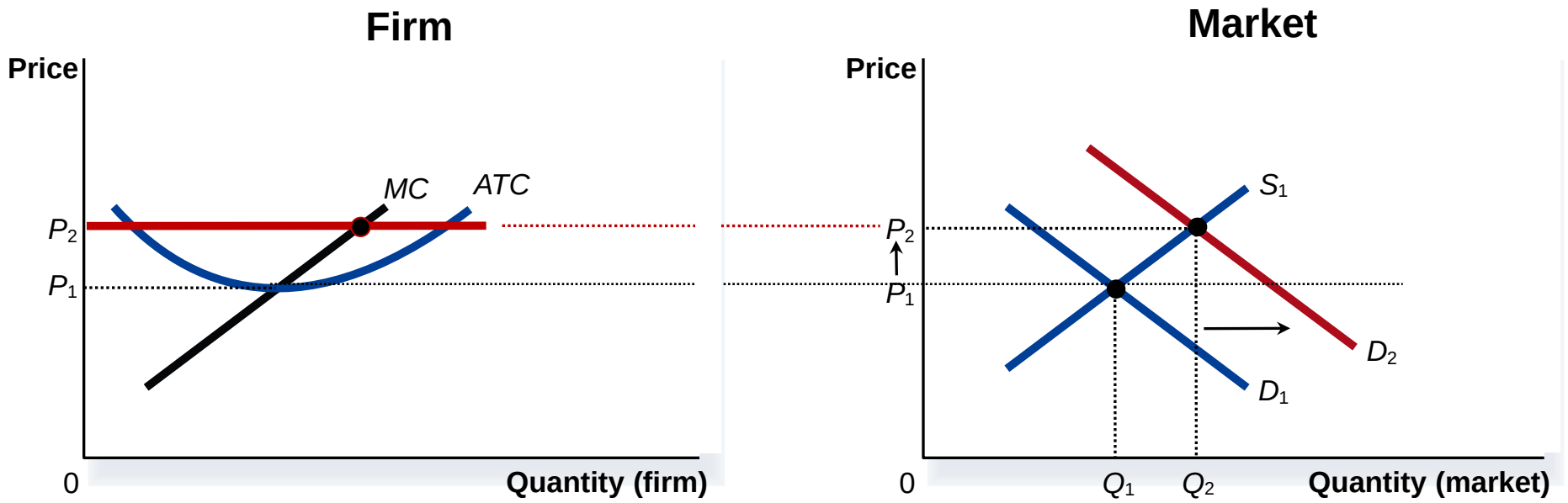
- Now suppose there's an increase in demand in the market.
- Market demand shifts right.

Initial Market Conditions: LR Equilibrium



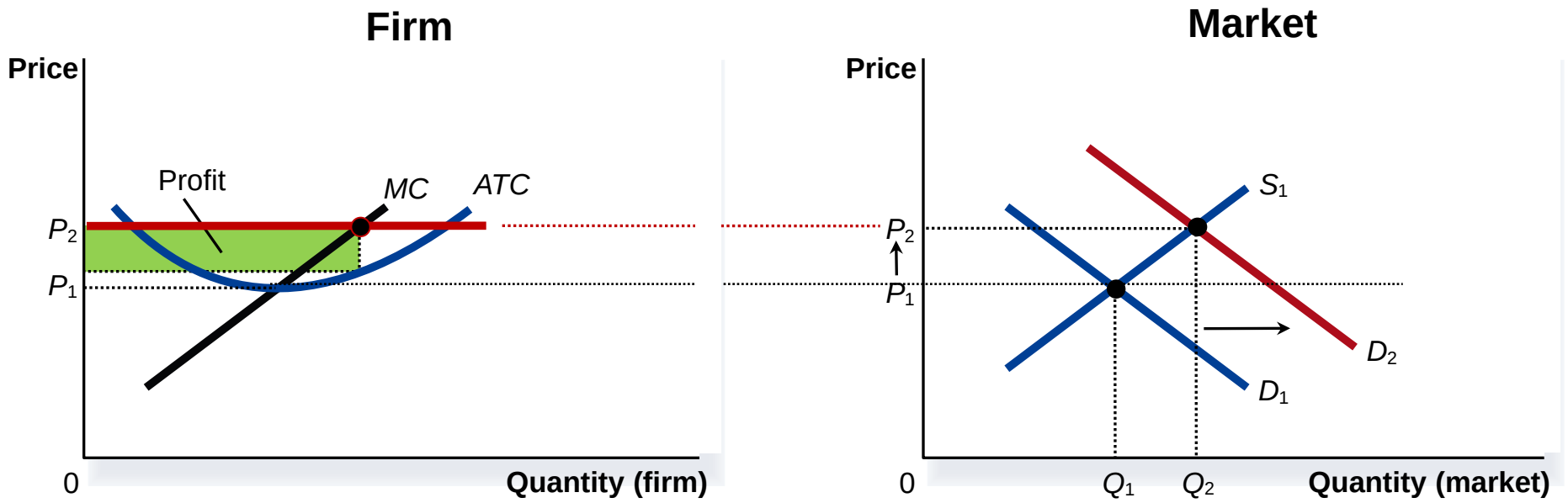


An Increase in Market Demand



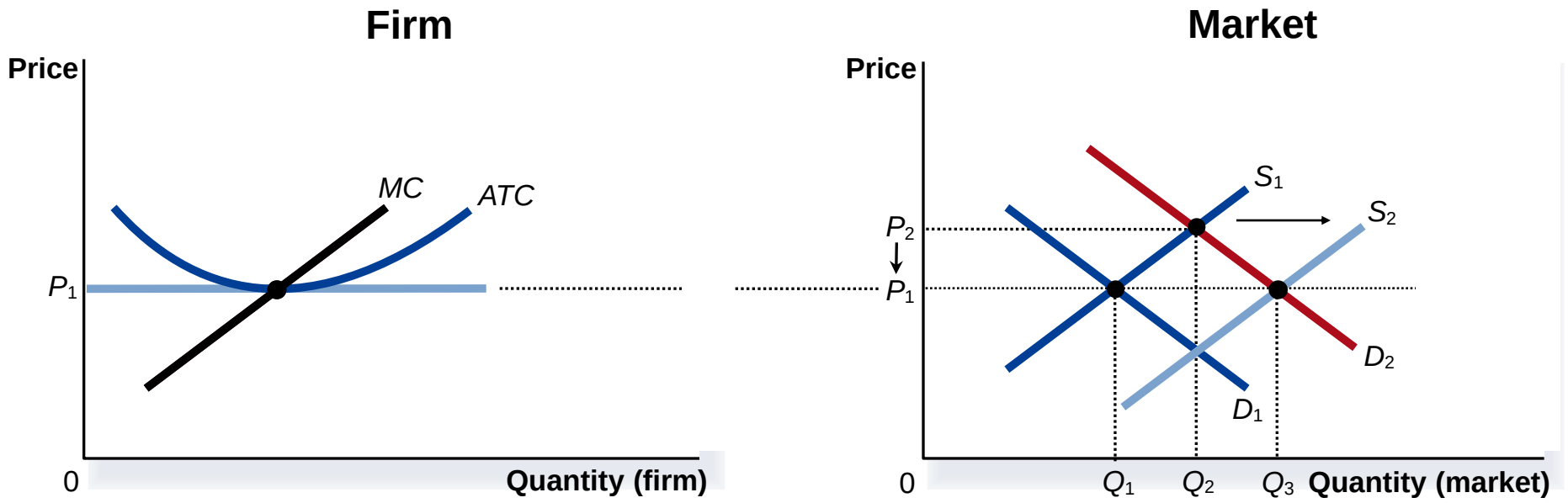
The increase in demand raises price to P2.

Positive Profits Lead to Entry by New Firms



Now, firms are making positive economic profits. New firms will start to enter the industry.

Return to LR Equilibrium



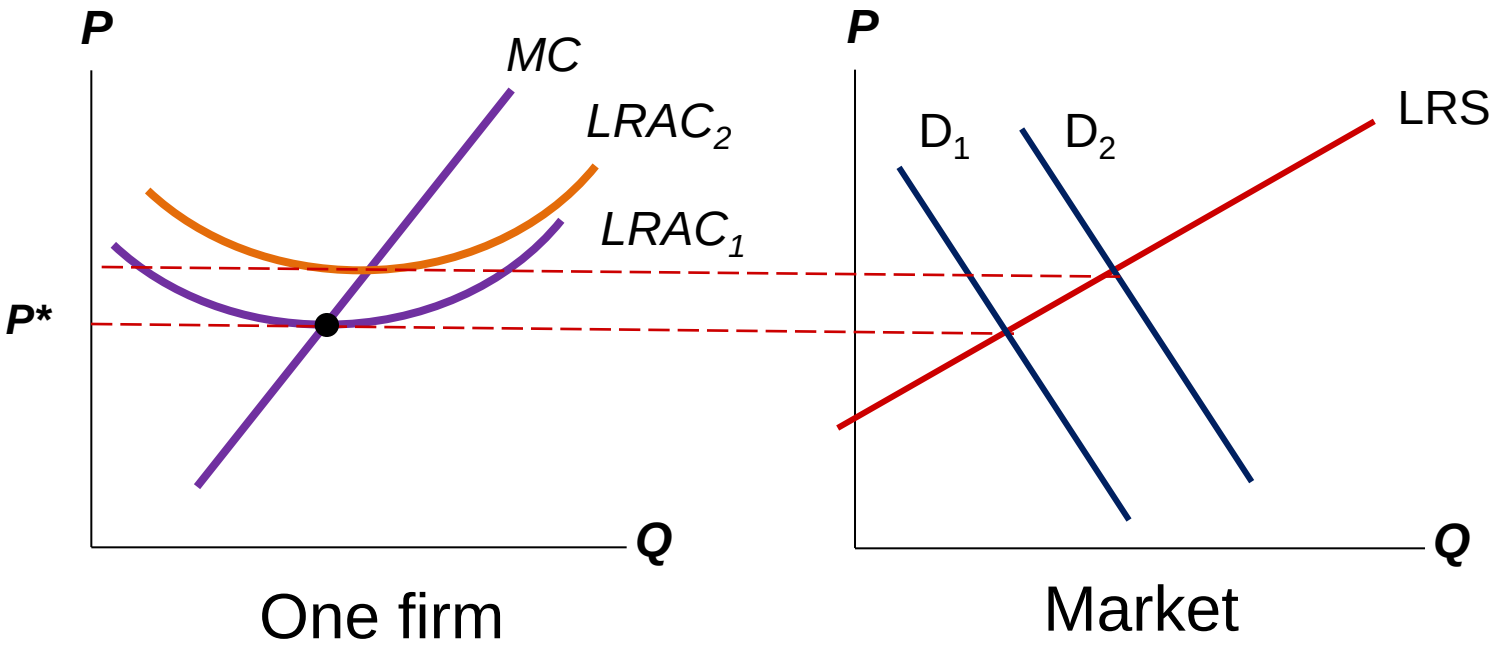
With more firms producing, supply increases. As supply increases, the price is driven back down. As price falls, profits fall and entry slows down. Firms stop entering when P returns to min ATC and Profits = 0. Net LR result: same market price, but more firms producing so more Q available in the market.

LR Market Supply

- As more firms enter the industry, it is possible that the costs of production may increase.
- This happens when the price of inputs increases: more firms enter, increasing the demand for these inputs (especially the case when key inputs are limited in availability) and input suppliers raise their prices.
- This is an increasing cost industry.
- With higher costs as more output is produced, firms will need higher prices to produce more.
- The market supply curve will be upward sloping.

LRS – Increasing Cost Industry

Suppose the market is in LR equilibrium. Say market demand increases from D_1 to D_2. Existing firms' now earn positive profits and new firms enter. With more firms demanding inputs, input prices rise and each firm's costs increase. In order to produce and sell more output, firms will require a higher price to cover their higher costs. The LR market supply curve slopes upward to reflect this.



Increasing Cost Industry

- Now consider when all firms have identical costs and costs do not change if firms enter or exit the industry.
- All firms would still produce at min LRAC which would not change no matter how much they produced.
- This would be a constant cost industry.
- The long run market supply curve will be a horizontal line at minimum average cost.

LRS – Constant Cost Industry

Suppose the market is in LR equilibrium. Say market demand increases from D_1 to D_2. Existing firms' now earn positive profits and new firms enter. More firms demand more inputs, but input prices don't change and each firm's costs stay the same. To produce and sell more output, firms will still only require the same price. The LR market supply curve is horizontal to reflect this.

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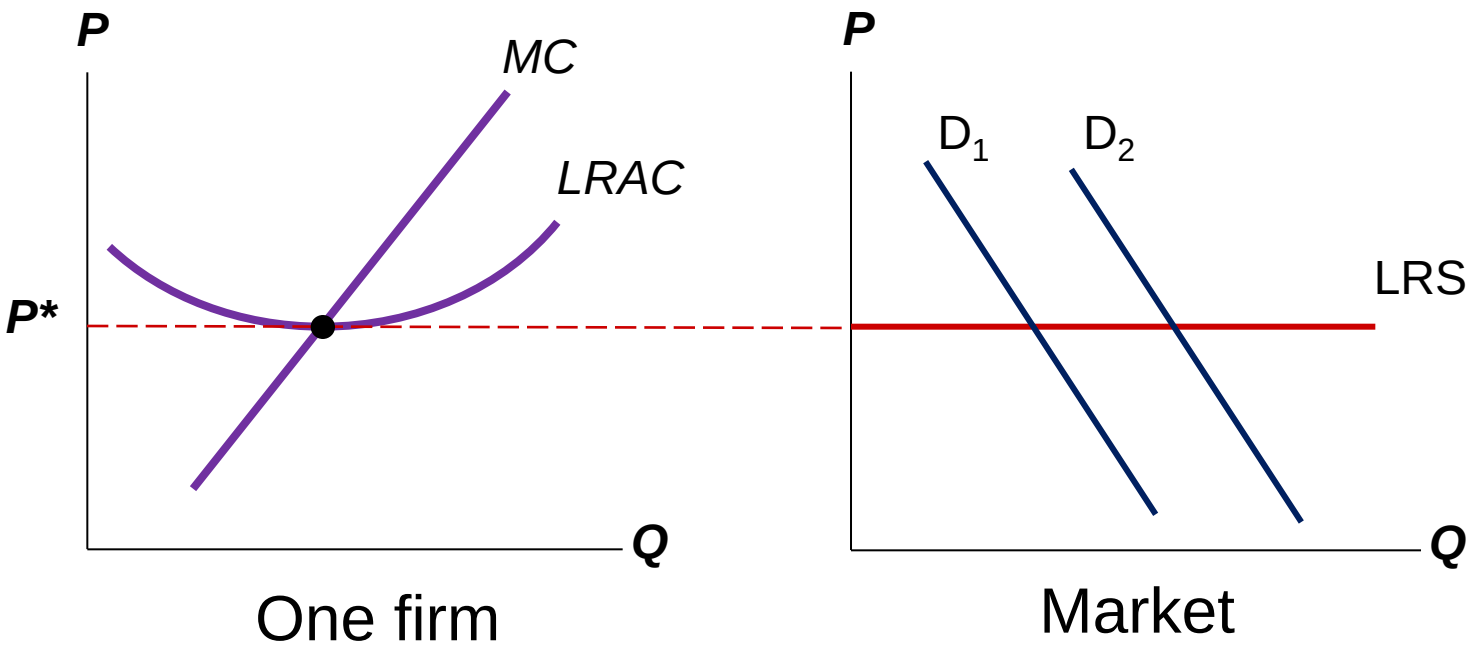


Constant Cost Industry

Numerical Example

- Sheldon & Leonard Ltd is a small firm in California that grows oranges in a perfectly competitive market.
- They face the following market conditions:

Let P = price, in dollars, of a crate of oranges

Let Q = qty of crates, in thousands

$Qd = 100 - P$ is market demand

$Qs = 3P$ is market supply

The firm's MC = 5Q and its ATC of a crate is constant at $15.

1. What is eqm market P and Q?

In eqm, Qd = Qs

$100 - P = 3P$

$100 = 4P$

$P^* = 25$

$Qs = 3P = 3*25 =$ 75 (thousand crates)

2. How many crates do Sheldon and Leonard supply?

Set P = MC for this competitive firm:

$$25 = 5Q$$

$$Q = 5 \text{ (thousand crates)}$$

3. What is the firm's profit?

Its ATC is $15 per crate.

$\Pi = (P - ATC)Q$

$= (25 - 15)*5$

$= \$50\ 000$ (remember, Q is measured in thousands of crates)

4. How many identical firms currently are there in the orange industry?

Since market supply is 75 000, and each firm produces 5000, there are 15 firms.

5. Is the industry in LR eqm?

No. Since firms are making positive economic profits, new firms will enter the industry. Market supply will increase, P will be driven down to P = min ATC and no more entry. Once entry stops, then we'll have a LR eqm.

6. How many firms will there be in the LR and what will be supplied?

In LR eqm, P = min ATC = $15 (ATC is constant)

A single firm will produce where P = MC

$$15 = 5Q$$

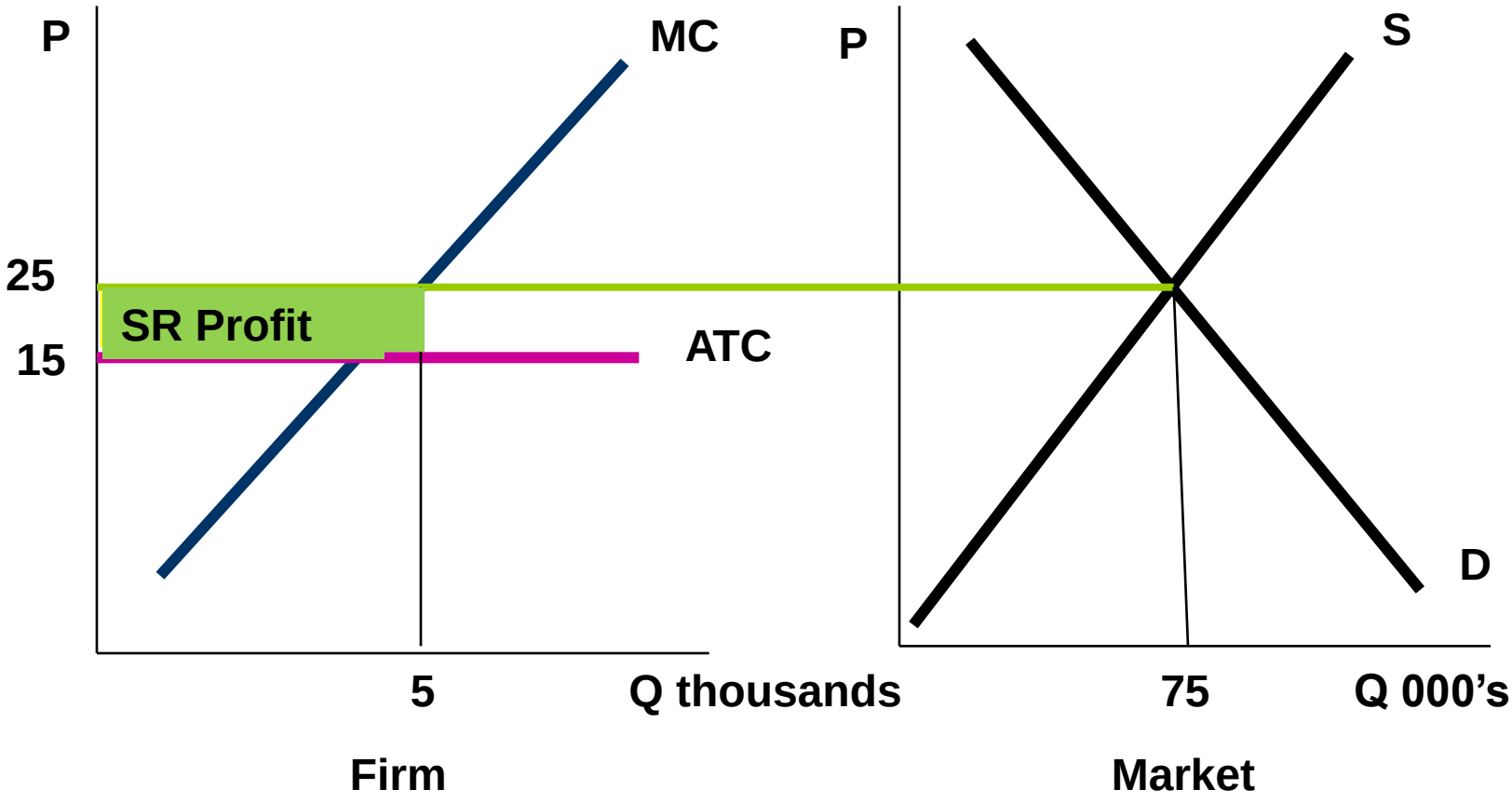
$$Q = 3\,000$$

At a price of $15,

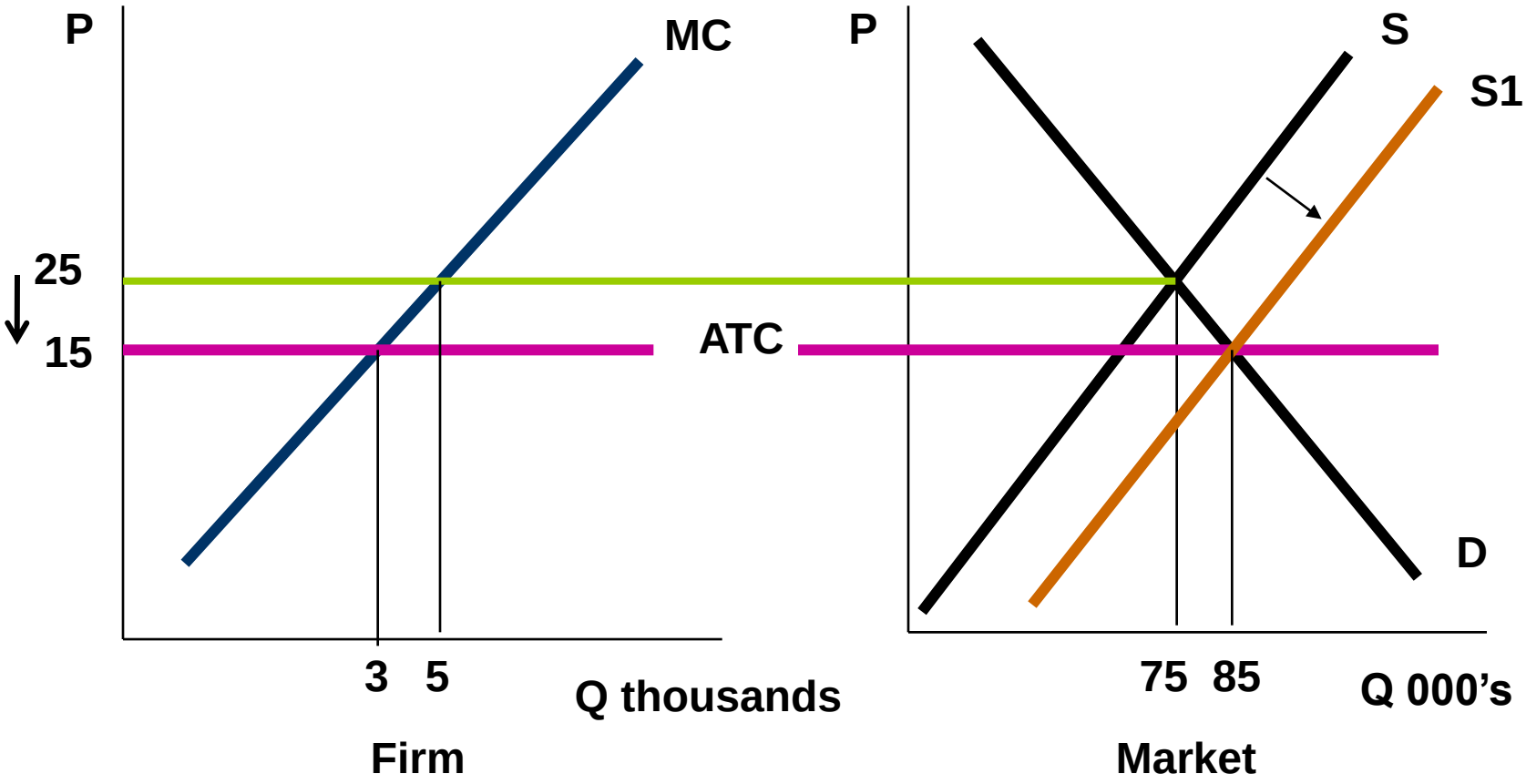
market Qd = 100 – 15 = 85 000 = Qs

If each identical firm produces 3000, there will be 85000/3000 = 28.3 firms (round to 28).

Initial Orange Market Conditions



Getting to LR Equilibrium



OPTIONAL MATERIAL

Proof that profit is maximized where MR = MC and that we always produce the greater amount

This is the second year calculus proof and is intended only for students who are interested – it is not required, nor will I teach it to this class.

- Profit is maximized where $d\pi / dy = 0$.
- That is, the rate of change of profit = 0 at max π.

- But, the rate of change of profit is the rate of change of TR minus the rate of change of TC with respect to y:

- $\Delta \pi = \Delta TR - \Delta TC = 0$

- Further…

- $\Delta TR = dTR/dQ = MR$ = slope of TR fn = p
- $\Delta TC = dTC/dQ = MC$ = slope of TC fn

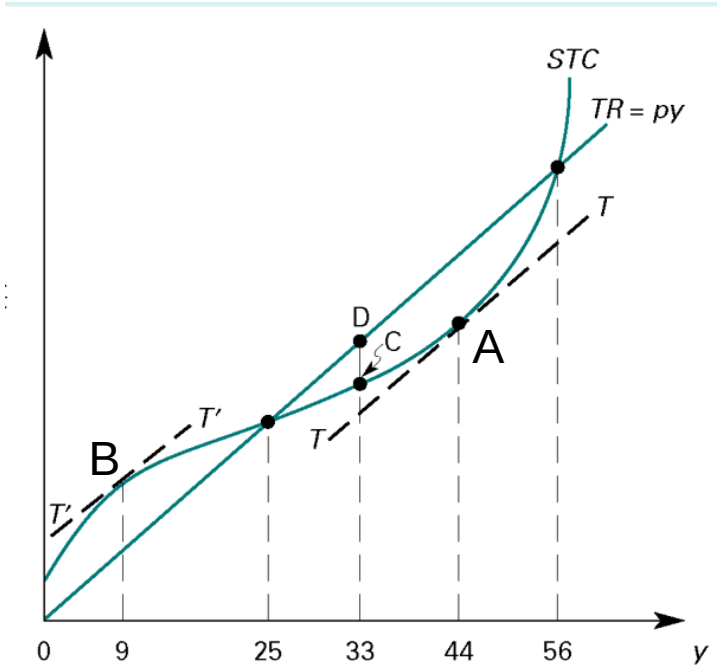
- So, profit is maximized where

$$MR - MC = 0$$

$$MR = MC$$

p = MC in competition

- There are 2 qualifications.
- First, the slope of the TR and TC functions actually will equal each other at two points.
- At A, profit is maximized.
- At B, profits are minimized (they're negative).



- The firm's supply curve is the upwards sloping part of the MC curve.
- The mathematical proof of this comes from the second-order condition:
- For profit maximization, the 2nd derivative has to be $\leq$ 0. Let output be denoted by y.
- Since p = MC(y), rewriting we get p – MC(y) = 0
- The second derivative of the profit fn is:

$$\frac{d^2\Pi(y)}{dy^2} = \frac{d}{dy}\left(p - MC(y)\right) = -\frac{dMC(y)}{dy} < 0.$$

- So, dMC(y)/dy has to be positive.

The competitive firm's supply function is composed of the two segments labelled *ss*. When p is less than \$23, the firm supplies nothing because it cannot cover the variable costs associated with any positive quantity. When p exceeds \$23, the firm chooses the level of output where $p = SMC$. Thus, the second segment of the firm's supply function is *SMC* above the point where *SMC* intersects *AVC*.