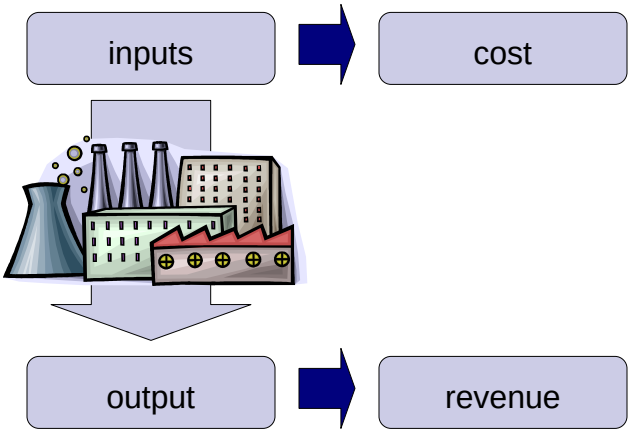
Firm behaviour

A “black box” theory of the firm – in the short run

What do firms do?



Inputs and Cost

Production in the short run

Short-run and long-run

- It can take time to adjust the level of production
  - inputs may not be available immediately
- e.g. Parcel Delivery Company
  - To increase production may need to :
    - build a warehouse
    - purchase/lease jets → These all take time
    - hire workers
- We will define the short and long-run by whether or not the quantity of inputs is fixed

Short run and long run

- In the *short run* a firm can change the quantities of only some of its inputs.
  - *Variable inputs* are those a firm can change in the short run.
  - *Fixed inputs* are those a firm cannot change in the short run.
  - Because there are fixed inputs firms can not enter.
- In the *long run* a firm can change the quantities of all of its inputs.
  - That means in the long run all inputs are variable.
  - Because all inputs are variable firms can enter.
- For the moment, we'll only study the short run.

(Short-run) production function

- A firm's *production function* tells you how much output is produced from given quantities of inputs.
  - For now, let's assume a firm uses only two inputs: labour and capital.
  - And: let's assume labour is the variable input and capital is the fixed input.
- The short-run production function shows how varying the variable input affects the quantity of output, for a given amount of the fixed input.

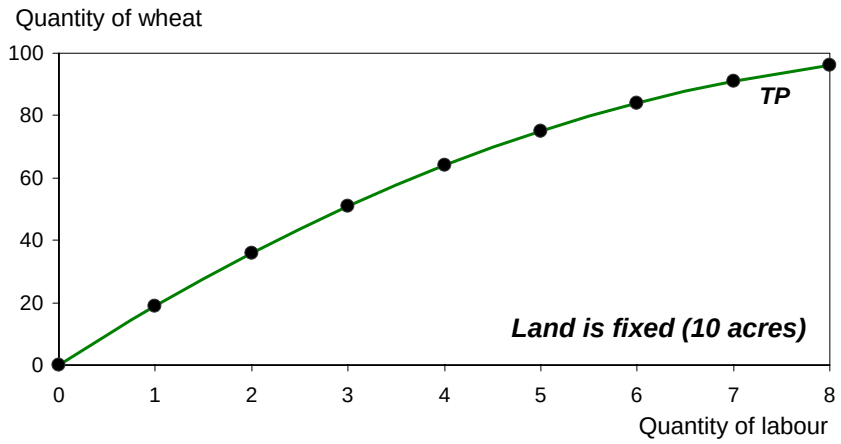
(Short-run) production function

- Example: wheat farm
  - Fixed input (land): 10 acres
  - Variable input (labour): workers
- We'll mostly restrict ourselves to two inputs (it's easy).
  - And, we'll usually think of land as the fixed input in the short run,
  - … and of labour as the variable input in the short run.

(Short-run) production function

Quantity of labour L	*Quantity of wheat Q*	
0	0	
1	19	
2	36	
3	51	
4	64	
5	75	
6	84	
7	91	
8	96	***Land is fixed (10 acres)***

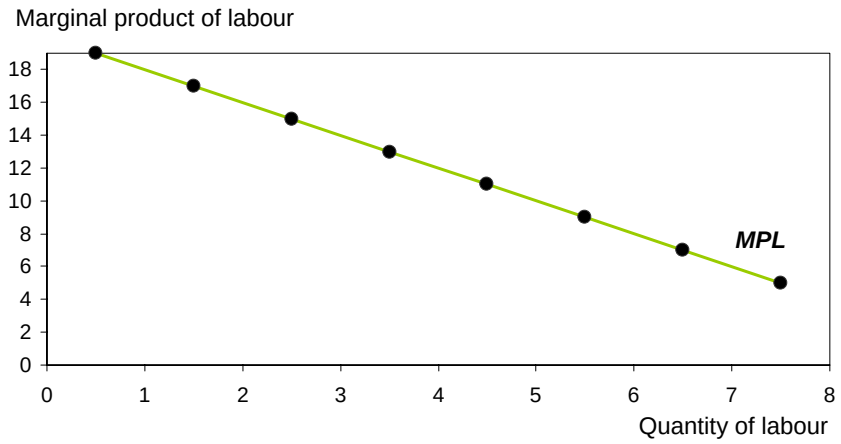
(Short-run) production function



Marginal product of labour

Quantity of labour L	*Quantity of wheat Q*	*Marginal product of labour MPL=ΔQ/ΔL*
0	0	
		19
1	19	
		17
2	36	
		15
3	51	
		13
4	64	
		11
5	75	
		9
6	84	
		7
7	91	
		5
8	96	

Marginal product of labour



Diminishing returns to an input

- There are *diminishing returns to an input* if the marginal product of that input declines (after some point) the more of that input you use, holding all other inputs fixed.
  - Here, there are diminishing returns to labour: the more workers you use, the less each extra worker adds to output.
- *Why do we assume that the returns will begin to diminish?*

Diminishing returns to an input

- In our example of wheat production, the amount of land is fixed.
- As the number of workers increases, the land is farmed more intensively.
- Thus, each additional worker is working with a smaller share of the 10 hectares than the previous worker.
- Eventually, additional workers will not be able to produce as much output as previous workers.
- This result rests on the assumption that at least one of the inputs is fixed.

From production to cost curves

- Firms are only tangentially interested in the relationship between *inputs* and *output.*
- To maximize profits, it would be helpful to know about the relationship between *output* and the *cost* of production.
- To translate the amount of capital and labour needed to produce a given level of production to the cost of production we need to know the prices of the inputs.

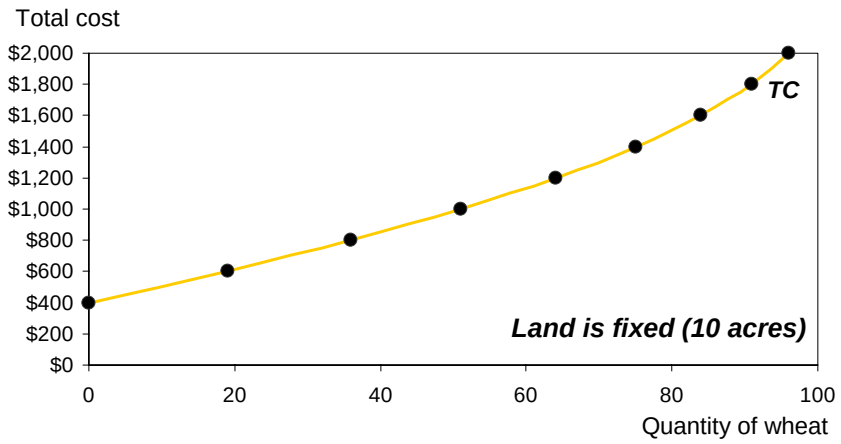
(Short-run) cost

- The cost that comes from the fixed input is called *fixed cost* (*FC*).
  - "Overhead"
  - Suppose 10 acres of land cost $400.
- The cost that comes from the variable input is called *variable cost* (*VC*).
  - Suppose each worker costs $200.
- The sum of fixed cost and variable cost is called *total cost* (*TC = FC + VC*).

(Short-run) cost

Quantity of labour L	*Quantity of wheat Q*	*Variable cost VC*	*Total cost TC = FC + VC*
0	0	$0	$400
1	19	200	600
2	36	400	800
3	51	600	1,000
4	64	800	1,200
5	75	1,000	1,400
6	84	1,200	1,600
7	91	1,400	1,800
8	96	1,600	2,000

(Short-run) cost



(Short-run) marginal cost

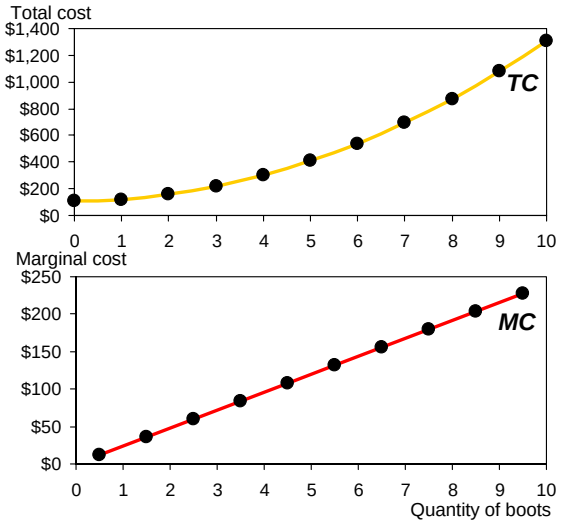
- The *marginal cost* is the additional cost from doing one more unit of an activity.
  - Here, it is the additional cost from producing one more unit of output.
  - It is the additional cost *per additional unit of output*.
  - $MC = \Delta TC/\Delta Q$
- Example (for convenience): bootmaking
  - Fixed cost (FC) = $108

(Short-run) marginal cost

Quantity of boots Q	*Variable cost VC*	*Total cost TC = FC + VC*	*Marginal cost MC = ΔTC/ΔQ*
0	$0	$108	
1	12	120	$12
2	48	156	36
3	108	216	60
4	192	300	84
5	300	408	108
6	432	540	132
7	588	696	156
8	768	876	180
9	972	1,080	204
10	1,200	1,308	228

(Short-run) marginal cost

- (Short-run) total cost
- (Short-run) marginal cost



Explaining increasing marginal cost

- Why does the short-run marginal costs increase as output expands?
- This is a direct result of diminishing marginal product of labour.
- Eventually, more and more labour is required to increase output by one unit.
- Because each unit of labour must be paid for, the cost per additional unit of output must rise.

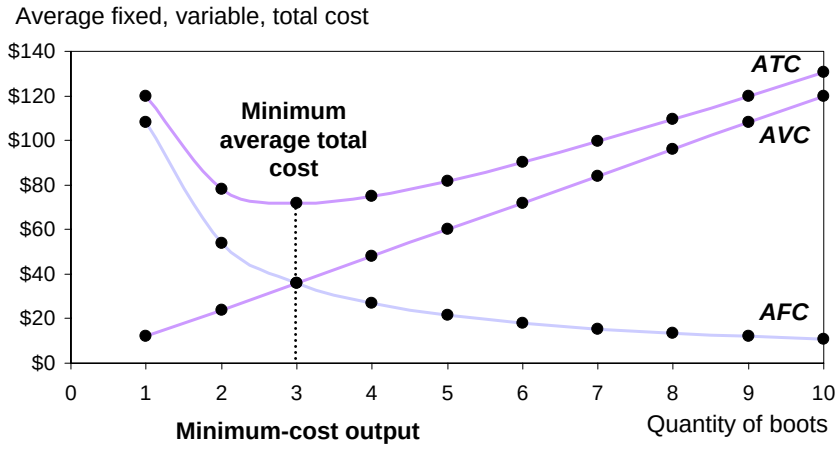
(Short-run) average costs

- The *average fixed cost* is the fixed cost *per unit* of output ($AFC = FC/Q$).
- The *average variable cost* is the variable cost *per unit* of output ($AVC = VC/Q$).
- The *average total cost* is the total cost *per unit* of output ($ATC = TC/Q$).
  - Also, of course, $ATC = AFC + AVC$.

(Short-run) average costs

Quantity of boots Q	*Variable cost VC*	*Average var. cost AVC*	*Total cost TC*	*Average total cost ATC*	*Average fixed cost AFC*
0	$0	-	$108	-	-
1	12	$12	120	$120	$108
2	48	24	156	78	54
3	108	36	216	72	36
4	192	48	300	75	27
5	300	60	408	81.60	21.60
6	432	72	540	90	18
7	588	84	696	99.43	15.43
8	768	96	876	109.50	13.50
9	972	108	1,080	120	12
10	1,200	120	1,308	130.80	10.80

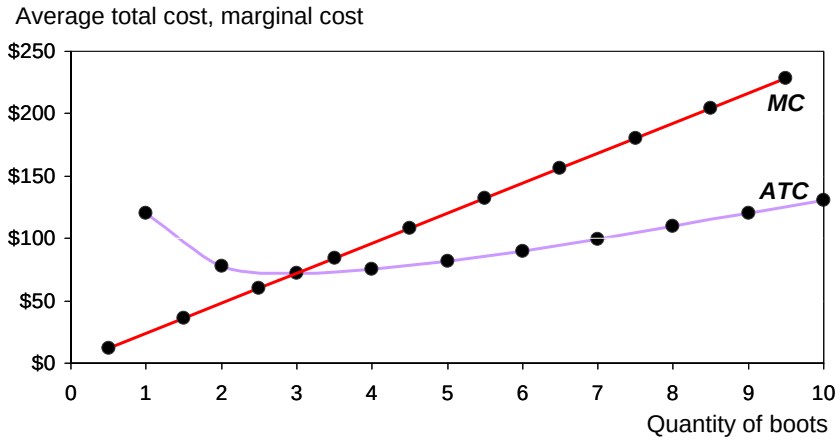
(Short-run) average costs



(Short-run) average total cost

- Two effects:
  - "Spreading effect"
    - The more output you produce, the more units of output the fixed cost is spread over.
      - Average fixed cost falls, which tends to make average total cost fall.
  - "Diminishing returns effect"
    - The more output you produce, the higher the average variable cost, because of diminishing returns to the variable input (labour).
      - Average variable cost rises, which tends to make average total cost rise.

(Short-run) ATC and MC

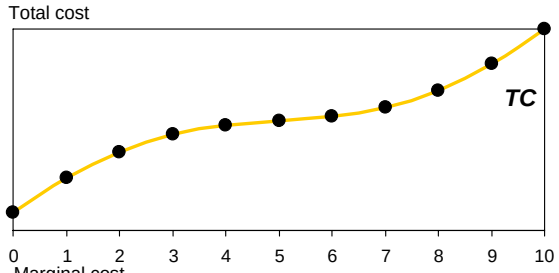


(Short-run) ATC and MC

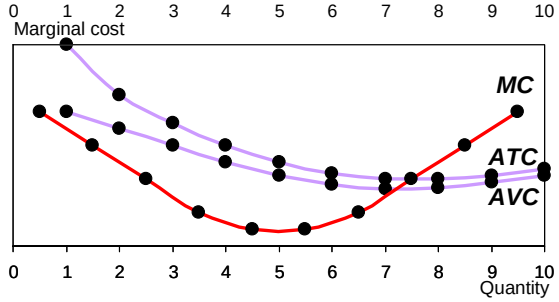
- Marginal cost always goes through the minimum average total cost.
  - If marginal cost is below average total cost, average total cost is falling.
  - If marginal cost is above average total cost, average total cost is rising.
  - Like grades in this class!

More realistic cost curves

- (Short-run) total cost



- (Short-run) ATC, AVC, MC



Perfect Competition and Short-Run Supply

Why unrealistic models can be useful.

Perfect competition

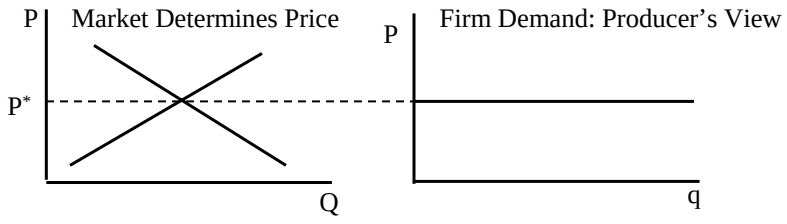
- In a "*perfectly competitive" industry:*
- There are many producers, each with a small market share.
  - No significant influence on total output and therefore price.
- Firms produce "homogeneous goods".
  - Output is perfectly substitutable.
- There is free entry and exit (in the long-run).
- All producers are *price-takers*.
  - The firm takes the market price as given because it has no influence on the price.

Production decisions

- Production decisions are “how much” decisions.
  - We study “how much” decisions by using marginal analysis:
  - Compare marginal costs and marginal benefits.
    - The marginal benefit of one more unit in the case of firms is the additional revenue from selling that one more unit.
    - This is called *marginal revenue* (*MR*).
- Produce output up to the point where *MR* = *MC*.
  - This *optimal output rule* has got to be true for any producer (perfectly competitive or not).

Price-taking and marginal revenue

- *Price-taking* means that regardless of how much the firm produces, for each additional unit produced it gets the same price.
- From the firm’s perspective, demand is perfectly elastic



Price-taking and optimization

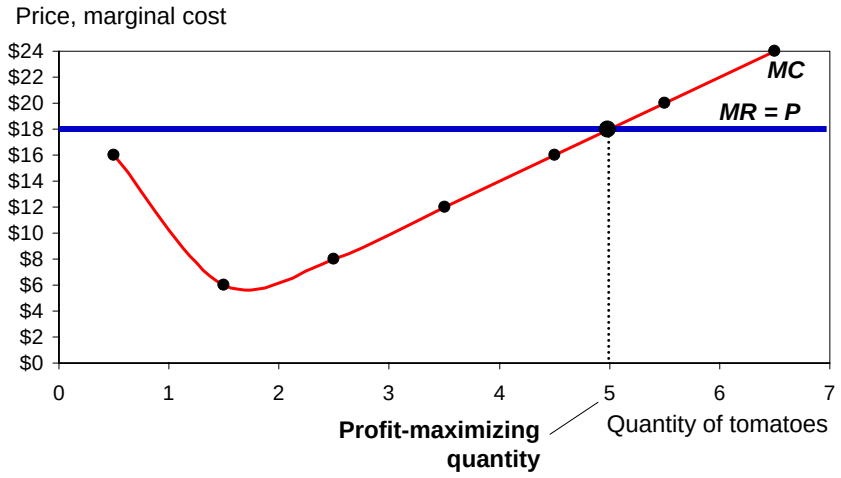
- This implies that marginal revenue is constant.
  - Marginal revenue is the additional revenue from selling one more unit of output.
  - For price-taking producers only, marginal revenue is the same as price.
- For price-taking producers only, the optimal output rule therefore becomes:
  - Produce output up to the point where $P = MC$.

(Short-run) costs and MR

- Example: tomato production.
  - Price P = \$18 ($MR = P$).

Quantity of tomatoes Q	*Variable cost VC*	*Total cost TC*	*Marginal cost MC*	*Marginal revenue MR*	*Total revenue TR*	*Profit TR - TC*
0	\$0	\$14			\$0	-\$14
			\$16	\$18 ✓		
1	16	30			18	-12
			6	18 ✓		
2	22	36			36	0
			8	18 ✓		
3	30	44			54	10
			12	18 ✓		
4	42	56			72	16
			16	18 ✓		
5	58	72			90	18
			20	18 ✗		
6	78	92			108	16
			24	18 ✗		
7	102	116			126	10

(Short-run) MC and MR



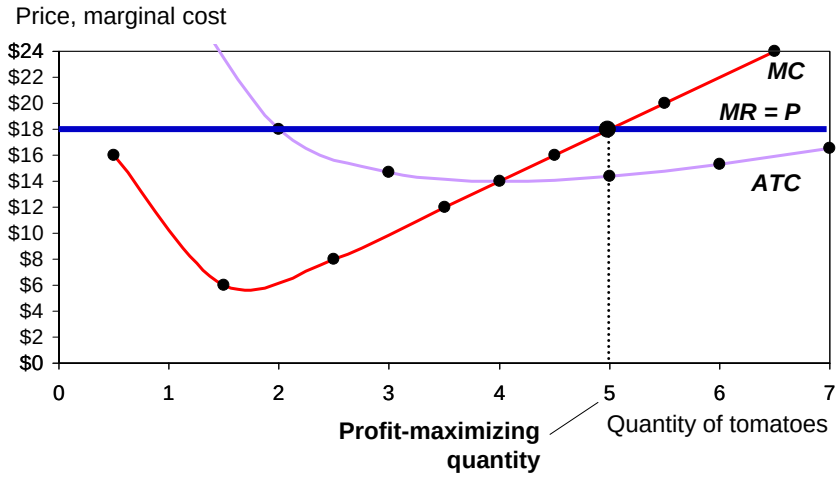
Profit or no?

- A producer makes positive profit when total revenue is greater than total cost.
  - *TR* > *TC*
- Now divide both sides by output (*Q*).
  - *TR/Q* > *TC/Q*
    - We have a term for *TR/Q* … *P*!
    - We have a term for *TC/Q* … *ATC*!
- So a producer is profitable when
  - *P* > *ATC*

(Short-run) average costs

Quantity of tomatoes Q	*Variable cost VC*	*Average var. cost AVC*	*Total cost TC*	*Average total cost ATC*
0	$0	-	$14	-
1	16	$16	30	$30
2	22	11	36	18
3	30	10	44	14.67
4	42	10.50	56	14
5	58	11.60	72	14.40
6	78	13	92	15.33
7	102	14.57	116	16.57

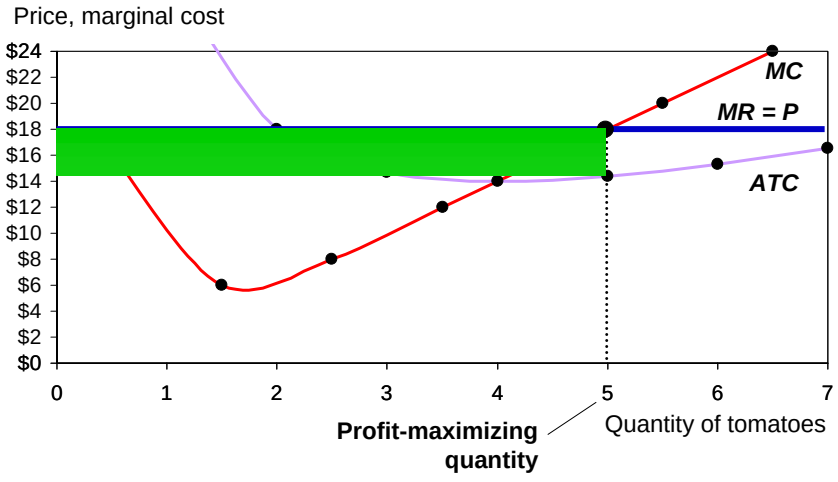
Profit (*P* > *ATC*)



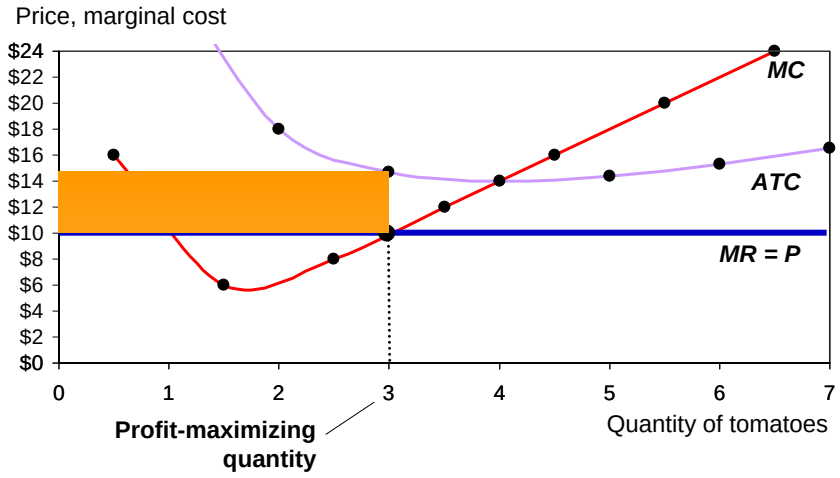
Profit or loss, graphically

- Profit is total revenue minus total cost:
  - Profit = *TR* – *TC*
- Divide and multiply by output (*Q*):
  - Profit = ((*TR* – *TC*)/*Q*) · *Q*
  - Profit = (*TR*/*Q* – *TC*/*Q*) · *Q*
  - Profit = (*P* – *ATC*) · Q

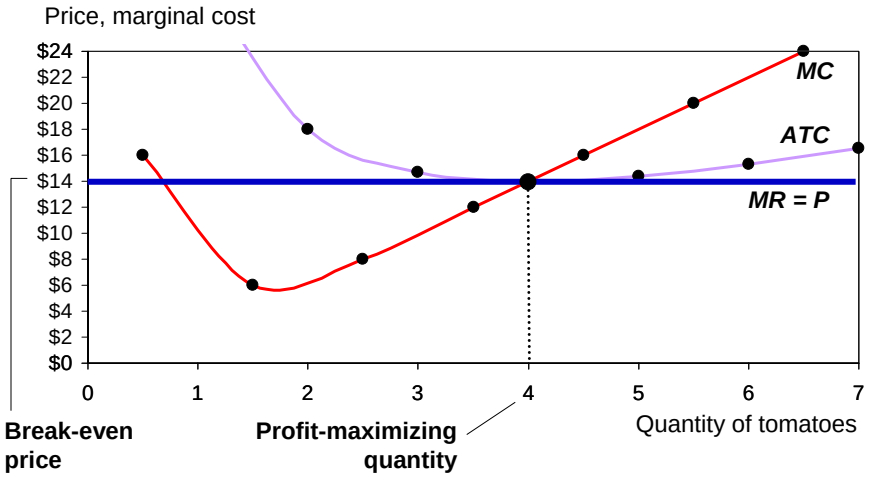
Profit (*P* > *ATC*)



Loss (*P* < *ATC*)



Breaking even (*P* = *ATC*)



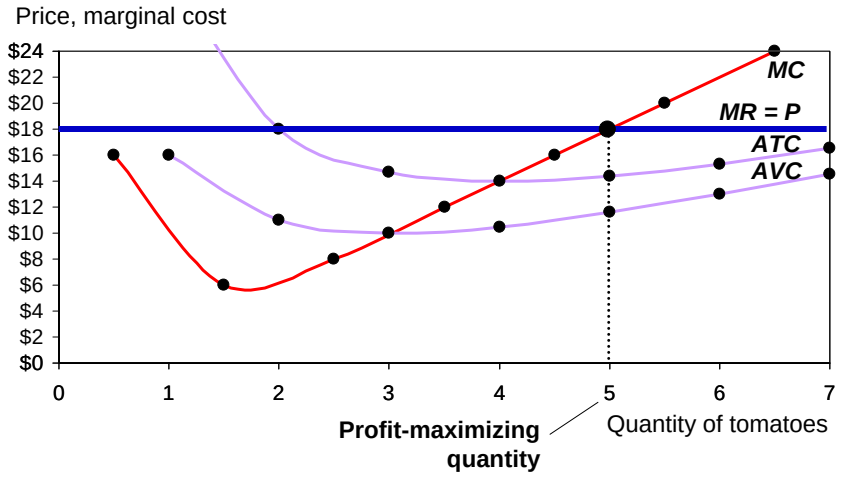
Produce or no?

- If a producer makes negative profit (a loss), will it automatically want to shut down (i.e. stop producing)?
  - No.
- Remember we're in the short run!
  - When a producer shuts down, she still has to pay the fixed cost, so that her profit is: - *FC.*
  - That is, a producer wants to shut down only if the loss from producing the profit-maximizing quantity is greater than the fixed cost.

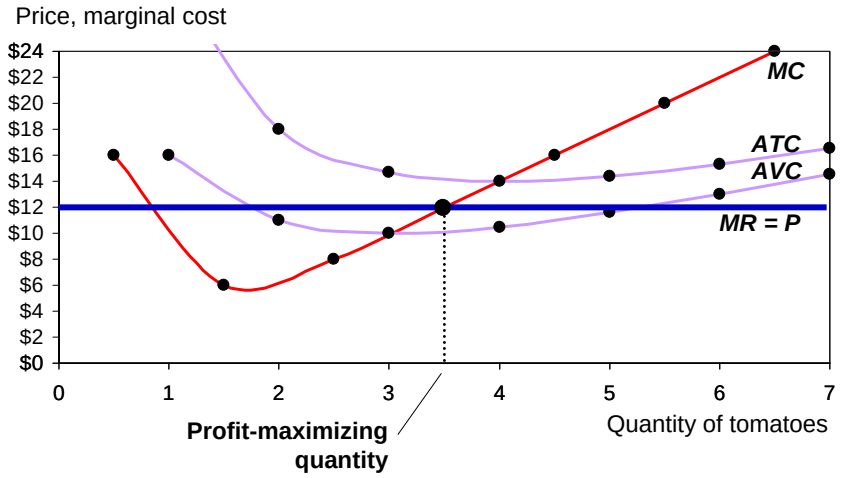
Produce or no?

- Shut down if:
  - Profit (producing) < profit (shutting down)
  - $TR - (VC + FC) < 0 - FC$
  - $TR - VC < 0$
  - $TR < VC$
  - $TR/Q < VC/Q$
  - $P < AVC$

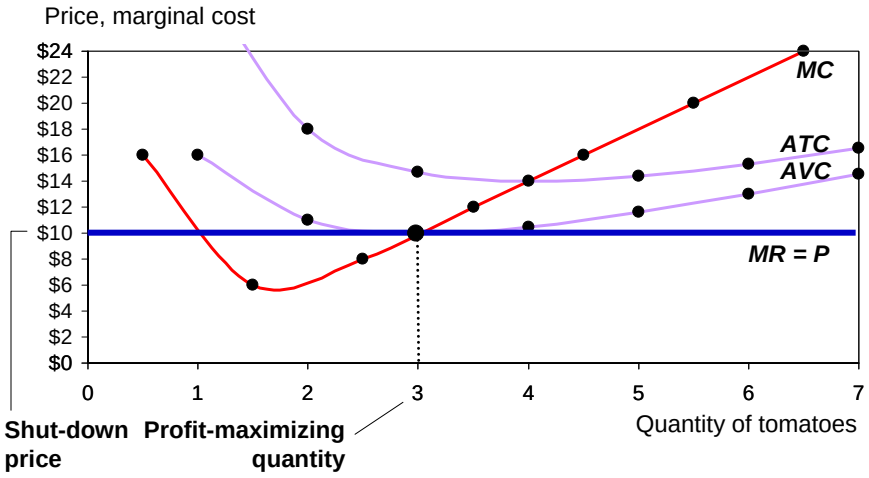
Produce, with profit



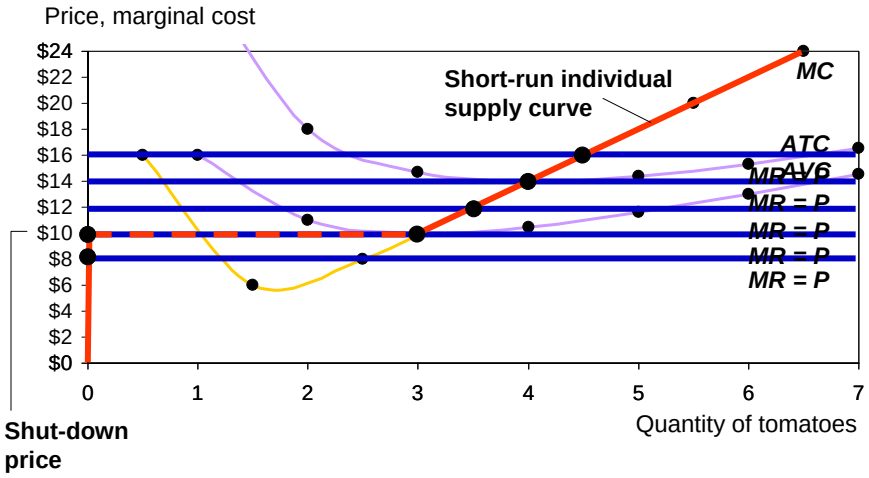
Produce, with loss



Shut-down price



Summary of producer decisions

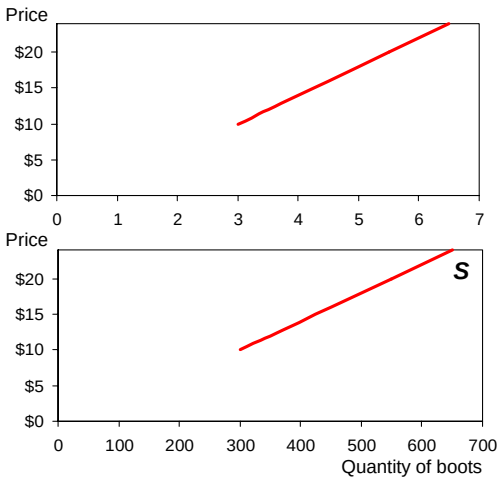


Summary of producer decisions

- The short-run individual supply curve summarizes the production ("supply") decisions of one individual, perfectly competitive, producer.
- The short-run industry supply curve summarizes the supply decisions by all producers in a perfectly competitive industry.

Individual and industry S curves

- Short-run individual supply curve
- Short-run industry supply curve …
  - … when the industry consists of 100 producers
- "Market supply curve"



The long run

Perfect competition means no profits

Long-run costs

- In the short-run the shape of the cost curves was determined by the fact that there was a fixed factor of production
- In the long-run:
  - there are no fixed factors of production
  - firm's scale is not fixed (could double/triple output)
  - firms can enter/exit the industry
- The shape of the long-run cost curves will not necessarily be the same as those in the short-run

Long-run total cost (LRTC)

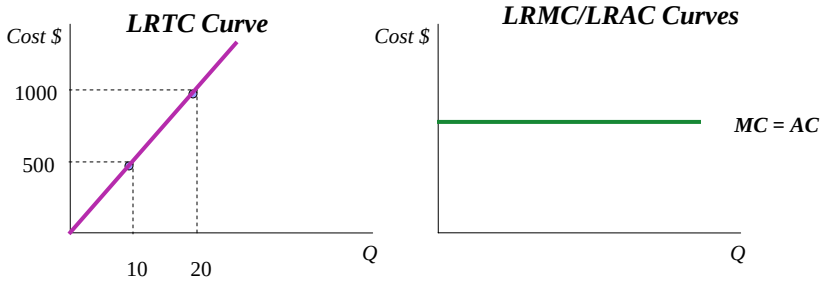
- The LRTC represents the least cost of producing each level of output (cost-output relationship)
- The shape of the LRTC curve depends on how costs vary with the scale of the firm
  - For some firms the cost of producing another unit of output decreases with the scale (size) of the firm
  - For other firms the cost of another unit of output increases with scale

Perfect competition

- The relationship between costs and scale is determined by whether the firm's long-run production function exhibits:
  - Constant Returns to Scale
  - Increasing Returns to Scale
  - Decreasing Returns to Scale
- Let's examine what is meant by each of these and what they imply about the shape of the long-run cost curves

Constant returns to scale

- Doubling inputs exactly doubles output
- Since the price of inputs are fixed, doubling outputs requires the firm to double it's total costs.
- What will the cost curves look like for this firm?

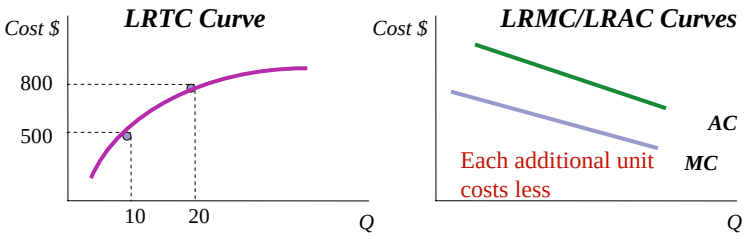


Increasing Returns to Scale

- Doubling inputs more than doubles outputs,
- Or, to double output requires less than a doubling of inputs
- Thus, doubling output requires less than a doubling of total costs
- This is sometimes referred to as *"Economies of Scale"*
  - Reduction in the per unit cost of output from large scale production

Increasing Returns to Scale

- Could be cost savings from size:
  - Cheaper to fly 100 people in a jumbo jet than to fly them 10 at a time
- Could be cost savings from technology:
  - "standardized production"
- What will the cost curves look like here?

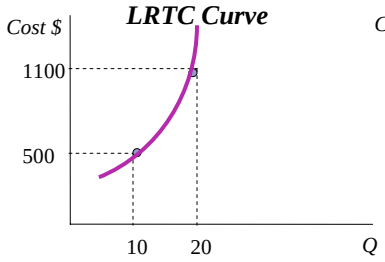


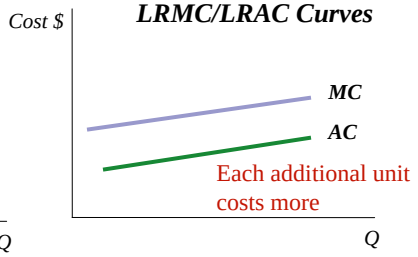
Decreasing Returns to Scale

- Doubling inputs less than doubles outputs,
- Or, to double output requires more than a doubling of inputs
- Thus, doubling output requires more than a doubling of total costs
- This is sometimes referred to as *"Diseconomies of Scale"*
  - Increase in the per unit cost of output from large scale production

Decreasing Returns to Scale

- Could result because of Bureaucratic Inefficiency:
  - Lots of managers and “red tape” makes coordination difficult
  - Coordination failure is costly
- What will the cost curves look like here?



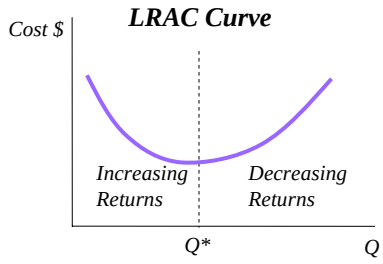


Long-run average cost curve

- Economists believe that that long-run costs exhibit:
- Initially, increasing returns to scale
  - Relatively small firms are likely to realize “economies of scale”
- As output expands, decreasing returns to scale
  - Larger firms will eventually experience bureaucratic inefficiencies

Long-run average cost curve

- This implies that the long-run average cost curve will have the following shape:



Between 0 and *Q:**
- Increasing Returns
- Average cost is decreasing

At *Q:**
- Constant Returns (constant costs)

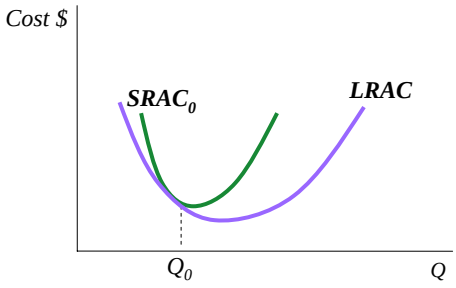
***Q** and above:**
- Decreasing Returns
- Average cost is increasing

Long and short-run costs

- Will the costs of production be higher or lower in the long-run?
  - In the long-run the firm can alter both capital and labour (more flexible)
  - Since firms are cost minimizing, any change in capital (fixed cost) the firm makes in the long-run must be because it will lower costs
- Therefore, at any level of output costs will be lower in the long-run
- Exception: there will be one level of output for which the level of capital (fixed cost) in the short-run will be the optimal level in the long-run

Long and short-run costs

- Thus, the long and short-run average costs curves will look as follows



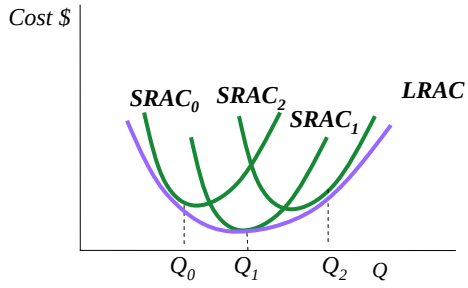
- $SRAC_0$ is short-run average cost if the producer chose the level of capital to minimize costs at Q_0
- The SRAC curve will be above the LRAC curve except at Q_0
- At Q_0 SRAC = LRAC

Long and short-run costs

- The shapes of the long-run and short-run cost curves look very similar
- It is important to note, however, that these shapes mean something very different in the long-run than they do in the short-run
  - Long-Run: The shape of the curves is determined by how costs change with the scale of the firm
  - Short-Run: The shape of the curves is determined by the assumption that the marginal product of the variable input (labour) eventually declines

"Envelope" theorem

- There is a different set of short-run cost curves (different optimal level of capital) for each level of output
- Each of the SRAC curves will equal the LRAC curve at one level of output

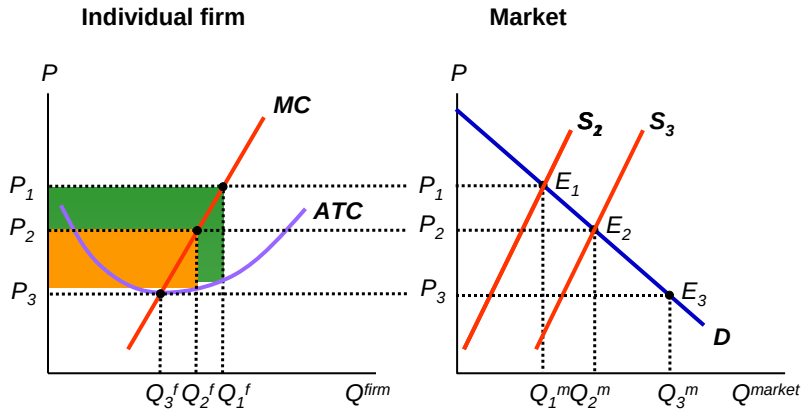


- The LRAC curve is like the "envelope" of all the SRAC curves
- The scale which minimizes LRAC is called the *"Efficient Scale"*

Perfect competition in the long-run

- So far, we have studied perfect competition in the short-run.
  - A perfectly competitive firm:
    - Produces the quantity at which $P = MC$
    - Shuts down if $P < AVC$
    - Makes (positive) profit if $P > ATC$
- If the price happened to be above the break-even price, a perfectly competitive firm in the short run made (positive) profit.
  - Can those profits persist in the long run?
    - There is free entry and exit.

Long-run equilibrium



Long-run equilibrium

- What's good about long-run equilibrium in a perfectly competitive industry?
  - Goods are produced at the lowest possible cost (minimum average total cost).
- Other properties:
  - Firms make zero profits.

Long-run supply curve

- The long-run supply curve in a perfectly competitive industry is perfectly elastic.