COSTS OF PRODUCTION

COST: the *minimum* payment a resource requires to supply its services at a particular endeavor

- anything above this -**ECONOMIC RENT**

<u>**TYPES OF COSTS:**</u>

EXPLICIT - direct $ payments

IMPLICIT - opportunity cost of owned resources

Ex: retained earnings - firms use their own profits - this has an opportunity cost (they could have invested this money in CD's)

Other Definitions:

ECONOMIC COST: the *minimum* payment an input requires (can be explicit + implicit)

ECONOMIC RENT: for entrepreneurship (ownership/management), its economic cost is called **NORMAL PROFIT** (their minimum rate of return/profit). Anything above or below this is ECONOMIC RENT.

> NORMAL PROFIT ⇒ ECONOMIC PROFIT (RENT) IS ZERO
> ⇒ total revenue = total economic cost

Economic rent can be positive *or* negative

- When total revenue > total economic cost there is positive economic rent, which for entrepreneurship, is **economic profit** (i.e., **above-normal profit**)

This differs from accounting profit:

Accounting Profit = total revenue minus explicit cost (only) (there is no implicit cost)

- *If accounting profit exists (revenue > explicit cost), there might not be economic profit since economic profit subtracts both explicit and implicit costs from revenue*

If economic profit is zero, then:
total revenue = explicit + implicit cost
and the firm is earning <u>*normal profit only*</u>

⇒ Zero economic profit can correspond to positive accounting profit, thus:

> *Normal profit does <u>not</u> necessarily imply that a firm is breaking even in terms of accounting cost*

<u>Cost is inversely related to productivity</u>

- A critical short-run feature of this relationship is the existence of diminishing returns

To see the link between productivity and cost:

Higher Productivity → **Less Input Use** → **Lower Cost**

To produce a given level of Q, as productivity rises, need a *smaller amount of labor input*
$\Rightarrow$ Cost is lower

Example: want Q = 20, wage = \$5/hour
"Low" $AP_L = 5 \Rightarrow Q/L = 5$
Need Q = 20, so $20/L = 5 \Rightarrow$ **L = 4**
Cost = wage x L = \$5(4) = \$20
"High" $AP_L = 10 \Rightarrow Q/L = 10$
Need Q = 20, so $20/L = 10 \Rightarrow$ **L = 2**
Cost = wage x L = \$5(2) = \$10

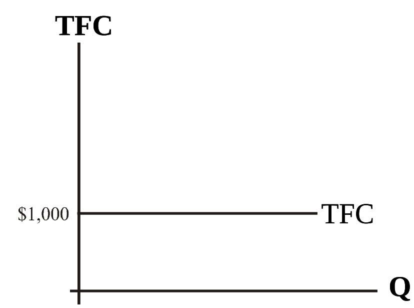
Exercise: do this for wanting ↑Q = 20 using "low" $MP_L = 5$ and "high" $MP_L = 10$

Recall, in the short run, *by definition*, there is a fixed factor, capital, and a variable factor, labor
=>Total input use = fixed input + variable input, and there is a cost associated with *each* of these

Total costs (TC) = total payments to the fixed and variable factors

Total fixed costs (TFC) = total payments to the fixed input, (real) capital

- Overhead is constant which must be paid no matter what output is
- Since amount of capital is constant the payment (cost) of capital is also constant
- Fixed and amount (ex. \$1,000/month)

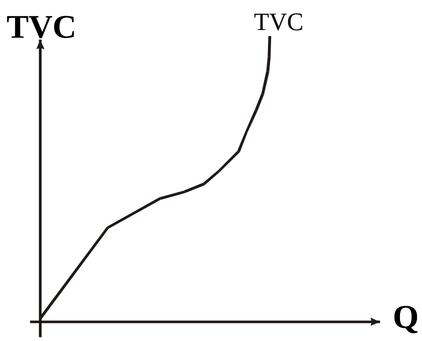


In a graph, value is height so; *constant value of TFC implies constant height (horizontal)*

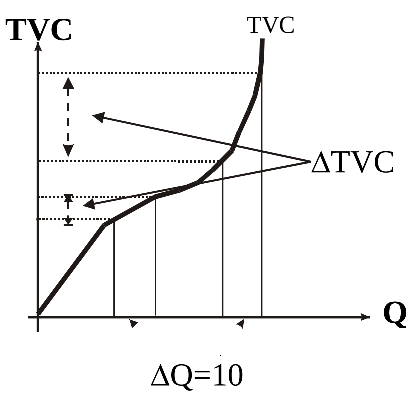
TFC is the same whether Q equals zero or if the firm produces output

Total Variable cost (TVC)

- Payments to variable input labor
- TVC does vary with output, since labor input changes with output based on productivity.



TVC is *not* linearly related to Q
- As Q increases, get different changes in TVC



For ↑Q = 10:

- When curve is flat, not very large ↑TVC
- For steep part, same ↑Q causes larger ↑TVC

Q: Why does this curve get steeper? Why does variable cost eventually rise more when have same increase in output? What determines TVC?

A: Payment to labor, the wage rate, is given ⇒ *rate of labor use* (L) is changing as Q increases.

In flat part of curve, to increase Q by10, need a fairly small increase in labor => small increase in TVC

⇨ MP_L is high and rising.

In steep part, to raise Q by10, need larger increase in labor, causing a larger increase in TVC
⇒ MP_L falling (or <0) ⇒ diminishing returns

So, as TVC gets flatter, MP_L is increasing, as TVC gets steeper, MP_L is decreasing => inverse relationship

<u>Derivation (don't try this at home)</u>:
Slope of TVC = ΔTVC/ΔQ
Given wage rate (w): TVC = w·L, and ΔTVC = w·ΔL
Slope of TVC = w·ΔL/ΔQ = w/(ΔQ/ΔL) = W/MP_L

- also called **Marginal Cost** (MC)

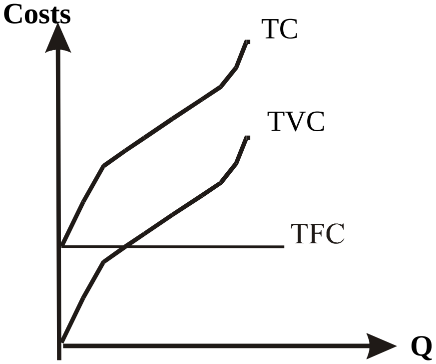
MC = ΔTVC/ΔQ = ΔTC/ΔQ

Marginal Cost: the rate of change in total cost as Q increases

-numerator, **ΔTC,** same as **ΔTVC** since only variable cost changes (fixed cost is (historically) fixed)

⇨ **MC = W/MP$_L$** and, given wages, *MC and MP are inversely related*

Total Cost (TC) = TFC + TVC



For any Q, vertically add TFC and TVC to get TC

⇒ TC Curve is parallel to TVC but with a vertical intercept of TFC

<u>Properties</u>:

1. Since TC is parallel to TVC ⇒ same slope, which is Marginal Cost
2. Minimum TC is *not* zero – it is the value of TFC (overhead) ⇒ if shut down production in short run the firm will *not* break even: Loss = TFC
3. This places a maximum on the loss a firm has to incur in short run:
   - ***Either produce, make profit or lose less than TFC, or, shut down and lose only TFC***.

⇨ If there is to be a loss, never need to lose more $ than TFC since can always shut down in short-run and lose only TFC

⇨ This is a behavioral rule for profit- maximizing firms

Major inroads into controlling overhead:

#1: Firms have fewer permanent employees:

- Reduced overhead in terms of fixed labor costs (fringe benefits, payroll processing expense, etc.)

To get TC vertically add TFC and TVC for any Q

- Benefits of using "temps" – don't have to pay fringe benefits and other "fixed costs" of labor.
- Makes it easier for firms to be profitable: if demand rises, hire temps to meet labor demands. When let go, firm avoids costs for unemployment insurance, etc.

#2: Treatment of inventories has also changed

- Firms once kept large inventories, had warehouses full of parts and hired people to manage these, resulting in added fixed costs.
- Today, many firms use **Just in Time** (JIT) inventory.

JIT – reduce or eliminate expense of warehouses and people to manage all the parts => lowers fixed costs.

- Parts are delivered at just before they are to be used in production
- Keep parts inventories low *but* parts must satisfy rigid quality requirements (CAN'T have parts rejection rates of the past)
- Producers routinely enter into long term relationships with part suppliers that guarantee acceptable parts quality
- Japanese producers saw US made parts as "inferior", now this is changing
- The recent west coast dock strike will make some re-thinking of JIT occur

In Summary: Firms have found ways to lower overhead (and TFC) by altering:

1. Hiring/ staffing practices
2. Control of inventory

Consider another dimension of fixed cost that affects whether firms survive – it explains the "high" fatality rate of small firms in their first couple of years.

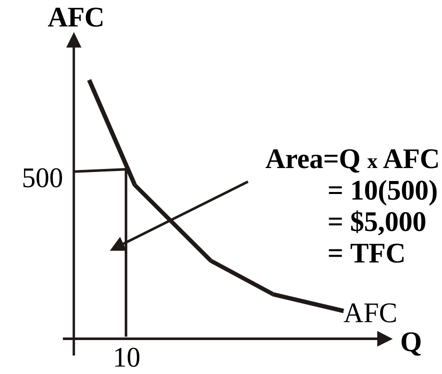
Per Unit, or Average Cost

Average ⇒ average cost over the total output

Average Fixed Cost (AFC)

AFC = TFC/Q

While TFC is constant (say $1,000), AFC is not: as Q rises, given TFC, AFC decreases.



Ex: If TFC = $1,000

When Q =1, AFC =$1,000/1 = $1,000 per unit

Q = 2, AFC =$1,000/2 = $500 per unit

Q = 10, AFC =$1,000/10 = $100 per unit

Q = 1,000, AFC =$1,000/1,000 = $1 per unit

As Q increases, even though TFC is constant, the firm is able to "spread" its fixed cost over a larger number of units, reducing the value of fixed cost per unit (AFC).

Q: Why does this matter?
A: To even "break even," firm must cover both its fixed and variable costs per unit.
The lower is AFC, the easier it is for firms to "break even", or to make profit.

Consider a small firm currently losing money
<u>Intuition</u>: if losing money at current price, they must raise price. BUT, if demand is elastic:

- as P↑, TR↓, since get a "large" ↓Q. As Q decreases by a large amount, even though TFC is constant, AFC rises substantially, as now spreading out TFC over a much smaller Q
- Lower total revenue + higher AFC ⇒ more likely their loss is *rising*, causing some firms to FAIL – They usually say- it was overhead that killed them.

In contrast, for large discount stores, demand is elastic. So, as they ↓P → ↑TR. They make their profit from a *large volume* of sales (with smaller profit/unit). Also, as Q↑, AFC↓, and they are able to "spread" TFC over a very large level of sales.

Continue looking at average costs:
Average variable cost (AVC)

- Labor cost per unit of output
- Related to the amount of labor input and productivity

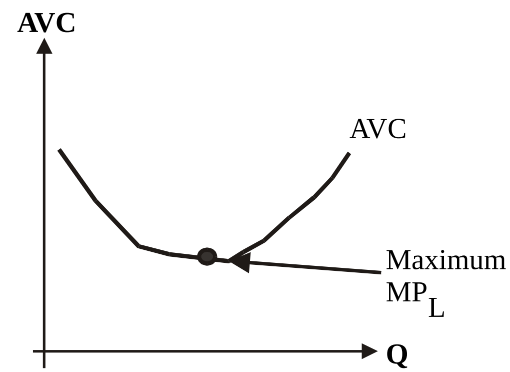
AVC = TVC/Q

Numerator: TVC = w·L, and productivity determines L
⇒ substitute w·L into AVC formula

AVC = w·L/Q = w/(Q/L), denominator is AP_L

AVC = W/AP_L

⇨ Given wages, AVC is inversely related to AP_L.
⇨ AVC curve looks like AP_L turned upside down



AVC falls, reaches a minimum, and then rises. Since AVC and AP_L are inversely related:
as AP_L↑, AVC↓
as AP_L↓, AVC↑
At minimum AVC, AP_L is at its maximum

Another name for AVC is **unit labor cost** (ULC)
= labor cost (= w·L) per unit of output.

The wage rate is *not* the correct measure of the cost of labor to a firm – ULC is, and ULC is related to *both* wages and productivity

***Labor is inexpensive if ULC is "low."* This does *<u>not</u>* require that wages be "low"**

#1: if w is "high" and AP_L is also "high," then these can offset, causing ULC to be "low"

#2: if w is "low," labor is *not* necessarily inexpensive

If wages are "low" and productivity is also "low," ULC will tend to be high

- ⇨ low wage, low skill, small value added areas.
- ⇨ The US continues to lose these industries

#3: Consider if an increase in wages. Is labor more expensive? The ULC formula implies:

$$\%\Delta ULC \cong \%\Delta w - \%\Delta AP_L$$

- ⇨ If wages and productivity both rise at the same rate, ULC remains constant and labor is *not* more expensive
- ⇨ *Only when wage growth outpaces productivity growth does ULC rise and labor becomes more expensive*

Q: What are implications of foreign trade?

A: The US can only compete with low-wage countries (LDC's) in industries where it has low ULC

- ⇨ US industries that don't have high labor productivity, ULC too high to be competitive
- ⇨ That US industry shrinks or exits US (ex. textiles and apparel).
- ⇨ US can't compete in industries that are very "labor intensive" (use much L, little K), low wage and skill, not much value added by firms

Q: Where can the US compete?

A: industries where US has advantage in ULC

- ⇨ Capital-intensive industries that use much capital, relatively little labor, or generally, skilled labor and high value added
- ⇨ Skilled labor implies high AP_L
- ⇨ High value added, differentiated products that are more difficult to replicate

- This is the basis for the drive is to enhance the skills of the US workforce ⇒ ↓ULC by ↑AP_L

Q: When, with ↑w, is labor more expensive?

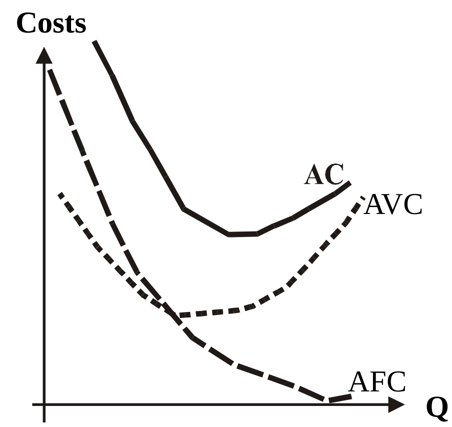
A: Only when $\%\Delta w > \%\Delta AP_L$

Consider the following quote: “It doesn’t matter how much you pay labor, but how much labor costs you.”
What you pay = wages
What labor costs = ULC
If you pay higher wages than competitors, you can still have lower ULC and be competitive

Q: Through management practices, is it possible to raise labor productivity?
A: Yes. By causing effort level to increase as the *direct* result of more effective management: $AP_L\uparrow \Rightarrow ULC\downarrow$

Average Total Cost (AC):
- total cost per unit of producing any output

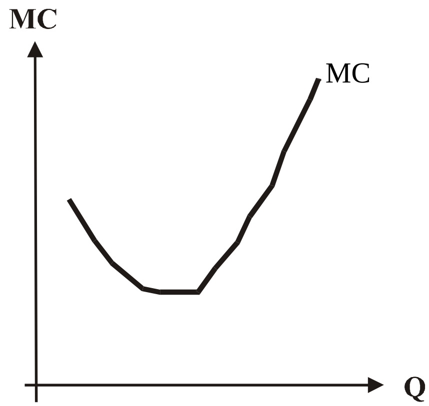
AC = AFC + AVC
- for any Q, add the values of AFC and AVC, or, in a graph, add the heights of AFC and AVC



AC is *not* parallel to AVC, since the difference between these is AFC. In other words:
AC – AVC = AFC = height difference

Since at any Q the vertical distance between AC and AVC is AFC, AC gets closer to AVC as Q rises, because AFC↓ as Q↑

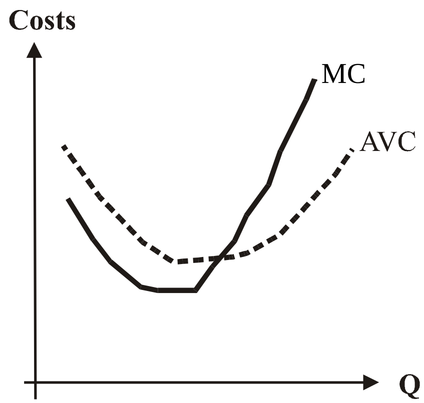
Need to add to this:
Marginal Cost (MC)
MC = ΔTC/ΔQ, as shown earlier
$MC = W / MP_L \Rightarrow$ MC inverse of MP_L
Change in total cost as Q increases, but related only to variable cost



Since MC is the inverse of MP_L, it looks like the MP_L curve upside down
- when MC↓, MP_L↑
- as MC↑, MP_L↓
(diminishing returns)

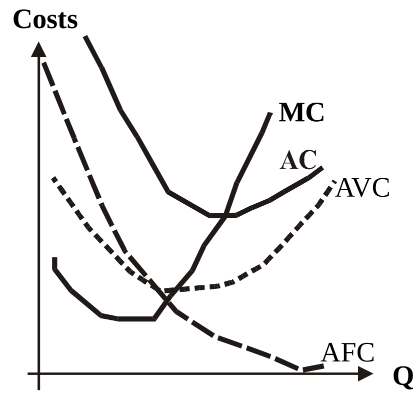
Min MC ⇒ max MP_L

Average - marginal relationship pertains here. We have already done this for AP_L and MP_L, now we apply this to MC, AVC, and AC.



- As average ↓, marginal < average
- As average ↑, marginal > average
- At min (max), marginal = average

Putting all of these curves together:



Generally, we don't need AFC (infer it)
MC = min AVC
MC = min AC

Cost information for firms in the short-run

Q: What happens to MC when fixed cost doubles?
A: To answer this, fill in blanks in the following table:

Q	TFC	TVC	TC	MC
0				---
10		30		
20	50	50		
30		80		

<u>Formulas to use:</u>
TC = TFC + TVC
MC = ΔTC/ΔQ, and in the table ΔQ = 10

Q	TFC	TVC	TC	MC
0	**50**	**0**	**50**	**---**
10	**50**	30	**80**	**3**
20	50	50	**100**	**2**
30	**50**	80	**130**	**3**

Next, let TFC double from the values in the table.

Q	TFC	TVC	TC	MC
0	~~**50**~~ **100**	**0**	~~**50**~~ **100**	**---**
10	~~**50**~~ **100**	30	~~**80**~~ **130**	**3**
20	~~**50**~~ **100**	50	~~**100**~~ **150**	**2**
30	~~**50**~~ **100**	80	~~**130**~~ **180**	**3**

IF FIXED COST DOUBLES (OR CHANGES BY ANY MULTIPLE), MARGINAL COST REMAINS UNCHANGED

This occurs since MC is the *rate of change* in total costs as Q changes.

- If TFC doubles, the *level* of TC changes, but *not* its rate of change.
- The rate of change in TC is determined by **TVC**

To model short-run production we need a Behavioral Assumption about firms:

Profit Maximization ⇒ maximum *dollar value* of profit, not maximum profit per unit
Economic Profit = total revenue – total *economic* cost

Up to now, we have viewed cost and production, focusing on individual firm cost curves. To model profit maximizing output, we need information on *revenues*

- having not analyzed market structure, we will take price as given, using a hypothetical price

Two behavioral rules for a profit- maximizing firm:

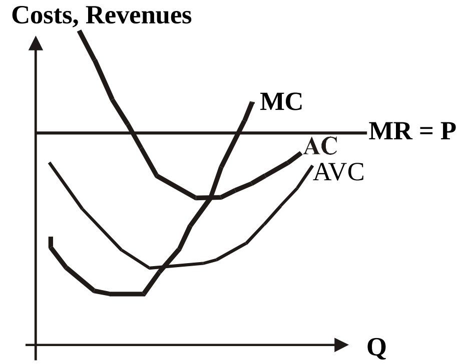
#1: Price Check: We saw before if Q = 0 (shutdown), TC = TFC, so only lose overhead. To maximize profit or minimize loss, set price so loss never exceeds TFC.

If P = AVC (< AC), lose money, lose TFC since difference between AC and AVC is AFC, lose this/unit, x dollars of units→ loss of TFC

Rule 1: Produce only if P ≥ min AVC. Then, either make profit or never lose more than TFC

If P > AVC, then, multiplying both sides by Q:
$P \cdot Q > AVC \cdot Q$

⇒ TR > TVC ⇒ Firm is earning positive **Operating Profit (= TR – TVC)** – this can be used to cover TFC



To determine profit/loss include price (P)
- we assume P = MR

#2: How Much to Produce:

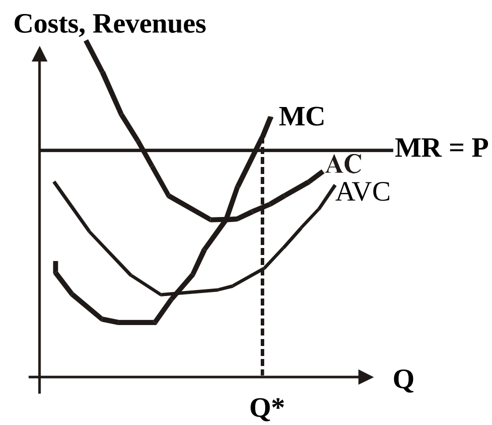
- Use profit maximization criterion
- As Q↑, incur marginal cost, additional costs of production, and marginal revenue (MR), added revenue as produce and sell the goods

If MR > MC, as Q↑, added revenue (MR) > added cost (MC) ⇒ can increase profits by increasing Q
- If this is possible, can't be a maximum profit now

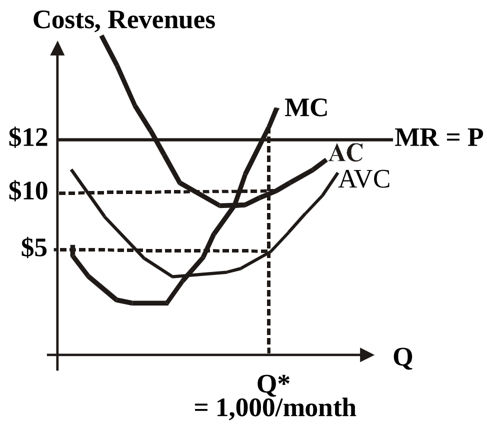
Rule 2: Produce up to where MR = MC. Then, as Q↑, added revenue exactly offsets added cost and profit can't be increased by changing Q (so must be *at* profit max Q).

For present purposes, assume MR = P (assumes constant price)

Procedure:
Step 1: If the firm were to produce, how much?
Step 2: Check to see if P ≥ min AVC at that Q

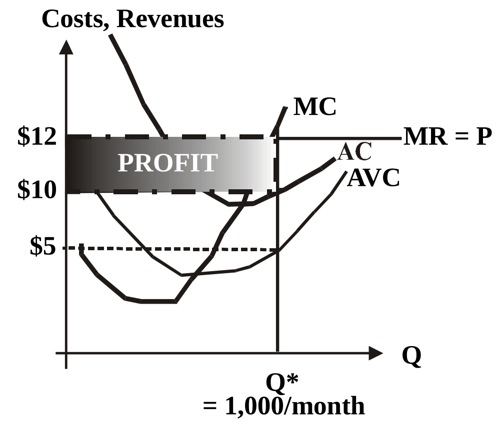


Produce where MR = MC
⇒ P = MC



Q: Will the firm produce?
A: Yes
At Q* (our anchor), P > AVC (AVC = $5 and P = $12)

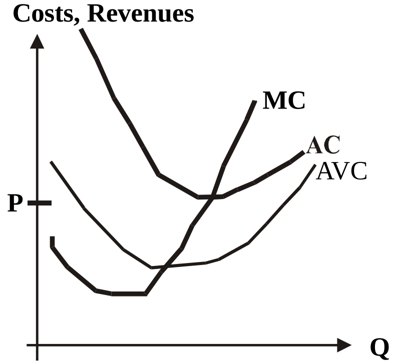
Q: Is there a profit or loss?
A: Use Q* as anchor and compare price/unit (revenue) at Q* (= $12), with cost/unit (AC) = $10. Since P > AC at Q*, economic profit of $2/unit exists (= P – AC)



Since P > AC,
profit/unit = $2

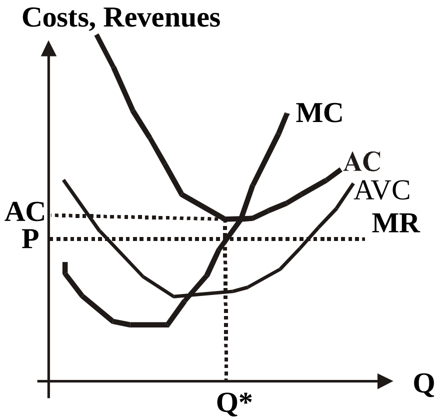
Total profit = (profit/unit)·Q* = area of rectangle

Exercises



Will the firm produce?
If so, how much?
Is there profit or loss?
How much?

#1: Find where MR = MC => Q*
#2: Is P > AVC at Q*?



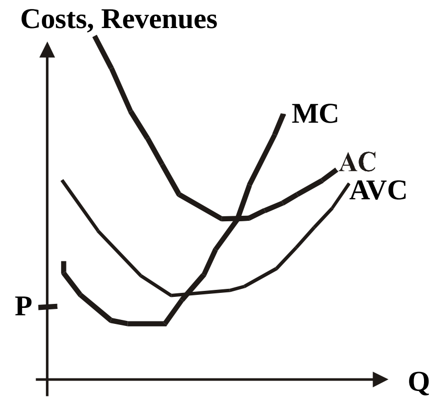
Assume Q*= 900 P = $9, AC = $11 And AVC = $6

Since P > AVC but less than AC at Q*, the firm incurs a loss, but loses less than its TFC (show this).

At Q*, cost/unit (AC) = $11 and price/unit (P) = $9, so loss/unit = $2

Economic loss = (loss/unit)·Q*

= $2($900) = $1,800/month



Will the firm produce?
If so, how much?
Is there profit or loss?
How much?

Draw a MR line at P. If the firm produces, it is where MR = MC, this defines Q*
Will the firm produce there? No
At Q* (say 600/month), let P = $4 < AVC of (say) $5.
Assume that AC at Q* = $9.
If the firm produces: loss = $3,000/month.
If shuts down: loss = $2,400/month.

Q: What happens to the profit-maximizing output when TFC doubles?
A: Nothing, since MC remains the same

LONG RUN COSTS

In the long run, can expand output by using more of *both* labor and capital. Capital is variable in the long run for an industry

Capital can increase as:

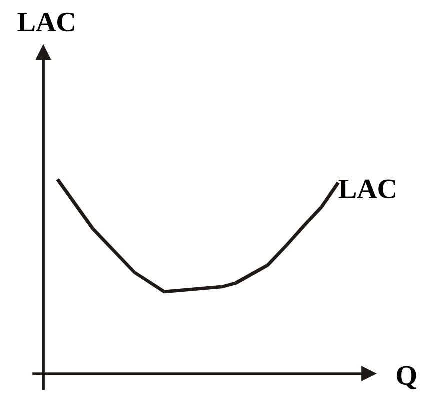
1. Existing firms add to equipment and/or expand their facilities
2. New firms can enter this industry, sometimes after previously producing a competing product, not necessarily a new firm
3. A firm that produces other products begins producing X along with the others (sometimes the result of mergers and acquisitions). This can lead to **economies of scope** (startup costs of new product less than for new company). Cost savings from mergers lowers fixed costs. Economies often entail layoffs and the consolidation of (redundant) services (ex: computer makers producing/selling LCD TVs

Over some range, as K↑, both AC and MC fall

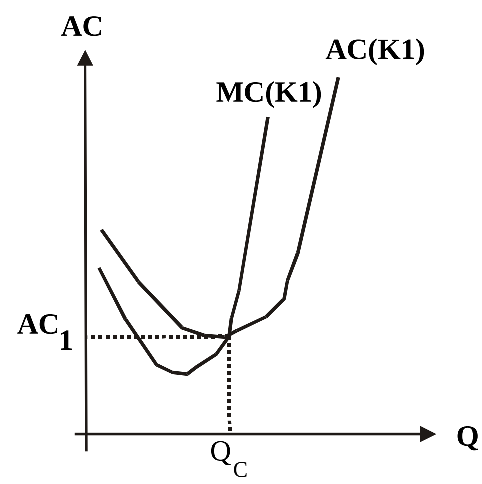
- Benefits: by decreasing cost/unit, can raise profit, making it easier to survive in that industry.
- This is where competition comes in; it forces firms to lower cost

When cost/unit in long run falls as Q increases, **Economies of Scale** exist

Derivation of Long-run Average Cost curve



To get long run average cost curve, use all short-run AC and MC curves (like AC(K1) and MC(K1))

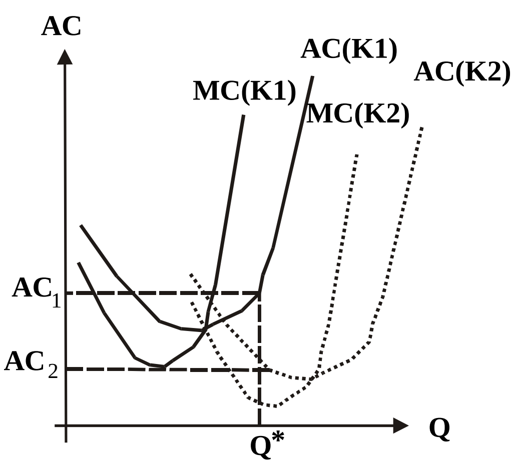


Q_c is the capacity output for capital stock K1 (short-run)

Capacity – output associated with point of *minimum* average cost (i.e. the output at which cost/unit is at minimum). Firms can produce beyond capacity, but cost/unit will be higher

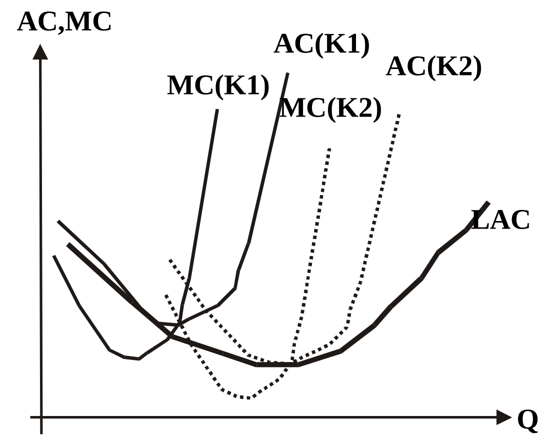
- To produce beyond capacity *in the short run*, must use K1 (existing capital stock) with cost/unit > AC_1
- In long run, can also increase capital, raising capacity and lowering cost/unit over some range

Derivation of long-run average cost (LAC) curve



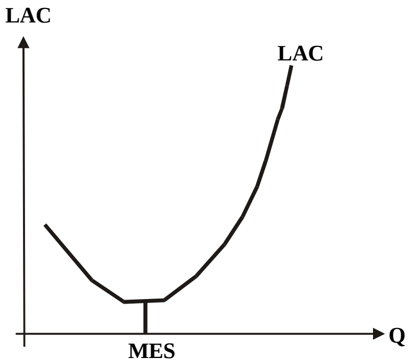
Choice: *over*utilize K1 (go beyond capacity) or *under*utilize K2 (produce below capacity)?
- AC lower when underutilizing K2 (= AC_2)

Competition forces firms to increase K to survive. Question: Over how large a range of Q does cost/unit fall in the long run? Recall: decrease in cost/unit in the long run is economies of scale



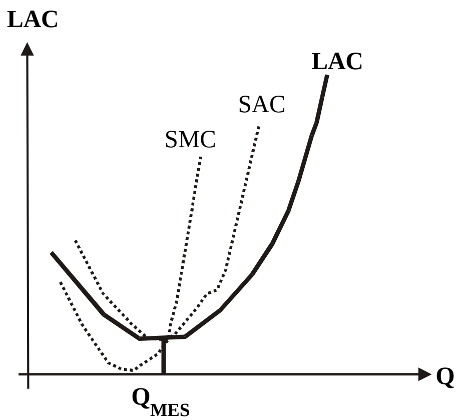
Derive long run average cost curve from the *set* of short run average cost curves

LAC is an *envelope curve*, it touches each short-run average cost curve at its optimal point. LAC shows the lowest possible cost/unit in the long-run for any Q along with the associated capital stock



Small range of economies of scale

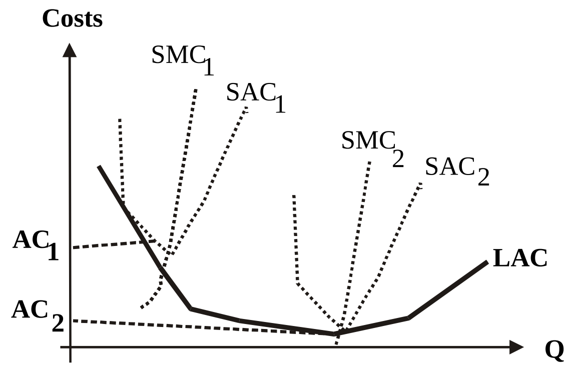
Question: will there be much competition?
Minimum Efficient Scale (MES): point at which LAC is at a minimum (i.e., long run capacity)



Low MES

To reap all economies of scale and to be cost efficient with small MES, don't need a very large-scale of operation. Thus, it is not difficult to be cost effective
⇒ Large number of small firms (highly competitive)

Economies of scale is a barrier to competition



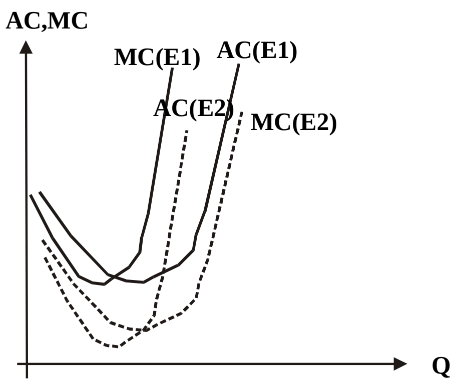
Where large economies of scale exist, there will be little competition: a few firms or a single large firm will often come to dominate the entire market

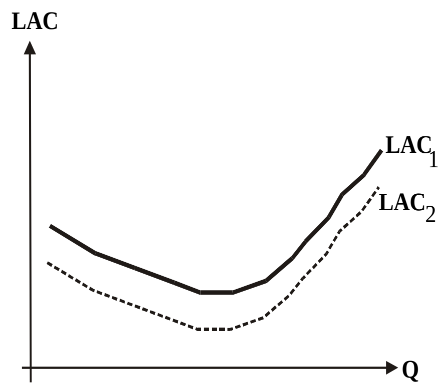
With technology and newer management techniques small firms can often survive *without* large capital investment. How?
- By raising the effort level (E) of workers and not incurring the large overhead of "big" firms, keep cost/unit low

⇨ $AP_L = f(K,L,E)$
⇨ $MP_L = f(K,L,E)$

As effort level increases, given capital and labor, MP_L and AP_L both rise

- ⇨ Since productivity is inversely related to production costs, as MP_L and AP_L rise, MC and AC (along with AVC) decrease
- ⇨ As AC and MC fall in the short-run, there will be a downward shift of the long-run average and marginal cost curves





PRACTICE QUESTIONS

Use the following to answer the next two questions:

Labor	Output	TFC	TVC	TC
0	0		0	
1	8		40	90
2	20		80	
3	28		120	170
4	35			210
5	41	50	200	250

Refer to the above table. The total variable cost of producing 35 units of output is:

A) $90. B) $120. C) $160. D) $210.

Refer to the above table. When output increases from 28 to 35 units, the marginal cost of the product is:

A) $4.44. B) $5.71. C) $6.00. D) $6.67.

A manufacturer's product is currently selling for a price of $6.00 per unit. At this time, the company's average total costs and marginal costs are both equal to $8.00 per unit, while average variable costs is $5 per unit. In order to maximize profits, this manufacturer should:

A) increase output.
B) increase selling price.
C) produce zero output and close down.
D) reduce output but continue production.

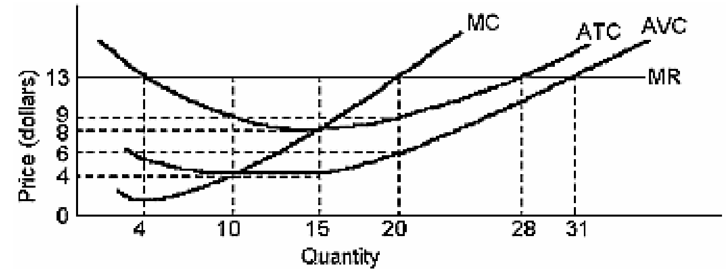
Use the following to answer the first two questions:

Output	TFC	TVC
1		$30
2		$44
3		$60
4		$80
5	$40	$110
6		$150
7		$200
8		$280

In the table above, marginal cost is largest for the
A) eighth unit produced.
B) fifth unit produced.
C) first unit produced.
D) sixth unit produced.
E) fourth unit produced.

In the table above, the average fixed cost of the first unit of output is ____________ while the average fixed cost of producing 8 units of output is _____________.
A) $40; $280.
B) $40; $5.
C) $40; $320.
D) $40; $40.
E) $30; $40.

Use the following to answer the next three questions:



In the figure above, to maximize profits or minimize losses the firm should produce __________ units.
A) 15.
B) 20.
C) 28.
D) 4.
E) 10.

In the figure above, at the profit-maximizing level of output total revenue will be
A) $130.
B) $260.
C) $280.
D) $120.
E) $180.

In the figure above, maximum profit is
A) $75.
B) $80.
C) $260.
D) $4.
E) $50.

When marginal cost is increasing:
A) total cost must be increasing.
B) average total cost must be increasing.
C) average total cost must be decreasing.
D) average fixed costs might be rising or falling.

In the short run, fixed costs for a profitable firm are:
A) zero.
B) negative.
C) important determinants of the output level.
D) irrelevant in determining the optimal level of output.