

Nellis and Parker Chapter 3 – The analysis of production costs

Law of diminishing marginal returns

TPL APL and MPL graphs

Types of costs

picture for the relationship between costs and productivity

Important points about short-run cost curves:

LONG RUN COSTS AND ECONOMIES OF SCALE

Econ costs vs. acct costs

Econ profit vs. acct profit

Normal profit

Q^* is where Marginal profit = 0 $\Rightarrow MR = MC$

SR and LR decisions to stay and shut down

"x-inefficiency"

supply and elasticity of supply

Law of diminishing marginal returns → the extra production obtained from increases in a variable input will eventually diminish as more of the variable input is used with fixed inputs.

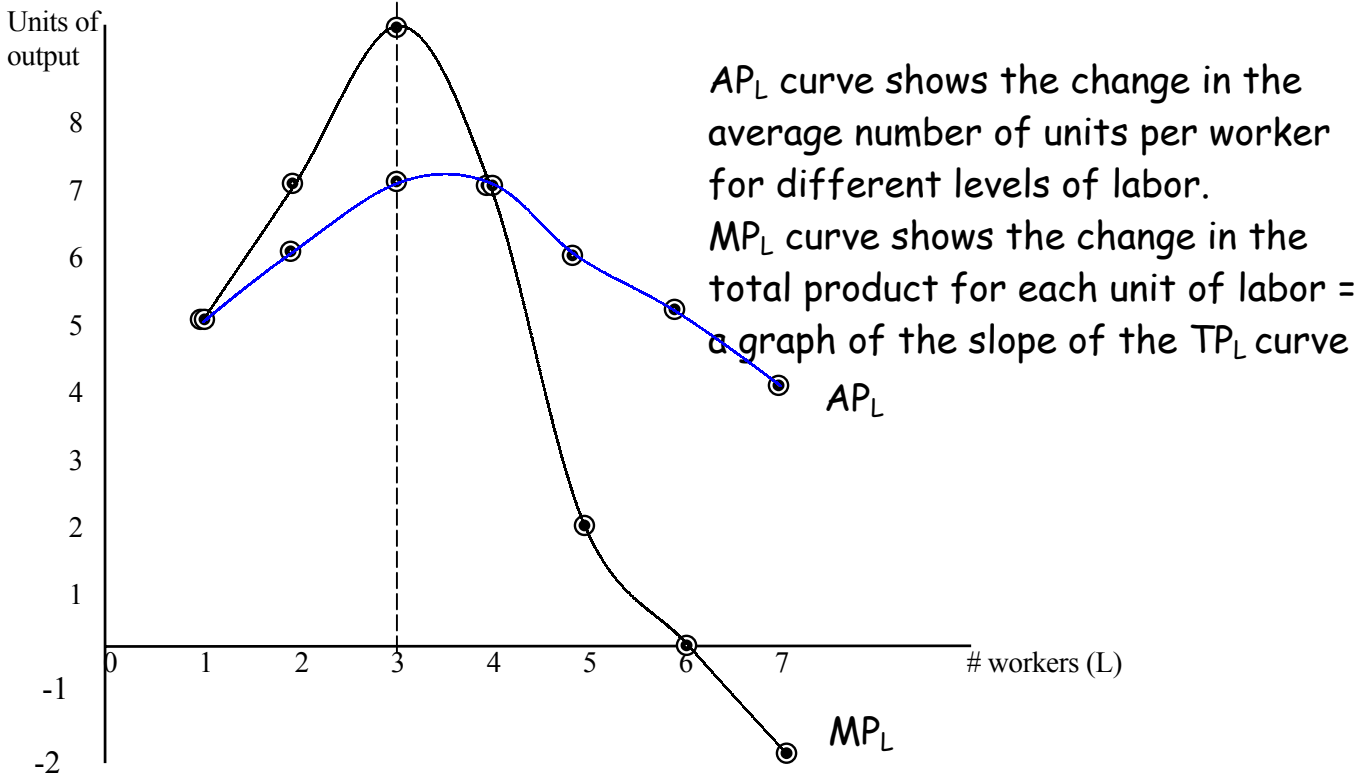
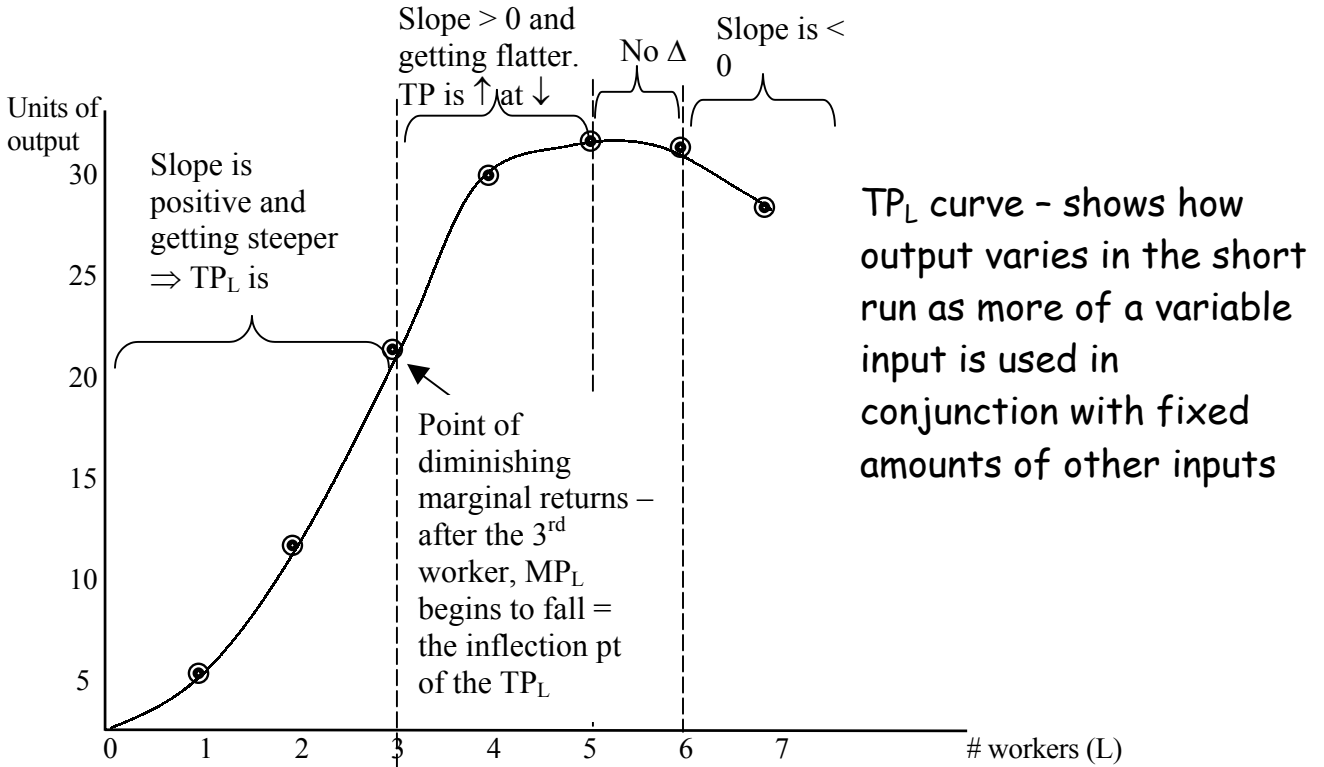
⇒ there is a limit to the extra production we can get by adding workers to fixed capital.

⇒ for a given amount of capital, there is some optimal quantity of labor.

Let's look at these relationships graphically: TP_L , MP_L , and AP_L

→ 2 graphs to represent how output changes with labor. For each put output on the vertical axis and units of labor on the horizontal axis.

Let's graph the total product of labor on top and then the marginal and average products of labor on the bottom.



Total Fixed Costs (TFC) are also known as "overhead". These are the costs associated with running a firm that do not change with the level of output. Fixed costs are the costs associated with fixed inputs. Examples of fixed costs include rent and management salaries.

Total Variable Costs (TVC) are costs that *do change* with the level of output. Variable costs are the costs associated with variable inputs. Examples of variable costs are fuel, electricity, labor costs, and materials costs.

Total Cost (TC) is the sum of all costs, both fixed and variable.
 $TC = TFC + TVC$

Average Fixed Cost (AFC) is the fixed costs divided by the number of units of output. $AFC = TFC / Q$

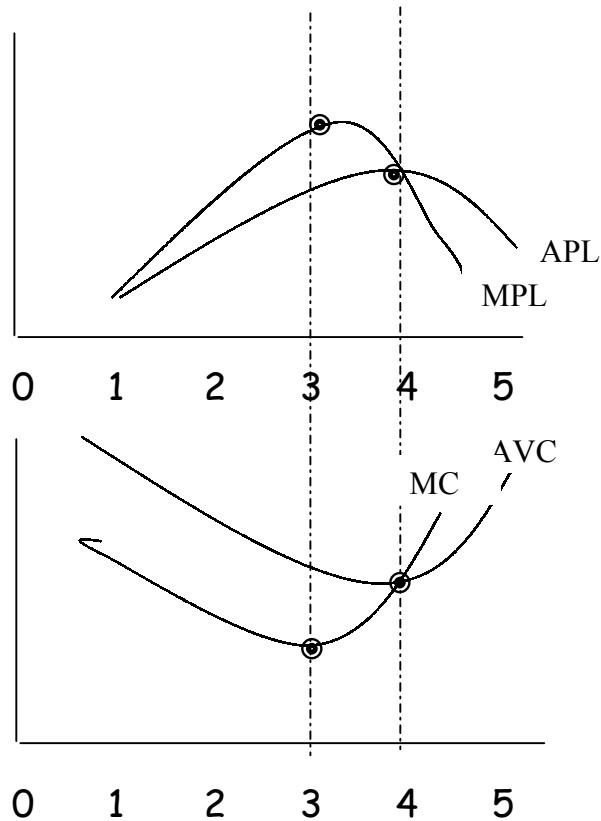
Average Variable Cost (AVC) is variable costs divided by the number of units of output. $AVC = TVC / Q$

Average Total Cost (ATC) is also known as "unit cost", and are found by dividing total costs by the number of units of output.
 $ATC = TC / Q = AFC + AVC$

Marginal Cost (MC) is the extra cost associated with producing one more unit of output. Marginal cost is found as the change in total cost for a given change in output. $MC = \Delta TC / \Delta Q$

(Just like we saw with the productivity measures - MPL intersects APL at the highest point of APL).

Generalized picture for the relationship between costs and productivity.



Notice that the peak of MPL corresponds with the low-point of MC. The peak of the APL corresponds with the low-point of AVC.

⇒ the intersection of MPL and APL corresponds with the intersection of the MC and AVC curves.

Important points about short-run cost curves:

1. MC, AVC, and ATC are "U-Shaped".

★ The U-shape of short-run cost curves reflects the law of diminishing marginal returns.

→ When additional output from variable inputs falls \Rightarrow each additional unit of output will cost more than the previous one. We're paying labor (whatever the variable input is) the same wage, but getting less output out of it

→ Costs are falling if productivity is rising and costs are rising if productivity is falling.

★ Unit costs are inversely related to productivity because high productivity (APL or MPL rising) \Rightarrow we're getting a lot of output for the wage (\therefore low unit costs)

likewise, low productivity (APL or MPL falling) \Rightarrow we're getting less output for a wage paid (\therefore higher unit costs)

Specifically,

when MPL is rising \Rightarrow MC is falling

when MPL is falling \Rightarrow MC is rising

when APL is rising \Rightarrow AVC is falling

when APL is falling \Rightarrow AVC is rising

★ Cost curves are U-shaped because productivity curves are shaped like upside-down U's

2. *AFC* is always decreasing in output. → distributing the overhead over more and more units. $AFC = TFC/Q$ (numerator is constant).

3. *MC* depends on *VC* only - marginal cost is the change in total costs. Total cost is $FC + VC$ and *FC* doesn't change.

4. *MC* intersects *AVC* and *ATC* at their lowest points.

⇒ when the marginal is below the average, the average gets pulled down.

⇒ when the marginal is above the average, the average gets pulled up.

** next we're going to discuss long-run cost curves, and we're going to see that they are U-shaped also, but for a different reason.

This is actually jumping a bit ahead (in fact into chapter 9), but I think it fits better.

Pause in chapter 8 on page 195 (pick-up there soon)

Insert chapter 9 pages 215-220 (then back into ch 8)

LONG RUN COSTS AND ECONOMIES OF SCALE

Vocabulary Term: "Scale" = degree or proportion

If we say that the firm "increased the scale of operations" that means that they increased the size or the proportion of operations.

Recall that we defined the long-run as the time required for all inputs to be variable.

⇒ in the long-run, firms have greater flexibility with regard to production decisions.

If a firm wants to increase output in the short-run, its options are limited: it can only increase the use of variable inputs - run machines longer, hire more labor or work labor overtime, perhaps use different or more materials.

In the long-run, however, firms have time to plan for and acquire new capital - purchase more machines, more production technology, or build new production facilities.

Recall that this is how we defined the long-run: we said that in the long-run, everything was variable \Rightarrow we can increase production by changing any inputs, even capital.

We can also go in the other direction.

Consider a firm that has a very large factory (8-track tape factory) - if *demand for that product decreases*, the firm might be stuck with excess capacity in the short-run (stuck paying the rent - lease), but in the long run, they can scale down operations and perhaps move to a smaller facility, or leave the market all together.

OK - so a firm can change the scale of its operations

They can increase the scale (get larger = increase the use of all inputs) or

They can decrease the scale (get smaller = decrease the use of all inputs).

The question we need to address is:

⊛ What happens to costs as a firm changes the scale of its operations?

\rightarrow We learned that changes in costs are a function of productivity. Higher productivity means lower unit costs. Lower productivity means lower unit costs.

So, we need to ask: As a firm expands, what is going to happen to productivity? As a result of that change in productivity, what is going to happen to unit costs?

Do returns from the use of all inputs increase or decrease as we expand scale?

Could think of reasons why returns would increase and we can think of reasons why returns would decrease and we can even think of situations when returns would not change at all.

Increasing returns to scale (IRTS): as a firm gets bigger (larger scale of operations) it gets more efficient, and therefore unit costs of production decrease.

⊛ A given percentage increase in all inputs \Rightarrow a larger percent change in output.

Eg: if a firm is characterized by IRTS: a 10% increase in all inputs will result in a larger than 10% increase in output.

? What are some reasons that we might see IRTS?

1. Labor and management can specialize.

\rightarrow an \uparrow in the size of operations means a larger employee and management pool. \therefore jobs can be divided and sub-divided to facilitate specialization.

Eg: high-skilled workers do high-skilled jobs and don't waste time and energy on tasks that can be performed by low-skill labor.

What happens when you specialize? \rightarrow You get better. "practice makes perfect" \Rightarrow \uparrow efficiency.

2. Larger firms can make more efficient use of high-tech capital.

A larger operation may justify the purchase of larger, more efficient machinery. Automation, robotics.

Farm example: big combine and tractors.

3. Large amounts of by-products can be recycled and/or re-used to make other goods or sold. Small firms may not generate enough by-products to justify the cost.

POINT: IRTS \Rightarrow larger firms may be more efficient (or productive) than smaller firm and therefore have lower unit costs.

Question: Should we expect this IRTS to continue forever? No matter how big a firm gets, is it always going to get more efficient?

\rightarrow Probably not. Firms might get so big that productivity falls off due to a thick bureaucracy.

IF a firm gets too big, we might see...

Decreasing returns to scale (DRTS): An increase in the size or scale of the firm may result in a decrease in efficiency and therefore an increase in unit costs.

A given percent change in the use of all inputs results in a smaller percent change in output.

Eg: DRTS \Rightarrow a 10% \uparrow in inputs \Rightarrow a less than 10% increase in output.

Why would we see DRTS?

\rightarrow As a firm gets bigger and bigger and management gets thicker and thicker, communication and decision-making may slow.

→ Workers may also feel disconnected if they are just a tiny part of a huge corporate monster ⇒ "shirking" = slacking-off ⇒ not being as productive as they could be.

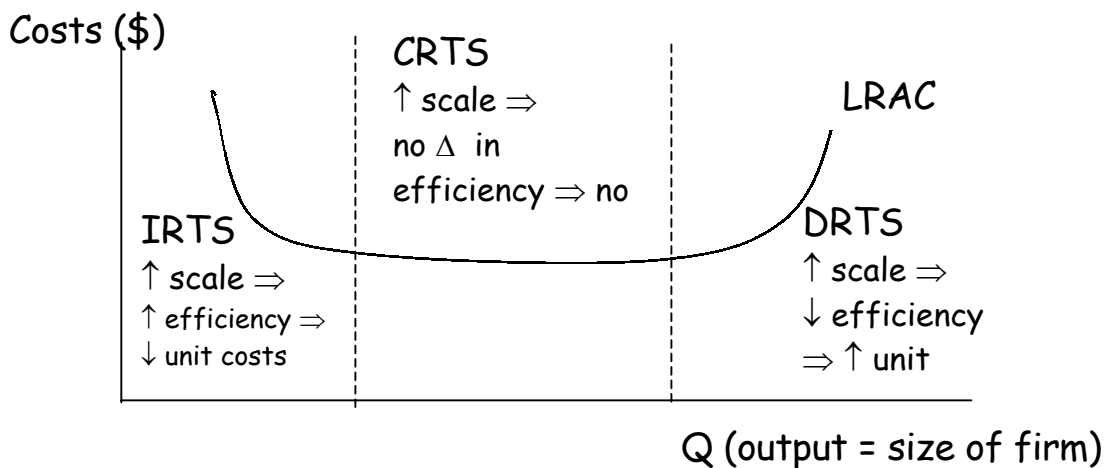
We might also see CRTS ⇒ a 10% ↑ in all inputs ⇒ a 10% ↑ in output.

No change in efficiency or costs as scale expands.

Whats the order of these? If a firm starts small and gets bigger they might experience IRTS initially, then CRTS then gets too big and goes into DRTS.

IRTS → CRTS → DRTS

So if we put costs (in dollars) on a vertical axis and size of the firm on the horizontal axis (we can think of the size of the firm in terms of units of output it produces) what will a long-run unit cost curve look like?



Big point: Cost curves tend to be U-shaped.

In the Short-Run: the U-shape of cost curves is due to diminishing marginal returns to variable inputs in the presence of some fixed inputs.

= the change in returns to a variable input.

⊛ SR: law of DMR $\Rightarrow \uparrow Q \Rightarrow$ first higher then lower productivity \Rightarrow first lower then higher unit costs

In the long run: The U-shape of cost curves is due to changes in productivity as a firm changes the scale of operations.

= the change in returns to all inputs.

⊛ LR: $\uparrow Q$ (scale) \Rightarrow first IRTS then CRTS then DRTS \Rightarrow first lower then higher unit costs.

One other point is that when economists consider cost curves, they include both explicit and implicit (opportunity) costs

Econ costs = explicit + implicit

Acct costs = explicit costs only

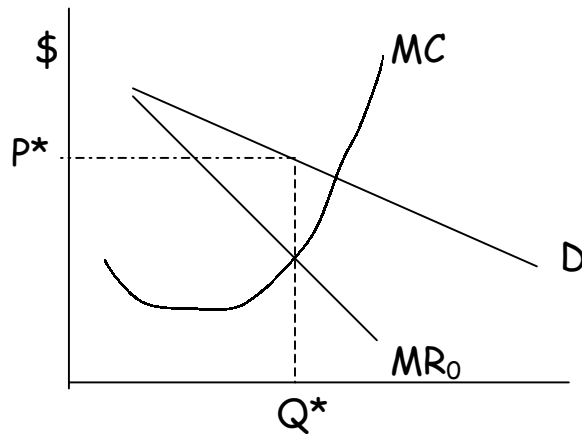
Econ profit = revenue – econ costs

Acct profit = revenue – acct costs

Normal profit = when acct profit exactly covers opp costs = doing as well as your next best alternative.

How can we use this stuff?

The U-shaped cost curves help us look at profit-maximizing output decisions by firms...



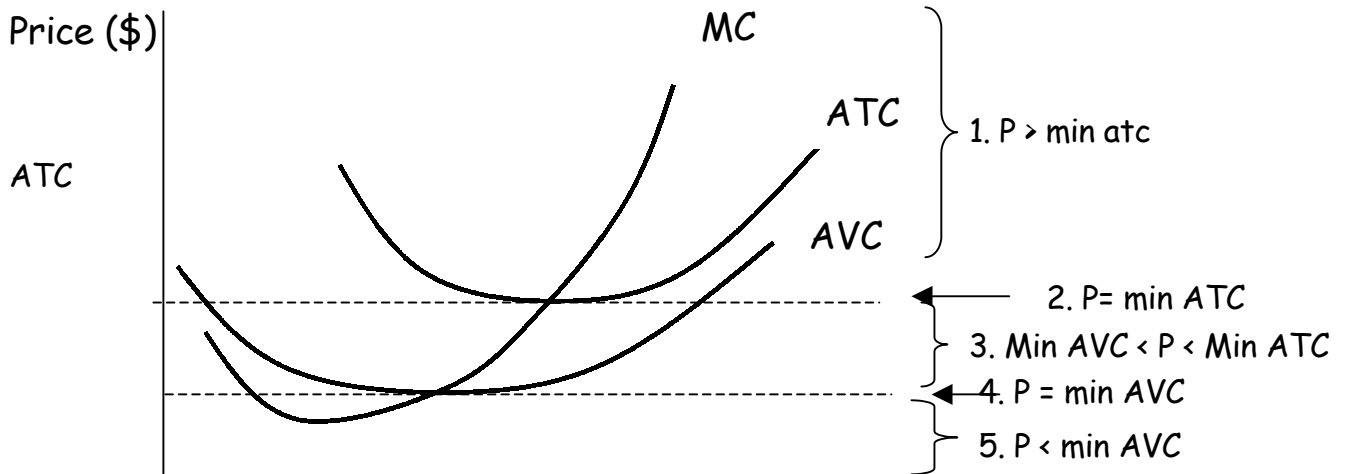
... firm maximizes profits at the level of output where marginal profit = 0

Marginal profit = 0 \Rightarrow MR = MC

So, the profit maximizing condition for a PC firm is to produce up to the point where MR = MC, and then set price according to the demand curve.

Graphically - the location of Price determines the profitability of the firm and the firm's decision whether to shut-down or not:

* show profit on this graph = TR box - TC box



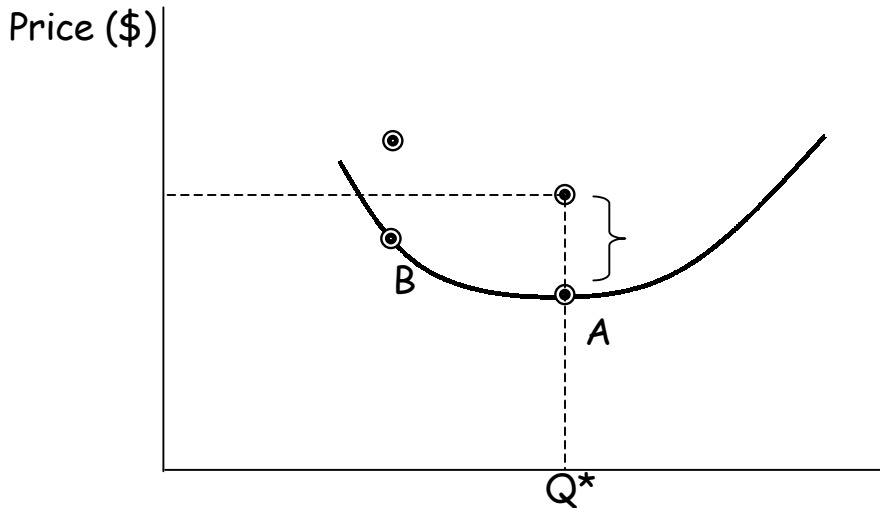
Q

1. $P > \min ATC \Rightarrow \text{Econ Profit} > 0 \Rightarrow$ earning more than opportunity costs \Rightarrow operate in the short run and stay in business in the Long Run (doing better than the next best alternative)
2. $P = \min ATC \Rightarrow \text{Econ Profit} = 0 \Rightarrow$ earning normal profit \Rightarrow exactly covering opportunity costs \Rightarrow operate in the short run and stay in business in the Long Run (can't do any better elsewhere)
3. $\min AVC < P < \min ATC \Rightarrow$ econ profit < 0 , but the firm is covering some of its fixed costs \Rightarrow operate in the short-run, but exit the market in the long run (because not doing as well as your next best alternative)

4. $P = \min AVC \Rightarrow$ econ profit < 0 and firm just covering $VC \Rightarrow$ indifferent between operating or not in the short run, and leave market in the long run
5. $P < \min AVC \Rightarrow$ econ profit < 0 , and not covering any fixed costs \Rightarrow shut down in short run and leave market in the long run.

With regard to the cost curve, we shouldn't expect that firms will be operating at the theoretically efficient point of minimum average costs...

We can use their location on the cost curve relative to the theoretically efficient point to measure inefficiency.



Q^* is the efficient scale of operations for this firm because that is where unit costs are minimized.

The firm might not be able to minimize costs for 2 reasons - there isn't sufficient demand to justify that scale of operations (like point B) or, they could be wasting resources in some regard.

For example, a firm could be operating at scale of Q^* , but has costs higher than the min ATC.

"x-inefficiency" is a measure of how much more efficient you could be at your existing scale of operations = vertical gap in costs between optimal costs and actual for a given scale.

