10.1 Technology: An Economic Definition

Define technology and give examples of technological change

The basic activity of a firm is to use *inputs*, for example

- Workers,
- Machines, and
- Natural resources

to produce *outputs* of goods and services.

We call the process by which a firm does this a *technology*; if a firm improves its ability to turn inputs into outputs, we refer to this as a positive *technological change*.

Technology: The processes a firm uses to turn inputs into outputs of goods and services.

Technological change: A change in the ability of a firm to produce a given level of output with a given quantity of inputs.

Making the Connection: UPS uses technology to deal with holiday surge

UPS was late delivering millions of packages leading up to Christmas 2013.

To correct this in following years, UPS could:

- Hire more workers
- Purchase more capital like airplanes

It decided instead to improve technology, to make its workers more efficient:

- New scanners to help sorting
- Better maps and routing for delivery drivers

11.2 The Short Run and the Long Run in Economics

Distinguish between the economic short run and the economic long run

Economists refer to the **short run** as a period of time during which at least one of a firm's inputs is fixed.

- *Example: A firm might have a long-term lease on a factory that is too costly to get out of.*

In the **long run**, the firm can vary all of its inputs, adopt new technology, and increase or decrease the size of its physical plant.

How long is the long run? It varies from firm to firm.

- Just think of it as "a long enough period of time that anything can be changed".

Fixed, variable, and total costs

The division of time into the short and long run reveals two types of costs:

- **Variable costs** are costs that change as output changes, while
- **Fixed costs** are costs that remain constant as output changes.

In the long run, all of a firm's costs are variable, since the long run is a sufficiently long time to alter the level of any input.

Total cost is the cost of all the inputs a firm uses in production:

$$\text{Total cost} = \text{Fixed cost} + \text{Variable cost}$$

$$TC = FC + VC$$

Making the Connection: Costs in the publishing industry

An academic book publisher turns its inputs (intellectual property, labor, printing machines, paper, factory, electricity, etc.) into its outputs (books).

As it increases the number of books it publishes, some of those inputs stay constant and some rise.

- Can you identify which ones?

Explicit and implicit costs

Recall that economists like to consider all of the *opportunity costs* of an activity; both the *explicit costs* and the *implicit costs*.

- **Explicit cost**: A cost that involves spending money
- **Implicit cost**: A non-monetary opportunity cost

The explicit costs of running a firm are relatively easy to identify: just look at what the firm spends money on.

The implicit costs are a little harder; finding them involves identify the resources used in the firm that could have been used for another beneficial purpose.

Example: If you own your own firm, you probably spend time working on the firm's activities. Even if you don't "pay yourself" explicitly for that time, it is still an opportunity cost.

Table 11.1 Jill Johnson's costs per year (1 of 2)

Jill's Costs	Amount
Pizza dough, tomato sauce, and other ingredients	$20,000
Wages	48,000
Interest payments on loan to buy pizza ovens	10,000
Electricity	6,000
Lease payment for store	24,000
Forgone salary	30,000
Forgone interest	3,000
Economic depreciation	10,000
Total	**$151,000**

Suppose Jill Johnson quits her $30,000 a year job to start a pizza store. She uses $50,000 of her savings to buy equipment—furniture, etc.—and takes out a loan as well.

- The items in red are explicit costs.
- The items in blue are implicit costs: her foregone salary, the interest the money could have earned…

Table 11.1 Jill Johnson's costs per year (2 of 2)

Jill's Costs	Amount
Pizza dough, tomato sauce, and other ingredients	$20,000
Wages	48,000
Interest payments on loan to buy pizza ovens	10,000
Electricity	6,000
Lease payment for store	24,000
Forgone salary	30,000
Forgone interest	3,000
Economic depreciation	10,000
Total	**$151,000**

… and *economic depreciation* (decrease in resale value) on the capital items Jill bought.

- All of these implicit costs are real costs of Jill owning the pizza store, even if they don't require an explicit outlay of money.
- Notice in particular Jill "charging herself" for the money she took out of her savings, just like the bank charges for her loans.

Production at Jill Johnson's restaurant

Jill Johnson's restaurant turns its inputs (pizza ovens, ingredients, labor, electricity, etc.) into pizzas for sale.

To make analysis simple, let's consider only two inputs:

- The pizza ovens, and
- Workers

The pizza ovens will be a fixed cost; we will assume Jill cannot change (in the short run) the number of ovens she has.

The workers will be a variable cost; we will assume Jill can easily change the number of workers she hires.

Table 11.2 Short-run production and cost at Jill Johnson's restaurant (1 of 3)

Quantity of Workers	Quantity of Pizza Ovens	Quantity of Pizzas per Week	Cost of Pizza Ovens (Fixed Cost)	Cost of Workers (Variable Cost)	Total Cost of Pizzas per Week	Cost per Pizza (Average Total Cost)
0	2	0	$800	$0	$800	—
1	2	200	800	650	1,450	$7.25
2	2	450	800	1,300	2,100	4.67
3	2	550	800	1,950	2,750	5.00
4	2	600	800	2,600	3,400	5.67
5	2	625	800	3,250	4,050	6.48
6	2	640	800	3,900	4,700	7.34

Jill Johnson's restaurant has a particular technology by which it transforms workers and pizza ovens into pizzas.

- With more workers, Jill can produce more pizzas.

This is the firm's **production function**: the relationship between the inputs employed and the maximum output from those inputs.

Table 11.2 Short-run production and cost at Jill Johnson's restaurant (2 of 3)

Quantity of Workers	Quantity of Pizza Ovens	Quantity of Pizzas per Week	Cost of Pizza Ovens (Fixed Cost)	Cost of Workers (Variable Cost)	Total Cost of Pizzas per Week	Cost per Pizza (Average Total Cost)
0	2	0	$800	$0	$800	—
1	2	200	800	650	1,450	$7.25
2	2	450	800	1,300	2,100	4.67
3	2	550	800	1,950	2,750	5.00
4	2	600	800	2,600	3,400	5.67
5	2	625	800	3,250	4,050	6.48
6	2	640	800	3,900	4,700	7.34

Each pizza oven costs $400 per week, and each worker costs $650 per week.

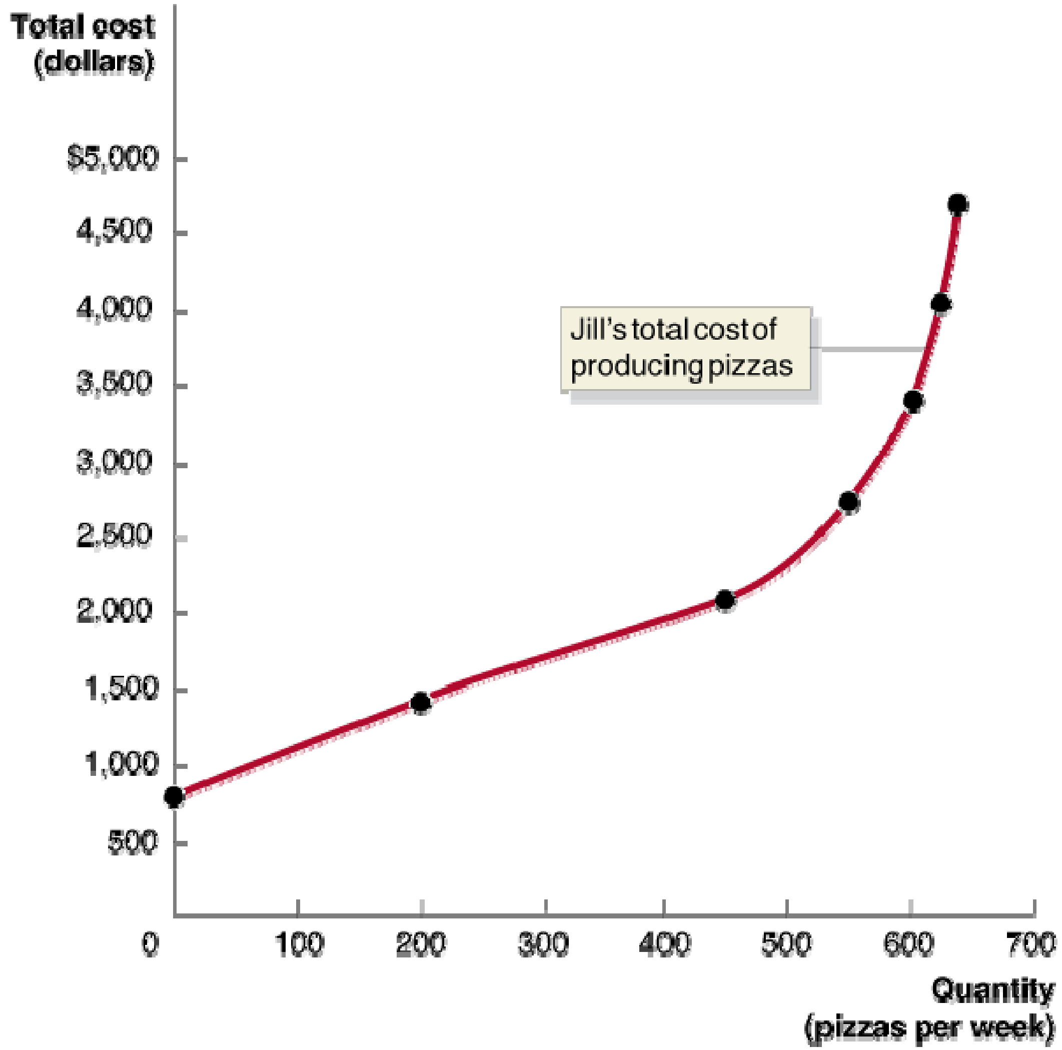
- So the firm has $800 in fixed costs, and its costs go up $650 for each worker employed.

Figure 11.1 Graphing total cost and average total cost at Jill Johnson’s restaurant (1 of 2)

Using the information from the table, we can graph the costs for Jill Johnson’s restaurant.

Notice that cost is not zero when quantity is zero, because of the fixed cost of the pizza ovens.

Naturally, costs increase as Jill wants to make more pizzas.



(a) Total cost

Table 11.2 Short-run production and cost at Jill Johnson's restaurant (3 of 3)

Quantity of Workers	Quantity of Pizza Ovens	Quantity of Pizzas per Week	Cost of Pizza Ovens (Fixed Cost)	Cost of Workers (Variable Cost)	Total Cost of Pizzas per Week	Cost per Pizza (Average Total Cost)
0	2	0	$800	$0	$800	—
1	2	200	800	650	1,450	$7.25
2	2	450	800	1,300	2,100	4.67
3	2	550	800	1,950	2,750	5.00
4	2	600	800	2,600	3,400	5.67
5	2	625	800	3,250	4,050	6.48
6	2	640	800	3,900	4,700	7.34

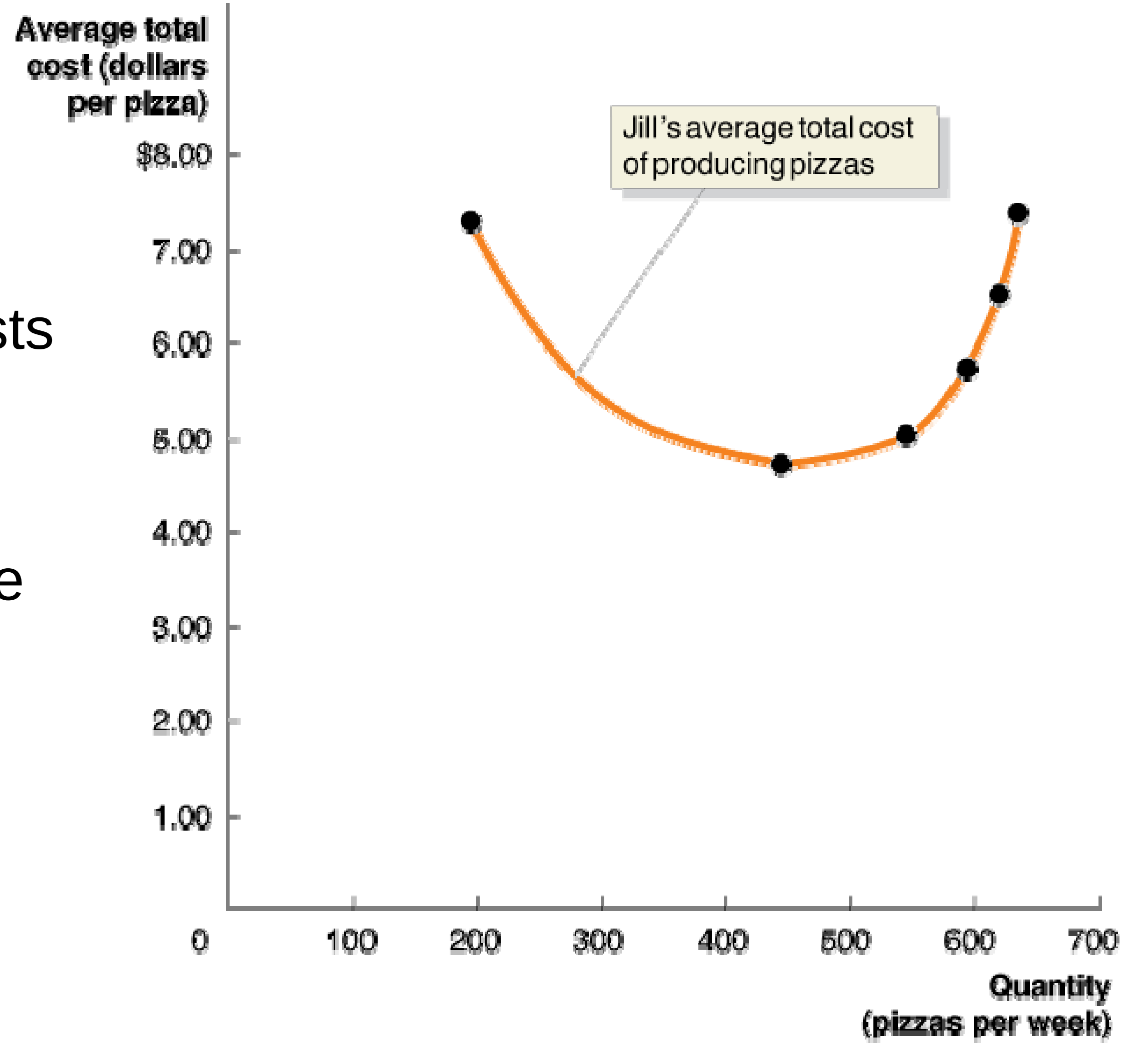
If we divide the total cost of the pizzas by the number of pizzas, we get the **average total cost** of the pizzas.

For low levels of production, the average cost falls as the number of pizzas rises; at higher levels, the average cost rises as the number of pizzas rises.

Figure 11.1 Graphing total cost and average total cost at Jill Johnson's restaurant (1 of 2)

The "falling-then-rising" nature of average total costs results in a U-shaped average total cost curve.

Our next task is to examine *why* we get this shape for average total costs.



(b) Average total cost

11.3 The Marginal Product of Labor and the Average Product of Labor

Understand the relationship between the marginal product of labor and the average product of labor

Suppose Jill Johnson hires just one worker; what does that worker have to do?

- Take orders
- Make and cook the pizzas
- Take pizzas to the tables
- Run the cash register, etc.

By hiring another worker, these tasks could be divided up, allowing for some *specialization* to take place, resulting from the *division of labor*.

Two workers can probably produce more output per worker than one worker can alone.

Table 11.3 The marginal product of labor at Jill Johnson's restaurant (1 of 2)

Quantity of Workers	Quantity of Pizza Ovens	Quantity of Pizzas	Marginal Product of Labor
0	2	0	—
1	2	200	200
2	2	450	250
3	2	550	100
4	2	600	50
5	2	625	25
6	2	640	15

Let's examine what happens as Jill Johnson hires more workers.

To think about this, consider the **marginal product of labor**: the additional output a firm produces as a result of hiring one more worker.

- The first worker increases output by 200 pizzas; the second increases output by 250.

Table 11.3 The marginal product of labor at Jill Johnson's restaurant (2 of 2)

Quantity of Workers	Quantity of Pizza Ovens	Quantity of Pizzas	Marginal Product of Labor
0	2	0	—
1	2	200	200
2	2	450	250
3	2	550	100
4	2	600	50
5	2	625	25
6	2	640	15

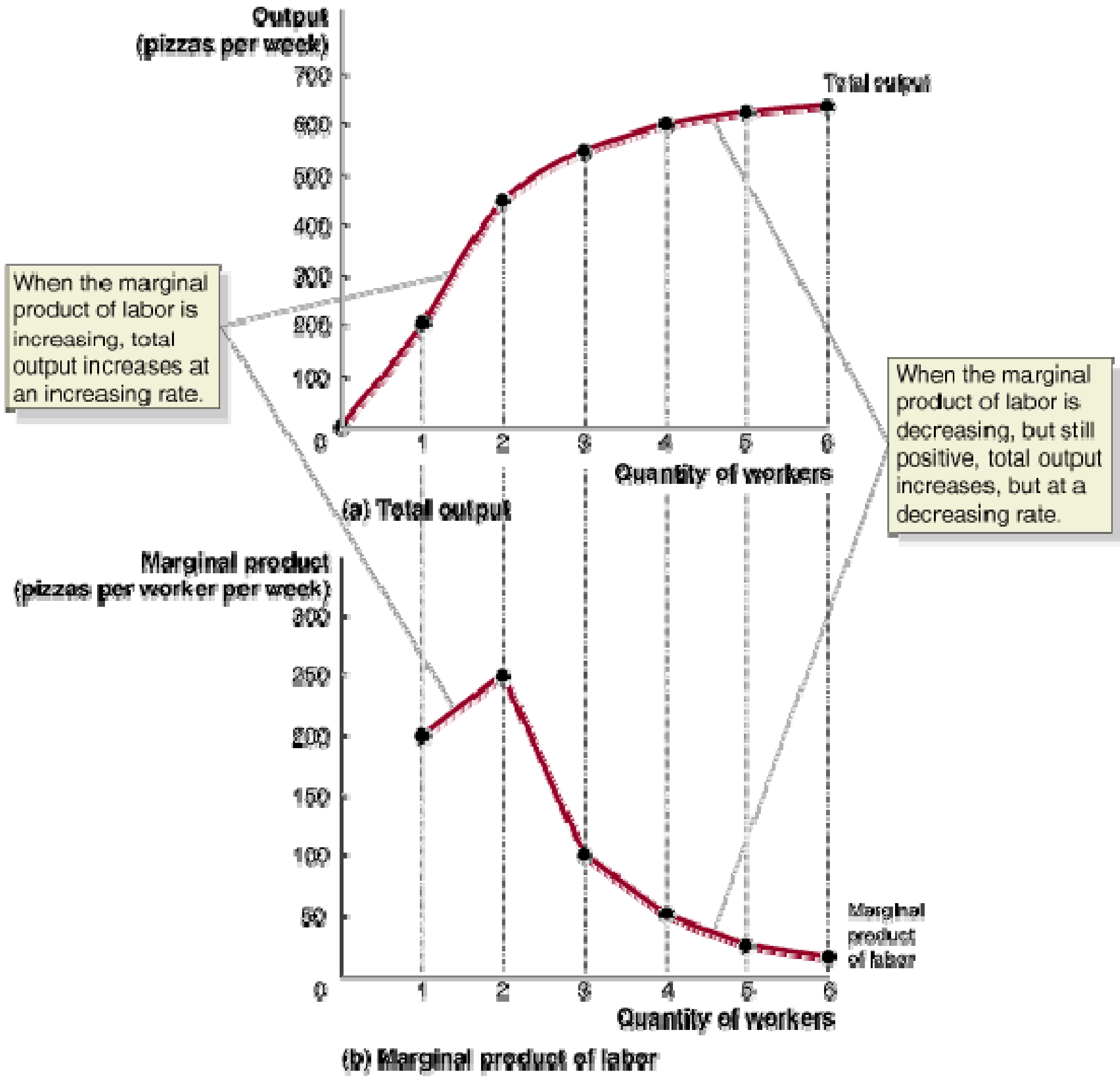
Additional workers add to the potential output, but not by as much. Eventually they start getting in each other's way, etc., because there is only a fixed number of pizza ovens, cash registers, etc.

Law of diminishing returns: At some point, adding more of a variable input, such as labor, to the same amount of a fixed input, such as capital, will cause the marginal product of the variable input to decline.

Figure 11.2 Total output and the marginal product of labor

Graphing the output and marginal product against the number of workers allows us to see the law of diminishing returns more clearly.

The output curve flattening out, and the decreasing marginal product curve, both illustrate the law of diminishing returns.



Average product of labor

Another useful indication of output is the **average product of labor**, calculated as the total output produced by a firm divided by the quantity of workers.

- With 3 workers, the restaurant can produce 550 pizzas, giving an average product of labor of:

$$\frac{550}{3} = 183.3$$

A useful way to think about this is that *the average product of labor is the average of the marginal products of labor*.

- The first three workers give 200, 250, and 100 additional pizzas respectively:

$$\frac{200 + 250 + 100}{3} = 183.3$$

Average and marginal product of labor

With only two workers, the average product of labor was:

$$\frac{200 + 250}{2} = \frac{450}{2} = 225$$

So the third worker made the average product of labor go down.

- This happened because the third worker produced *less (marginal) output than the average of the previous workers*.

If the next worker produces more (marginal) output than the average, then the average product will rise instead.

- The next slide illustrates this idea using college grade point averages (GPAs).

Figure 11.3 Marginal and average GPAs

Paul's semester GPA starts off poorly, rises, then eventually falls in his senior year.

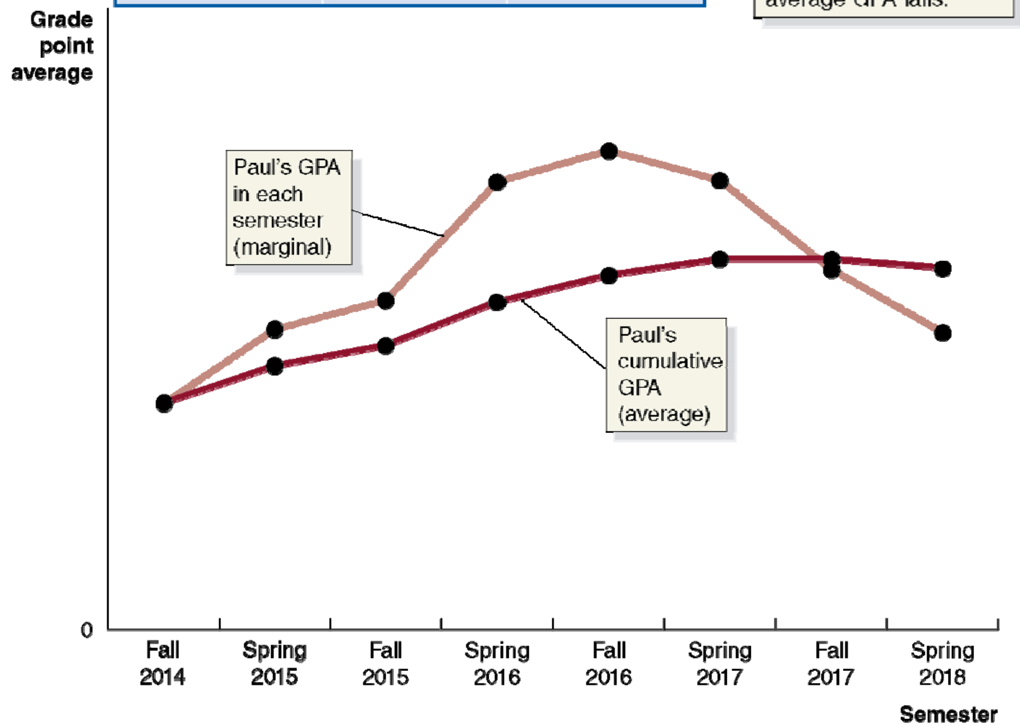
His cumulative GPA follows his semester GPA upward, as long as the semester GPA is higher than the cumulative GPA.

When his semester GPA dips down below the cumulative GPA, the cumulative GPA starts to head down also.

	Semester GPA (marginal GPA)	Cumulative GPA (average GPA)
First year		
Fall	1.50	1.50
Spring	2.00	1.75
Sophomore year		
Fall	2.20	1.90
Spring	3.00	2.18
Junior year		
Fall	3.20	2.38
Spring	3.00	2.48
Senior year		
Fall	2.40	2.47
Spring	2.00	2.41

Average GPA continues to rise, although marginal GPA falls.

With the marginal GPA below the average, the average GPA falls.



11.4 The Relationship between Short-Run Production and Short-Run Cost

Explain and illustrate the relationship between marginal cost and average total cost

We have already seen the *average total cost*: total cost divided by output.

We can also define the **marginal cost** as the change in a firm's total cost from producing one more unit of a good or service:

$$MC = \frac{\Delta TC}{\Delta Q}$$

Sometimes $\Delta Q = 1$, so we can ignore the bottom line; but don't get in the habit of doing that, or you'll make mistakes when quantity changes by more than 1 unit.

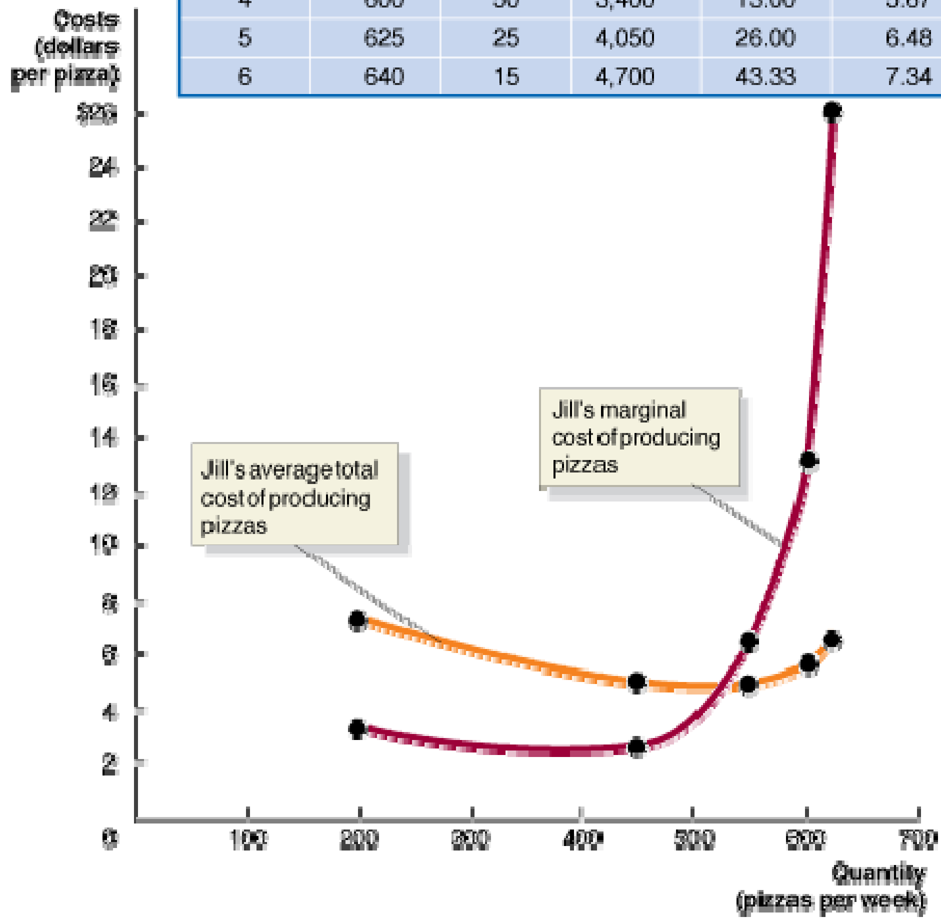
Figure 11.4 Jill Johnson's marginal cost and average cost of producing pizzas

We can visualize the average and marginal costs of production with a graph.

The first two workers increase average production, and cause cost per unit to fall; the next four workers are less productive, resulting in high marginal costs of production.

Since the average cost of production "follows" the marginal cost down and then up, this generates a U-shaped average cost curve.

Quantity of Workers	Quantity of Pizzas	Marginal Product of Labor	Total Cost of Pizzas	Marginal Cost of Pizzas	Average Total Cost of Pizzas
0	0	–	$800	–	–
1	200	200	1,450	$3.25	$7.25
2	450	250	2,100	2.60	4.67
3	550	100	2,750	6.50	5.00
4	600	50	3,400	13.00	5.67
5	625	25	4,050	26.00	6.48
6	640	15	4,700	43.33	7.34



11.5 Graphing Cost Curves

Graph average total cost, average variable cost, average fixed cost, and marginal cost

We know that total costs can be divided into fixed and variable costs:

$$TC = FC + VC$$

Dividing both sides by output (*Q*) gives a useful relationship:

$$TC / Q = FC / Q + VC / Q$$

- The first quantity is *average total cost*.
- The second is **average fixed cost**: fixed cost divided by the quantity of output produced.
- The third is **average variable cost**: variable cost divided by the quantity of output produced.

So $ATC = AFC + AVC$

Figure 11.5 Costs at Jill Johnson's restaurant (1 of 2)

Quantity of Workers	Quantity of Ovens	Quantity of Pizzas	Cost of Ovens (fixed cost)	Cost of Workers (variable cost)	Total Cost of Pizzas	*ATC*	*AFC*	*AVC*	*MC*
0	2	0	$800	$0	$800	–	–	–	–
1	2	200	800	650	1,450	$7.25	$4.00	$3.25	$3.25
2	2	450	800	1,300	2,100	4.67	1.78	2.89	2.60
3	2	550	800	1,950	2,750	5.00	1.45	3.54	6.50
4	2	600	800	2,600	3,400	5.67	1.33	4.33	13.00
5	2	625	800	3,250	4,050	6.48	1.28	5.20	26.00
6	2	640	800	3,900	4,700	7.34	1.25	6.09	43.33

Observe that:

- In each row, *ATC* = *AFC* + *AVC.*
- When *MC* is above *ATC*, *ATC* is falling.
- When *MC* is above *ATC*, *ATC* is rising.
- The same is true for *MC* and *AVC*.

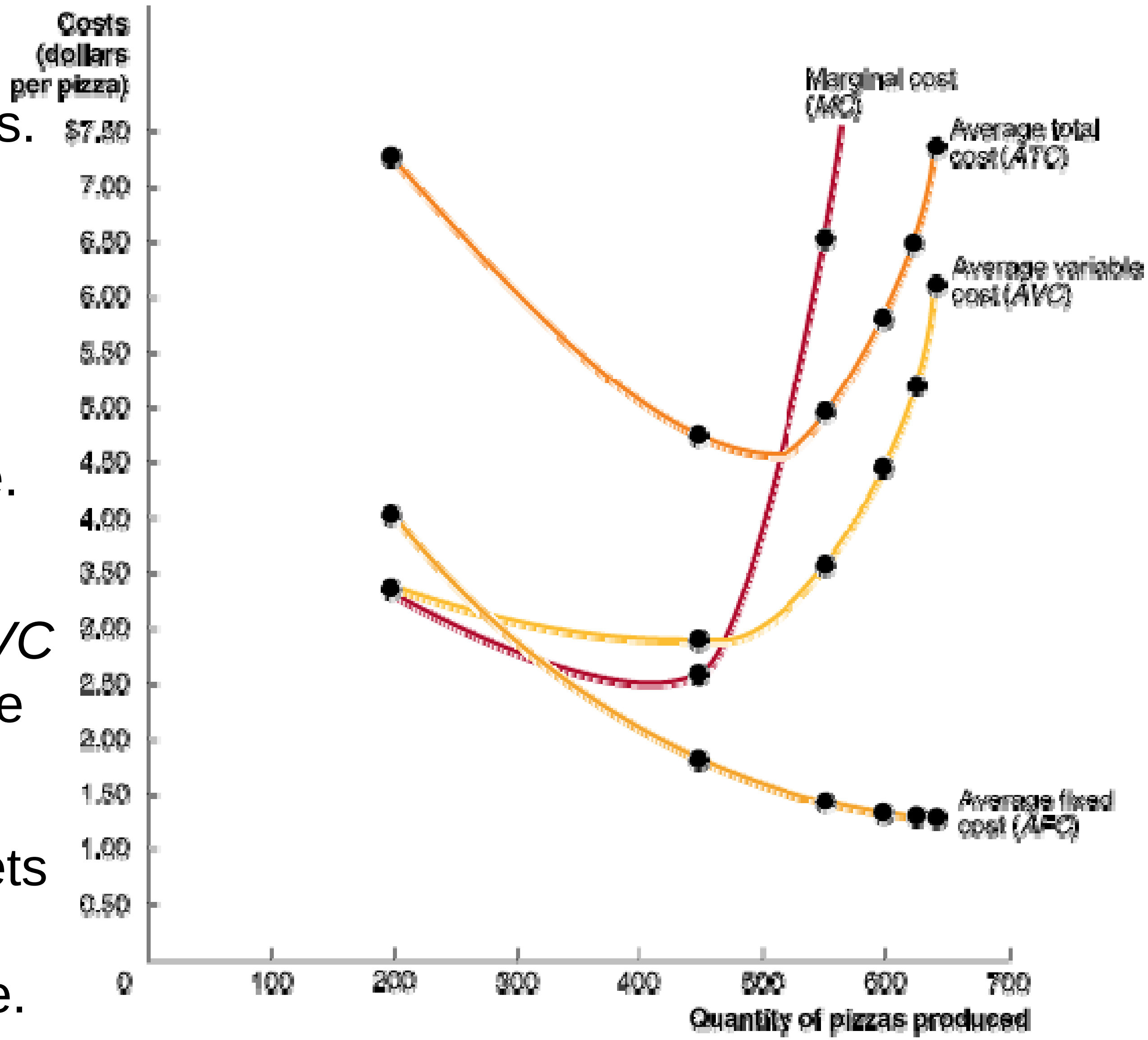
Figure 11.5 Costs at Jill Johnson's restaurant (2 of 2)

This results in both *ATC* and *AVC* having their U-shaped curves.

The *MC* curve cuts through each at its minimum point, since both *ATC* and *AVC* "follow" the *MC* curve.

Also notice that the vertical sum of the *AVC* and *AFC* curves is the *ATC* curve.

And because *AFC* gets smaller, the *ATC and AVC* curves converge.



11.6 Costs in the Long Run

Understand how firms use the long-run average cost curve in their planning

Recall that the long run is a sufficiently long period of time that all costs are variable.

- So In the long run, there is no distinction between fixed and variable costs.

A **long-run average cost curve** shows the lowest cost at which a firm is able to produce a given quantity of output in the long run, when no inputs are fixed.

Figure 11.6 The relationship between short-run average cost and long-run average cost (1 of 3)

At low quantities, a firm might experience **economies of scale**: the firm's long-run average costs falling as it increases the quantity of output it produces.

Here, a small car factory can produce at a lower average cost than a large one, for small quantities. For more output, a larger factory is more efficient.

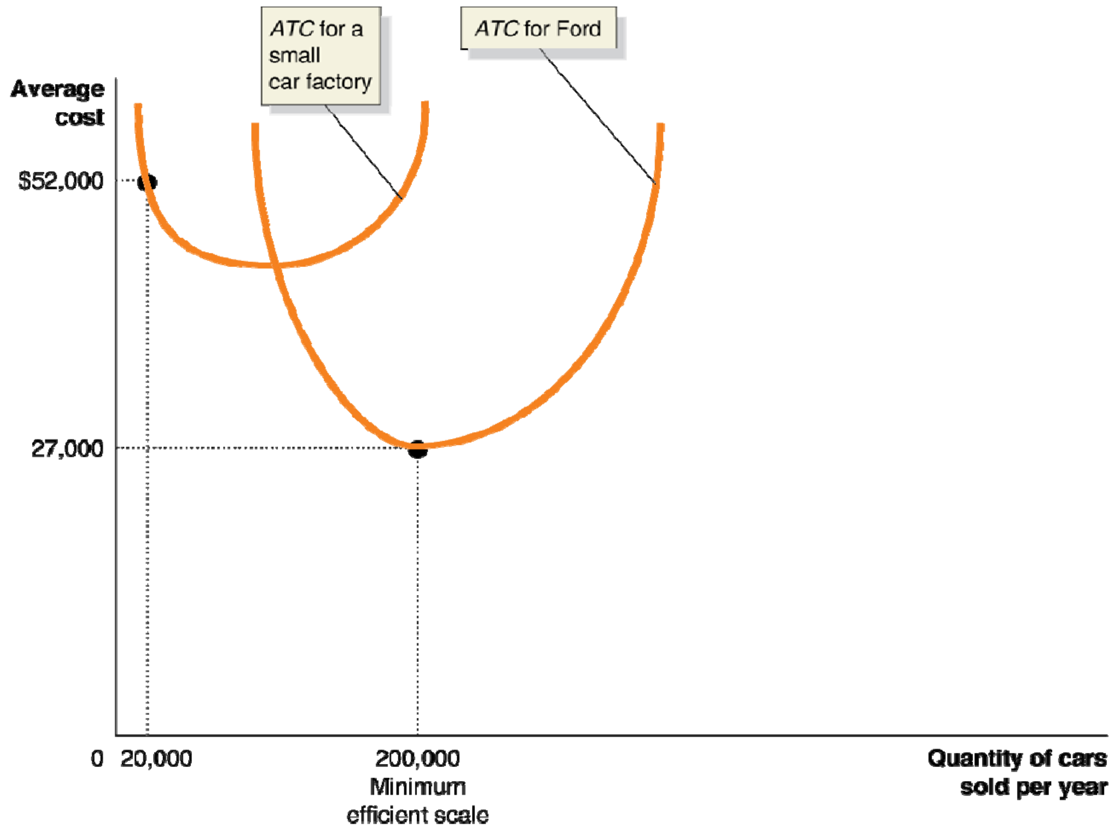


Figure 11.6 The relationship between short-run average cost and long-run average cost (2 of 3)

The lowest level of output at which all economies of scale are exhausted is known as the **minimum efficient scale**.

At some point, growing larger does not allow more economies of scale. The firm experiences **constant returns to scale**: its long-run average cost remains unchanged as it increases output.

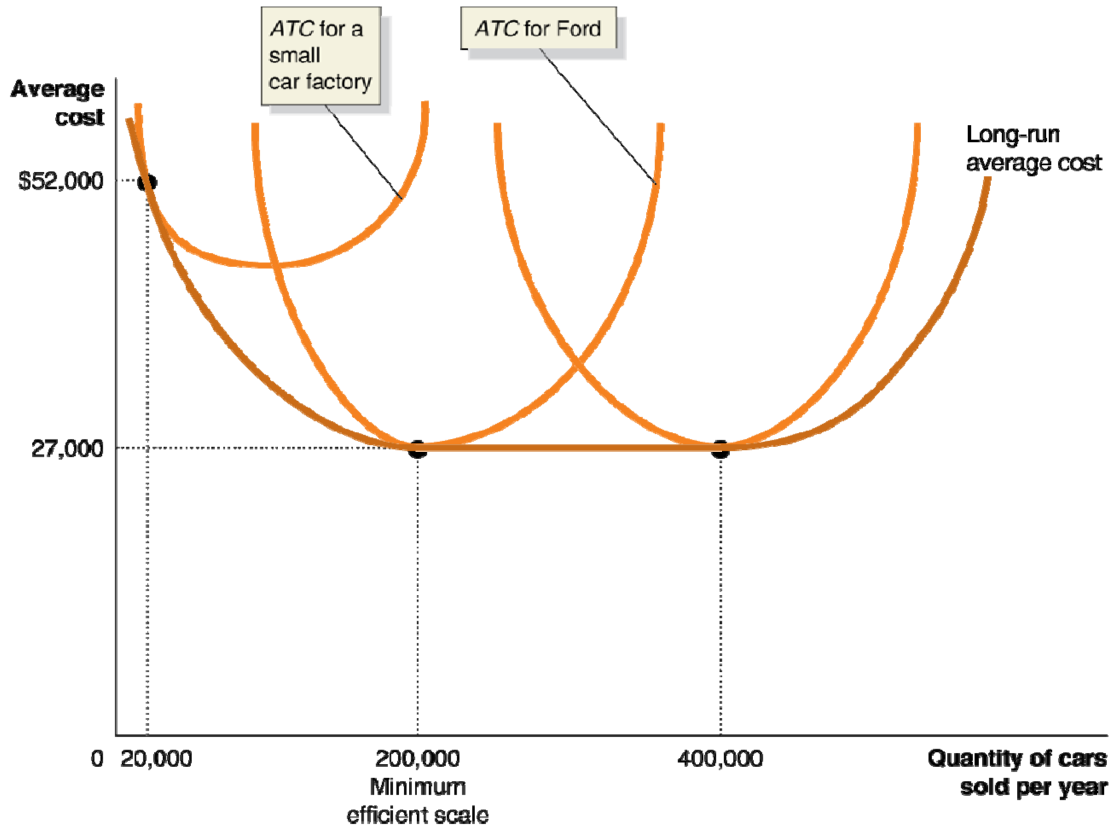
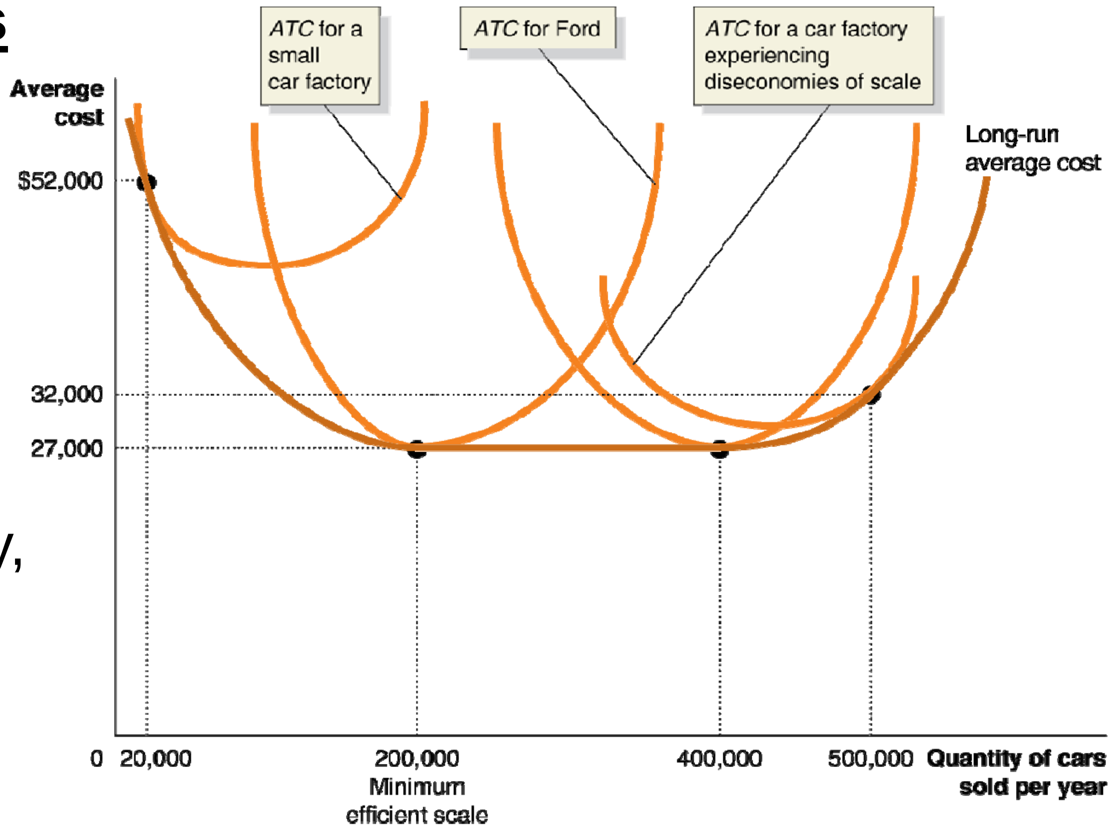


Figure 11.6 The relationship between short-run average cost and long-run average cost (3 of 3)

Eventually, firms might get so large that they experience **diseconomies of scale**: a situation in which a firm's long-run average costs rise as the firm increases output.

This might happen because the firm gets to large to manage effectively, or because the firm has to employ workers or other factors of production that are less well suited to production.



Long-run average cost curves for automobile factories

Why might a car company experience economies of scale?

- Production might increase at a greater-than-proportional rate as inputs increase.
- Having more workers can allow specialization.
- Large firms may be able to purchase inputs at lower prices.

But economies of scale will not last forever.

- Eventually managers may have difficulty coordinating huge operations.

“Demand for… high volumes saps your energy. Over a period of time, it eroded our focus… [and] thinned out the expertise and knowledge we painstakingly built up over the years.”

- President of Toyota’s Georgetown plant

Making the Connection: Diseconomies of scale at Ford Motor Company

Henry Ford is well known for his successes producing cars on an assembly line, allowing division of labor to help achieve economies of scale.

Hoping to build on this, Ford built an enormous industrial complex along the River Rouge in Dearborn, Michigan, to produce the Model A.

The Model A lost money for Ford, because the River Rouge complex was too large to allow efficient production, producing a disconnect between workers and management.

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Table 11.4 A summary of definitions of cost

Term	Definition	Symbols and Equations
Total cost	The cost of all the inputs used by a firm, or fixed cost plus variable cost	TC
Fixed costs	Costs that remain constant as a firm's level of output changes	FC
Variable costs	Costs that change as a firm's level of output changes	VC
Marginal cost	An increase in total cost resulting from producing another unit of output	$MC = \frac{\Delta TC}{\Delta Q}$
Average total cost	Total cost divided by the quantity of output produced	$ATC = \frac{TC}{Q}$
Average fixed cost	Fixed cost divided by the quantity of output produced	$AFC = \frac{FC}{Q}$
Average variable cost	Variable cost divided by the quantity of output produced	$AVC = \frac{VC}{Q}$
Implicit cost	A nonmonetary opportunity cost	—
Explicit cost	A cost that involves spending money	—

Appendix: Using Isoquants and Isocost Lines to Understand Production and Cost

Use isoquants and isocost lines to understand production and cost

Suppose a firm has determined it wants to produce a particular level of output. What determines the cost of that output?

1. Technology

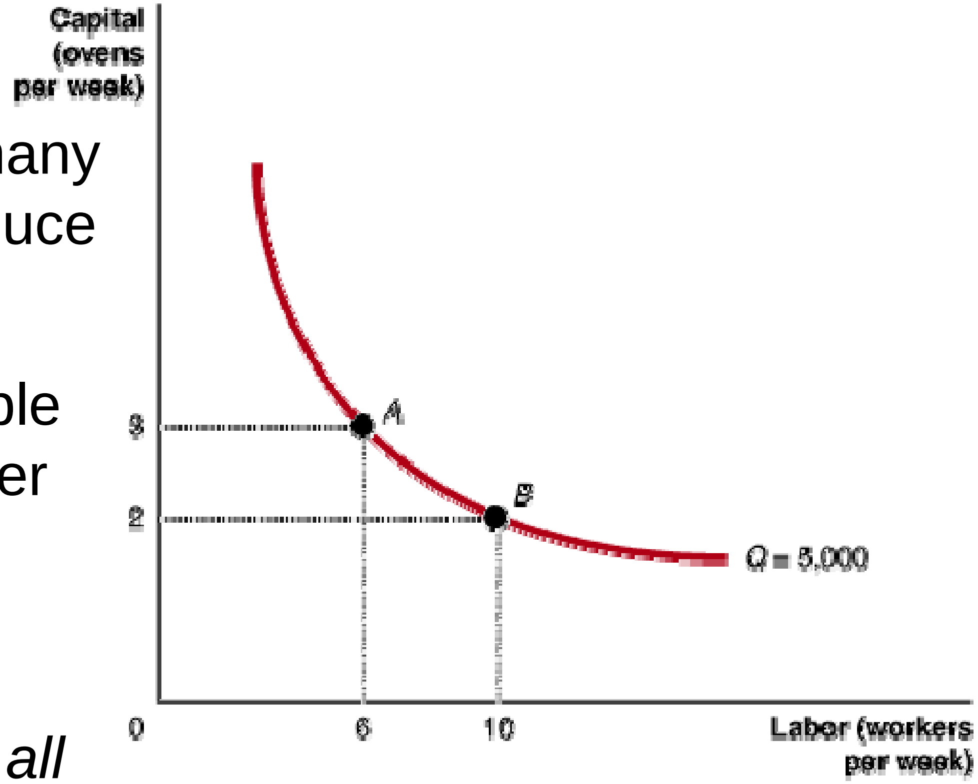
In what ways can inputs be combined to produce output?

2. Input prices

What is the cost of each input compared with the other? That is, what is the *relative price* of each input?

Figure 11A.1 Isoquants (1 of 3)

If a firm's technology allows one input to be substituted for the other in order to maintain the same level of production, then many combinations of inputs may produce the same level of output.



The pizza restaurant might be able to produce 5000 pizzas with either

- 6 workers and 3 ovens; or
- 10 workers and 2 ovens.

An ***isoquant*** is a curve showing *all* combinations of two inputs, such as capital and labor, that will produce the same level of output.

Figure 11A.1 Isoquants (2 of 3)

More inputs would allow a higher level of production; with 12 workers and 4 ovens, the restaurant could produce 10,000 pizzas.

A new isoquant describes all combinations of inputs that could produce 10,000 pizzas.

Greater production would require more inputs.

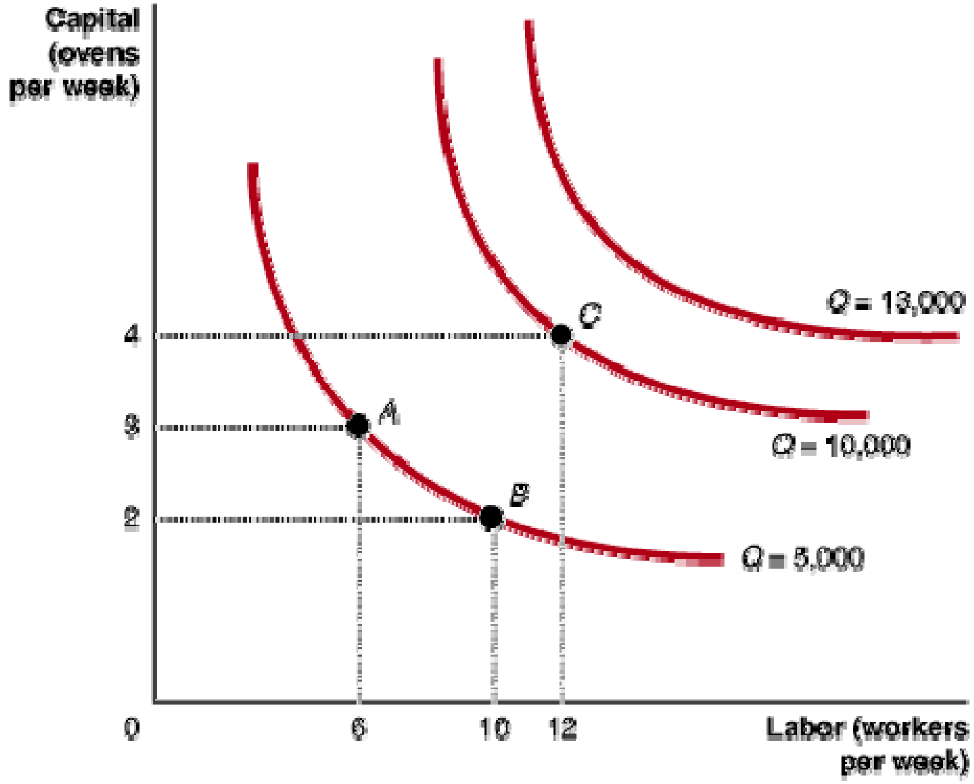


Figure 11A.1 Isoquants (2 of 3)

The slope of an isoquant describes how many units of capital are required to compensate for a unit of labor, keeping production constant.

- This is the **marginal rate of technical substitution**.

Between *A* and *B*, 1 oven can compensate for 4 workers; the MRTS=1/4.

Additional workers are poorer and poorer substitutes for capital, due to diminishing returns; so the MRTS gets smaller as we move along the isoquant, giving a convex shape.

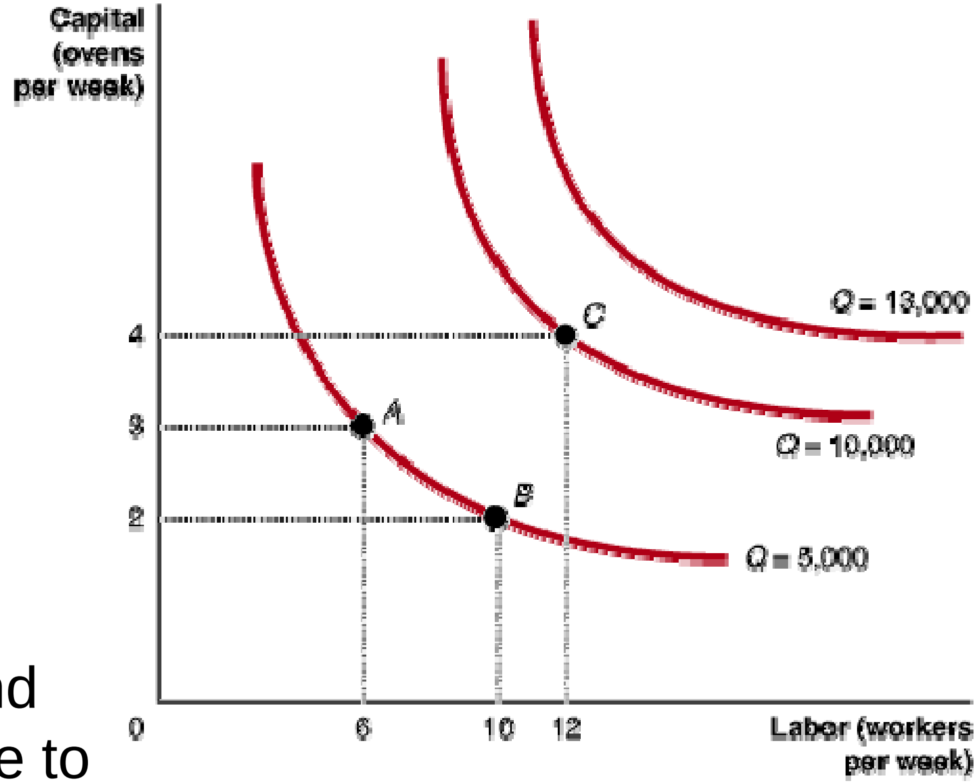


Figure 11A.2 An isocost line

For a given cost, various combinations of inputs can be purchased.

The table shows combinations of ovens and workers that could be produced with $6000, if ovens cost $1000 and workers cost $500.

<u>Isocost line</u>: All the combinations of two inputs, such as capital and labor, the have the same total cost.

Combinations of Workers and Ovens with a Total Cost of $6,000

Point	Ovens	Workers	Total Cost
A	6	0	(6 x $1,000) + (0 x $500) = $6,000
B	5	2	(5 x $1,000) + (2 x $500) = 6,000
C	4	4	(4 x $1,000) + (4 x $500) = 6,000
D	3	6	(3 x $1,000) + (6 x $500) = 6,000
E	2	8	(2 x $1,000) + (8 x $500) = 6,000
F	1	10	(1 x $1,000) + (10 x $500) = 6,000
G	0	12	(0 x $1,000) + (12 x $500) = 6,000

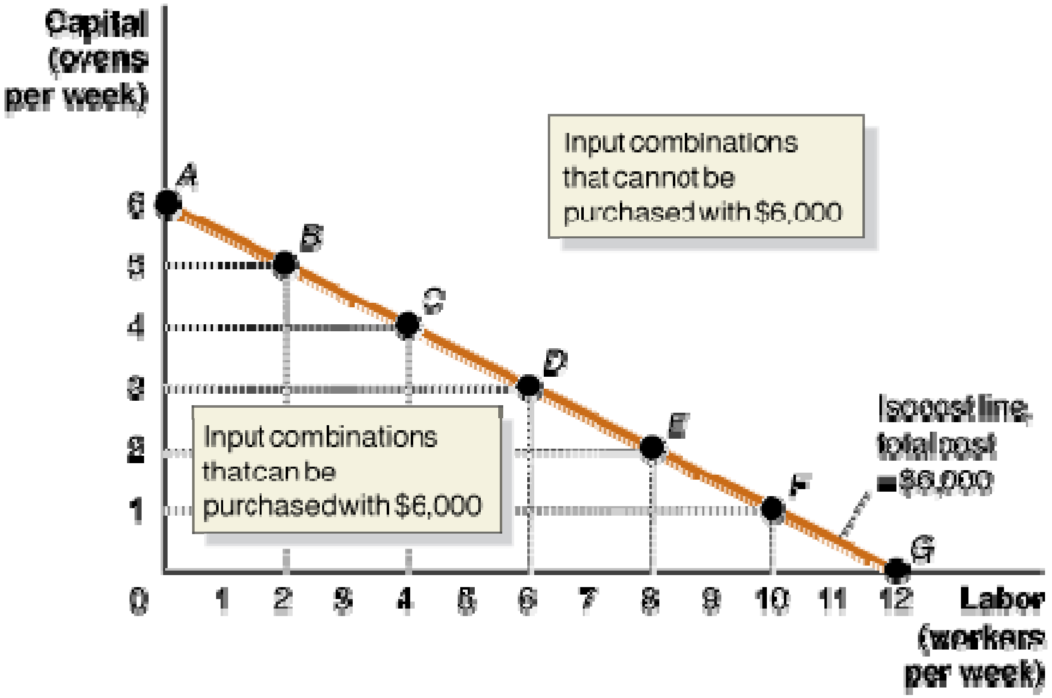


Figure 11A.3 The position of the isocost line

With more money, more inputs can be purchased.

The slope of the isocost line remains constant, because it is always equal to the *price of the input on the horizontal axis divided by the price of the input on the vertical axis, multiplied by -1.*

The slope indicates the rate at which prices allow one input to be traded for the other: here, 1 oven costs the same as 2 workers:

slope = -1/2.

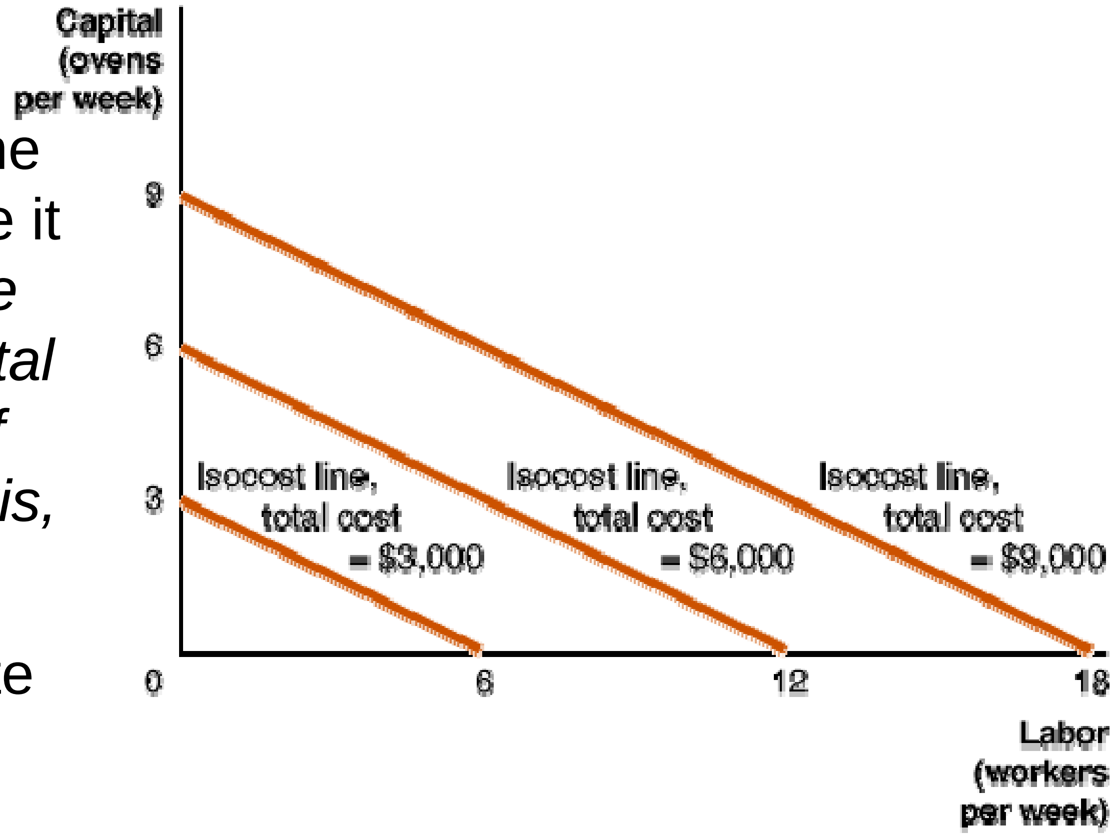
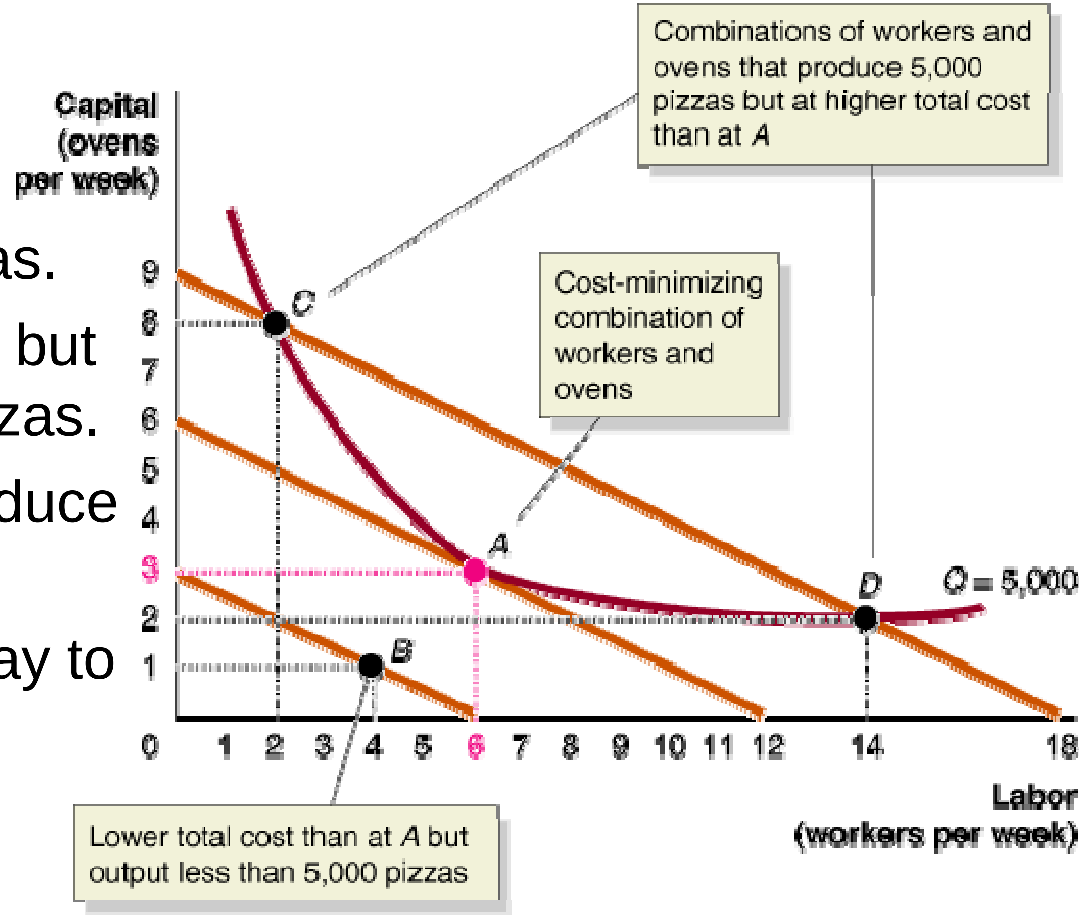


Figure 11A.4 Choosing capital and labor to minimize total cost

Suppose the restaurant wants to produce 5000 pizzas.

- Point B costs only $3000, but doesn't produce 5000 pizzas.
- Points A, C, and D all produce 5000 pizzas.
- Point A is the cheapest way to produce 5000 pizzas; the isocost line going through it is the lowest.



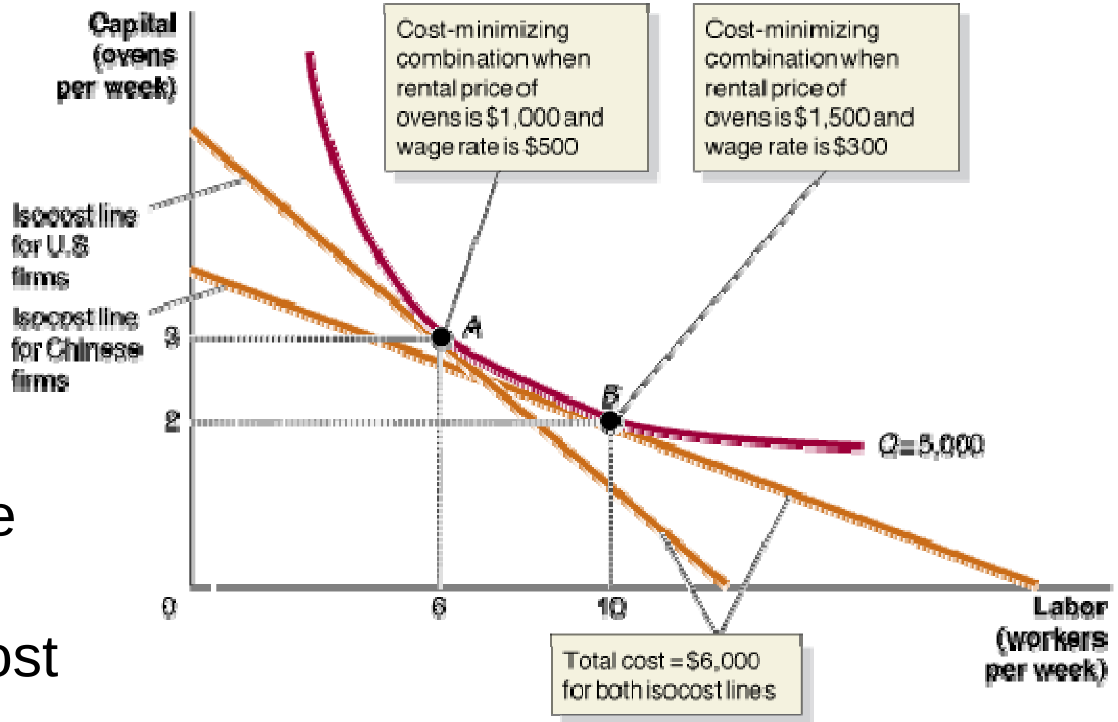
Observe that at this point, the slope of the isoquant and isocost line are equal.

Figure 11A.5 Changing input prices affects the cost-minimizing input choice

If prices change, so does the cost-minimizing combination of capital and labor.

Suppose we open a pizza franchise in China, where ovens are more expensive ($1500) and workers are cheaper ($300). The isocost lines are now flatter.

To obtain the same level of production, we would *substitute* toward the input that is now relatively cheaper: workers.



Another look at cost minimization

We observed that at the minimum cost level of production, the slopes of the isocost line and the isoquant were equal.

Generally, writing labor as *L* and capital as *K*, we have:

$$\text{Slope of isoquant} = -MRTS = -\frac{P_L}{P_K} = \text{Slope of isocost line}$$

So at the cost-minimizing level of production, $MRTS = P_L/P_K$.

- The MRTS tells us the rate at which a firm is able to substitute labor for capital, *given existing technology*.
- The slope of the isocost line tells us the rate at which a firm is able to substitute labor for capital, *given current input prices*.
- These are equal at the cost-minimizing level of production, but there is no reason they should be equal elsewhere.

Moving along an isoquant (1 of 2)

Suppose we move between two points on an isoquant, increasing labor and decreasing the capital used.

When we increase labor, we increase production by the number of workers we add, times their marginal production:

$$\text{Change in quantity of workers} \times MP_L$$

We can interpret the reduction in output from reducing capital in the same way: it is equal to the amount of capital we remove, times the marginal production of that capital:

$$-\text{Change in quantity of capital} \times MP_K$$

Moving along an isoquant (2 of 2)

Since we are moving along an isoquant, production stays constant

- So the decrease in output from using less capital must exactly equal the increase in output from increasing labor:

$$-\text{Change in quantity of capital} \times MP_K = \text{Change in quantity of workers} \times MP_L$$

Rearranging this equation gives:

$$\frac{-\text{Change in the quantity of capital}}{\text{Change in the quantity of workers}} = \frac{MP_L}{MP_K}$$

The left hand side is the slope of the isoquant: the *MRTS*. So:

$$MRTS = \frac{MP_L}{MP_K}$$

Optimality condition for a firm

The slope of the isocost line is the wage rate (*w*) divided by the rental price of capital (*r*). Earlier in the appendix, we showed that at the cost-minimizing point,

$$MRTS = \frac{w}{r}$$

So now we know that at the cost-minimizing point:

$$\frac{MP_L}{MP_K} = \frac{w}{r}$$

Rearranging gives us:

$$\frac{MP_L}{w} = \frac{MP_K}{r}$$

Interpreting the firm's optimality condition

$$\frac{MP_L}{w} = \frac{MP_K}{r}$$

At the cost-minimizing input combination, the marginal output of the last dollar spent on labor should be equal to the marginal output of the last dollar spent on capital.

We could use this idea to determine whether a firm was producing efficiently or not: if an extra dollar spent on capital produced more (less) output than an extra dollar spent on labor, then the firm is *not* minimizing costs; it could:

- increase (decrease) capital, and
- decrease (increase) labor,

maintaining the same level of output and lowering cost.

Making the Connection: Do NFL teams behave efficiently?

NFL teams face a salary cap, and try to maximize wins subject to this total cost.

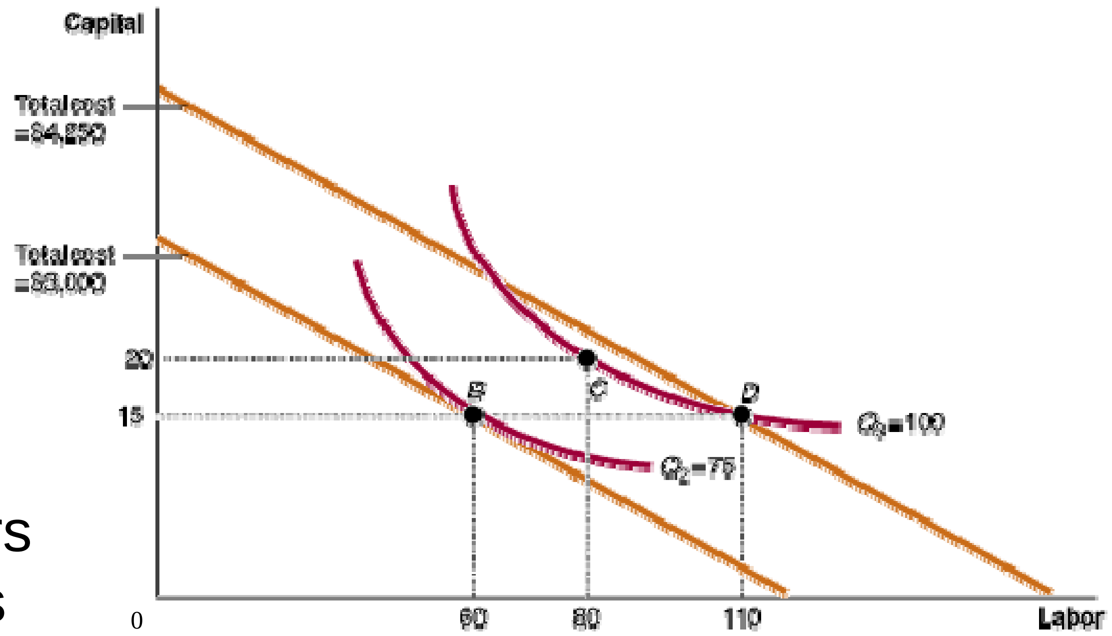
Teams face an important choice between trying to win with veterans or rookies. If the teams are optimizing, the marginal productivity per dollar spent on each type of player should be equal.

Economists Cade Massey and Richard Thaler found that teams were over-spending on high draft picks; they attributed this to NFL general managers being *overconfident* in their ability to spot NFL-level talent among college players.

Figure 11A.6 The expansion path (1 of 2)

A bookcase manufacturing firm produces 75 bookcases a day, using 60 workers and 15 machines.

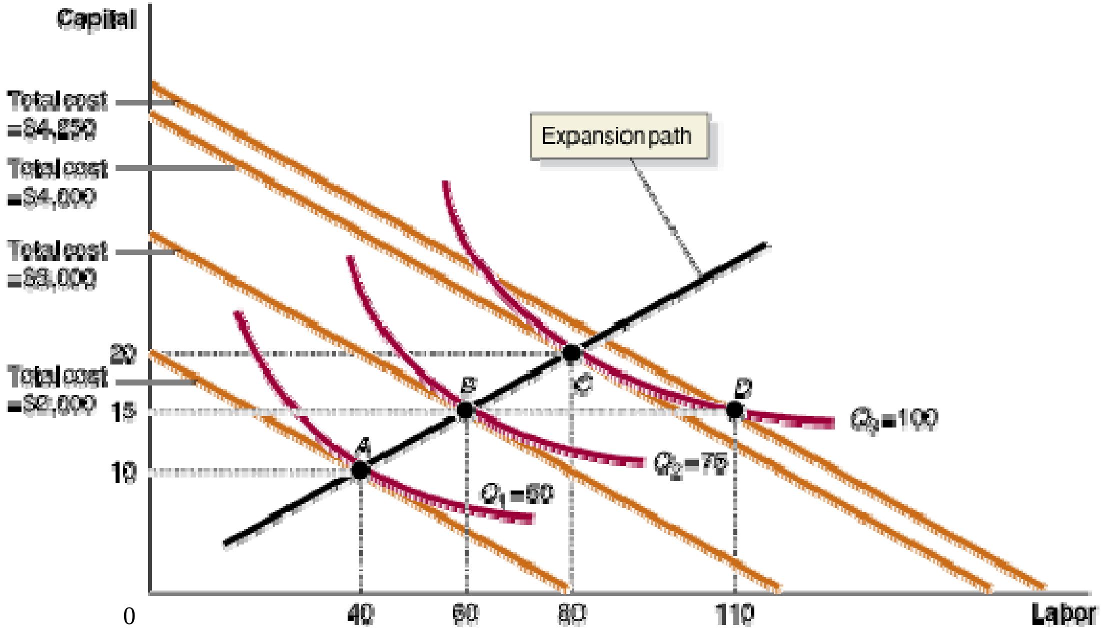
In the short run, if the firm wants to expand production to 100 bookcases, it must do so by employing more workers only; the number of machines is fixed.



Notice that there is are lower-cost combination of inputs (like point C) that would produce 100 bookcases; in the long run, the firm will switch to one of those.

Figure 11A.6 The expansion path (2 of 2)

Point C is a combination on the long-run **expansion path** for the firm: a curve that shows the firm's cost-minimizing combination of inputs for every level of output.



We can tell because the isocost line and isoquant are tangent at point C.

Point A minimizes costs for a lower quantity (50).

The expansion path is the set of all cost-minimizing bundle, given a particular set of input prices.