Lecture 9: Costs

October 24, 2023

Course Administration

1. Problem Set 8 posted
2. Use Numbers 3 posted

Course Administration

1. Problem Set 8 posted
2. Use Numbers 3 posted
3. Midterm return and curve next slide
4. Any questions?

Midterm Results

Score $>$	Score $\leq$	Grade	Number
50	59	B-	4
60	69	B	3
70	79	B+	1
80	89	A-	3
90	99	A	3

- If you are on the border of a letter grade, I round up
- If you got an A and are willing to volunteer to help a student, email me
- If you got a B- or below and would like a student partner, please let me know
- Nov. 6, 10:30 to 11:30 am: midterm review – come to ask questions

Next Week: Ripped from the Headlines

Send article by Wednesday midnight.

Finder	Presenter
Emily	Vanea

This Week: Ripped from the Headlines

Finder	Presenter
Trenton	Kari

Costs

- Basics and assumptions
- Short run
- Long run
- Cost minimization
- Economies of scale, returns to scale, returns to scope
- Total cost

Costs and Policymakers

Why Should Policymakers Care About Firm Costs?

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  - see recent subsidies for computer chip industry
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- Government is frequently a producer itself
  - how many fighter aircraft do we need to provide defense?

Economic Costs vs. Accounting Costs

Economic Costs vs. Accounting Costs

- Accounting cost $\equiv$ direct cost
- Opportunity cost $\equiv$ cost of what you give up by using an input
  - Perhaps most easily thought of as next best opportunity for funds
  - What's the opportunity cost of pursuing a MPP?

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Economic cost $\equiv$ accounting cost $+$ opportunity cost

Opportunity Cost in Policy Action: VW Fraud

- 2008 to 2015, VW markets "Clean Diesel" low emissions technology
- But vehicles have "defeat device" that gives low emissions for tests only
- Federal Trade Commission has to figure out how much VW should pay consumers
- Usually rely on "replacement cost" but that doesn't work here because there is no replacement for this non-existing product

Use Opportunity Cost to Value Damage

- Before fraud was revealed, consumers had a high level surplus from VW clean diesel
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- FTC's components of consumer injury
  1. Lost opportunity to avoid excess pollution
  2. Price premium for clean emissions – via comparison to other vehicle
  3. For those who choose emissions repair, compensation for performance reduction
  4. Additional transaction costs from this remedy

Thanks to Mary Sullivan for this example, and find FTC report here.

Opportunity Costs in Government

Newsletters *The Atlantic*

IDEAS

Buses Shouldn't Be Free

The push for fareless transit is downstream of a larger failure: American urban elected officials have struggled to improve government services, especially infrastructure development.

By Jerusalem Demsas

- Late 2022 DC council considered making WMATA buses free in the city
- Argues that transit riders care more about service than cost
- Cutting fares has an opportunity cost – what is it?

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- Argues that transit riders care more about service than cost
- Cutting fares has an opportunity cost – what is it?
- "Focusing on zero-dollar rides is like overseeing a library system stocked solely with out-of-date self-help books in crumbling buildings and wondering if a fresh coat of paint will improve morale."

"Buses Shouldn't Be Free," *The Atlantic*, December 9, 2022. [link]

Sunk Costs

Defining Sunk Costs

- Firm has some fixed costs
- If the firm went bankrupt, some of those costs could be recovered
- The non-recoverable part of the fixed costs is called "sunk" – or sunk costs
- Examples?

Now that the Costs are Sunk

- When costs are sunk, they should not enter into future business decisions
- Making decisions based on sunk costs is known as the "sunk cost fallacy"
- Decisions should be forward-looking: sunk costs are gone

Waterworld and Sunk Costs

Or Iraq/Afghanistan Invasion and Sunk Costs, If You Prefer

		Costs			Ex. Profit	
Mo.	Ex. Rev.	Total	Sunk	Addt'l	Continue	No Prod.
June	150	-100	-16	-84	50	-16

[a] Two good listens on this topics are a Freakonomics podcast and a Planet Money transcript/podcast.

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- June: Ex. Profit > 0, clearly should go ahead.
- Sept.: Ex. Profit still > 0.
- Dec.: Ex. Profit < 0. Halt production? No, because alternative is loss of 140.[a]

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Fixed & Variable Costs
Cost Curves

Types of Cost

- Fixed costs $\equiv$ costs that do not depend on how much output the firm produces
- Variable costs $\equiv$ costs that do vary with the firm's output

What Determines Whether the Cost is Fixed or Variable?

Time Horizon

- Many things are fixed in the short run
- Nothing is fixed in the long run

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Other Factors

- Active rental markets can turn fixed costs into variable costs
- Long-run labor contracts can make labor a fixed, rather than variable cost

3 Key Cost Curves

- Total cost – recall the expansion path!
- Fixed cost
- Variable cost

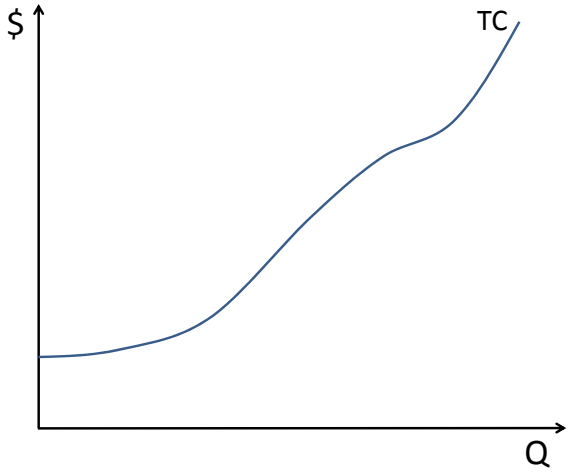
$$TC = FC + VC.$$

Drawing TC, FC and VC

What Does the Total Cost Curve Look Like?

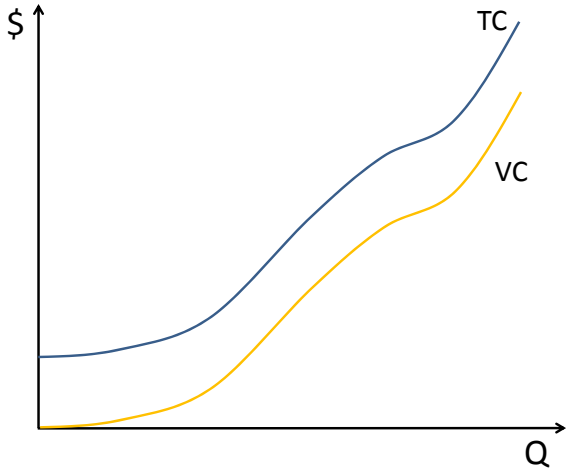
Drawing TC, FC and VC

What About the Variable Cost Curve?



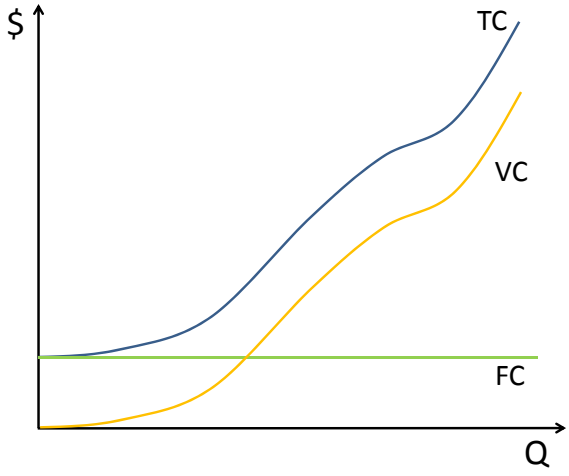
Drawing TC, FC and VC

And the Fixed Cost Curve?



Drawing TC, FC and VC

Everyone, Together



Average & Marginal Costs

Average Costs

Definitions

- Average total costs: $ATC = \frac{TC}{Q}$
- Average fixed costs: $AFC = \frac{FC}{Q}$
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- AFC

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- AVC – remember the law of diminishing returns

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What about the shapes?

- AFC
- AVC – remember the law of diminishing returns
- ATC

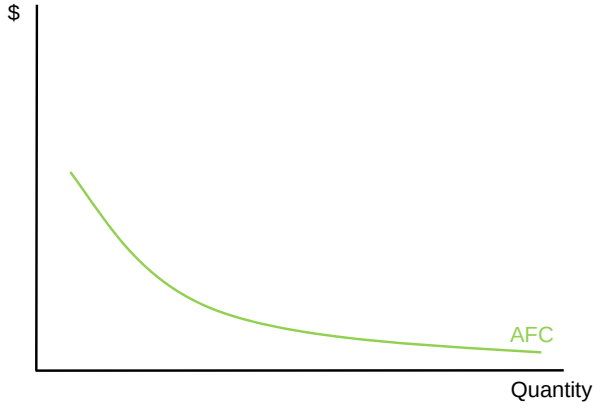
Note that because there are fixed costs, this must be the short run.

Average Costs in Pictures

What Does Average Fixed Cost Look Like?

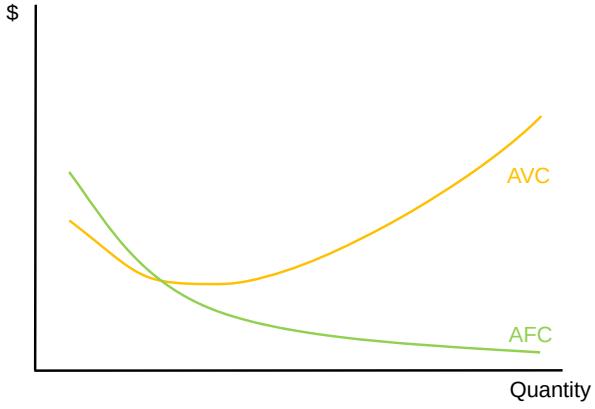
Average Costs in Pictures

What About Average Variable Costs?



Average Costs in Pictures

And Average Total Cost?



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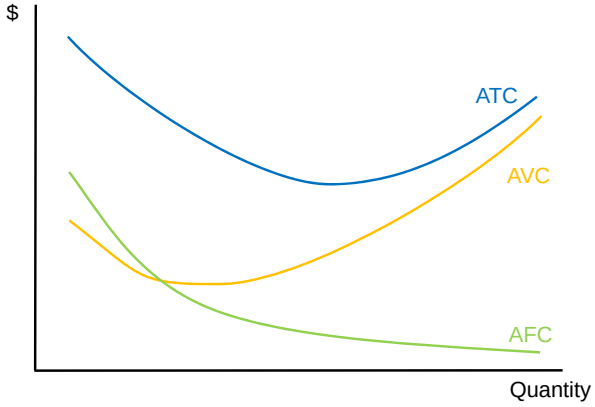
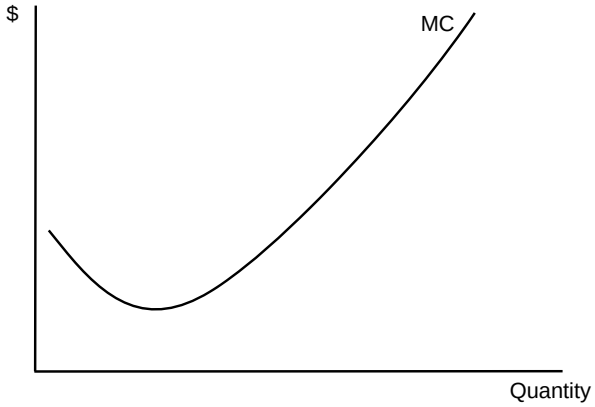
Everyone, Together



Marginal Cost

- Marginal cost $\equiv$ additional cost to produce an additional unit of output
- Without calculus, $MC = \frac{\Delta C}{\Delta Q}$, or the slope of the total cost curve
- With calculus, $MC = \frac{\partial C}{\partial Q}$
- What is its shape?

Drawing Marginal Cost



Average vs. Marginal Cost

$$ATC = \frac{TC}{Q}$$

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$$MC = \frac{\Delta C}{\Delta Q} = \left(\frac{\partial C}{\partial Q}\right)$$

- Both come from total cost
- When $MC < ATC$, what happens to average cost as Q increases?

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- When $MC > ATC$, what happens to average cost as Q increases?

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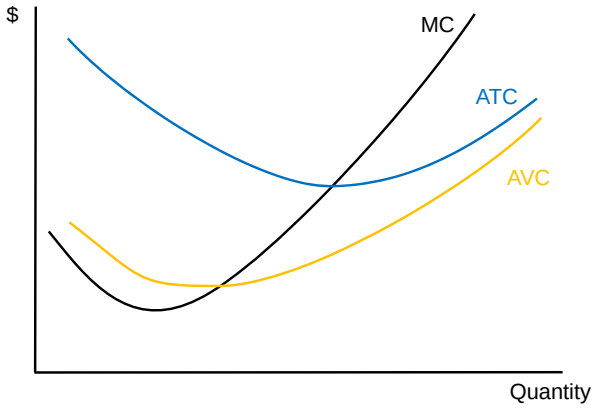
- Both come from total cost
- When $MC < ATC$, what happens to average cost as Q increases? decreases
- When $MC > ATC$, what happens to average cost as Q increases? increases
- $\rightarrow MC = AC \rightarrow AC$ must be at a minimum
- $\rightarrow MC$ curve intersects AC curve at minimum

Average and Marginal Costs



Relationship Between Costs

Use the logic of costs to figure out what's missing.

Q	TC	FC	VC	MC
0		5		
1			10	
2				8
3	28			

Relationship Between Costs

The filled in boxes.

Q	TC	FC	VC	MC
0	5	5	0	0
1	15	5	10	10
2	23	5	18	8
3	28	5	23	5

Short Run & Long Run Costs

In the long run, nothing is fixed.

Implications of No Fixed Costs in Long Run

- Long run costs are never higher than short run costs
- Long run average cost curve intersected by marginal cost curve at the same place as the short-run average cost curve (where's that?)

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- Long run costs are never higher than short run costs
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  - the minimum of the average cost curve
- But all costs in the long run are variable

An In-Class Problem: Costs

Suppose a firm's total cost curve is $TC = 10Q^2 + 6Q + 60$, and the marginal cost curve is $MC = 20Q + 6$.

1. Find an expressions for the firm's
   - 1.1 fixed cost
   - 1.2 variable cost
   - 1.3 average total cost
   - 1.4 average variable cost
2. Find the output level that minimizes average total cost.
3. Find the output level that minimizes average variable cost.
4. If $MC = 20Q + 6$ were the firm's long run marginal cost, could $MC_{SR} = 15Q + 6$ be the firm's short-run marginal cost?

In-Class Problem Answer

1. Expressions for
   - 1.1 Fixed cost: The part of output not a function of price – or costs when output is zero $\rightarrow FC = 60$
   - 1.2 Variable cost: Recall that $TC = FC + VC \rightarrow 10Q^2 + 6Q + 60 = 60 + VC$, or $VC = 10Q^2 + 6Q$
   - 1.3 Average total cost: $ATC = C/Q = 10Q + 6 + 60/Q$
   - 1.4 Average variable cost: $AVC = VC/Q = 10Q^2 + 6Q = 10Q + 6$.
2. Output level that minimizes average total cost: Recall that ATC is at a minimum where $ATC = MC \rightarrow 10Q + 6 + 60/Q = 20Q + 6$, or $10Q + 60/Q = 20Q \rightarrow 10Q = 60/Q \rightarrow 10Q^2 = 60 \rightarrow Q^2 = 6 \rightarrow Q = \sqrt{6}$
3. Output level that minimizes AVC is where $AVC = MC \rightarrow 10Q + 6 = 20Q + 6 \rightarrow 10Q = 0 \rightarrow Q = 0$. Remember that AVC increases with production.
4. We know that $MC_{SR} \geq MC_{LR}$, $15Q + 6 \leq 20Q + 6$, so, no.

Scale: Returns, Economies, and Scope

Three Separate but Related Concepts

1. Returns to scale
2. Economies of scale
3. Economies of scope

Returns to Scale

Returns to Scale $\equiv$ changes in output given a change in inputs, **where the inputs increase in fixed proportions**.

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What does "fixed proportions" mean?

- Suppose your firm uses 20 units of capital and 30 units of labor
- This is a capital-labor ratio of $\frac{20}{30}$
- Any combination of K and L that gives a ratio of $\frac{2}{3}$ is in **fixed proportions**

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- Give me some examples!

Flavors of Returns to Scale

1. Constant $\rightarrow$ outputs increase proportionately with inputs
2. Increasing $\rightarrow$ outputs increase more than proportionately with inputs
3. Decreasing $\rightarrow$ outputs increase less than proportionately with inputs

Evaluating Types of Returns to Scale

- Suppose your production function is

$$Q = 5K + L$$

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$$\begin{aligned} Q' &= 5K' + L' \\ &= 5(2K) + (2L) \\ &= 2(5K + L) \\ &= 2Q \end{aligned}$$

Evaluating Types of Returns to Scale

- Suppose your production function is

$$Q = 5K + L$$

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$$\begin{aligned} Q' &= 5K' + L' \\ &= 5(2K) + (2L) \\ &= 2(5K + L) \\ &= 2Q \end{aligned}$$

We call this constant returns to scale.

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In general, put in inputs, find Q.
Double the inputs, find Q'. Is $Q' = 2Q$? $Q' > 2Q$? $Q' < 2Q$?

What Drives Returns to Scale?

- Increasing returns
  - Fixed costs
  - Learning by doing – if the firm gets bigger and better at production by producing
- Decreasing returns
  - Regulation
  - Limited low cost/high quality inputs (violates one of our assumptions)

Now, **Economies** of Scale

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- Economies of scale $\equiv$
  - output increases more rapidly than total cost
  - double total cost, more than double output
- Diseconomies of scale $\equiv$
  - output increases more slowly than total cost
  - double total cost, less than double output
- Constant economies of scale $\equiv$
  - total cost and output increase as same rate
  - double total cost, double output

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You can see these in the shape of the average cost curve.

Economies of Scale vs. Returns to Scale

Returns to scale

- Does increase in inputs increase output? By how much?

Economies of Scale vs. Returns to Scale

Returns to scale

- Does increase in inputs increase output? By how much?

Economies of Scale

- Does increase in costs increase output? By how much?

Economies of Scale vs. Returns to Scale

Returns to scale

- Does increase in inputs increase output? By how much?

Economies of Scale

- Does increase in costs increase output? By how much?

Therefore

- Increasing returns to scale $\implies$ economies of scale
- Economies of scale $\not\implies$ returns to scale

Economies of Scale vs Returns to Scale

Returns to Scale

- You use 5 units of K and 3 units of L
- This costs \$100
- Gives output of 20

Economies of Scale vs Returns to Scale

Returns to Scale

- You use 5 units of K and 3 units of L
- This costs \$100
- Gives output of 20
- Now you use 10 units of K and 6 units of L
- Do you make more or less than 40 units of output?

Economies of Scale vs Returns to Scale

Returns to Scale

- You use 5 units of K and 3 units of L
- This costs \$100
- Gives output of 20
- Now you use 10 units of K and 6 units of L
- Do you make more or less than 40 units of output?

Economies of Scale

- You use \$100 to produce output of 20

Economies of Scale vs Returns to Scale

Returns to Scale

- You use 5 units of K and 3 units of L
- This costs \$100
- Gives output of 20
- Now you use 10 units of K and 6 units of L
- Do you make more or less than 40 units of output?

Economies of Scale

- You use \$100 to produce output of 20
- Now you can spend \$200
- Do you make more or less than 40 units of output?

Economies of Scope

- Economies of scope $\equiv$ firm produces multiple outputs more cheaply together than it would each individual output
- Diseconomies of scope $\equiv$ firm produces multiple outputs at a higher cost than it would if it produced each output individually
- Where do they come from?

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- Diseconomies of scope $\equiv$ firm produces multiple outputs at a higher cost than it would if it produced each output individually
- Where do they come from?
- From sharing common inputs or knowledge

Economies of Scope: Bath and Body Works

- What do they produce?

Bath & Body Works®

Economies of Scope: Bath and Body Works

Bath & Body Works®

- What do they produce?
- What could economies of scope be?

Economies of Scope: Bath and Body Works

Bath & Body Works®

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- *Wall Street Journal* says that onshoring production enhances economies of scope

Economies of Scope: Bath and Body Works

Bath & Body Works®

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- *Wall Street Journal* says that onshoring production enhances economies of scope
  - respond more rapid to market changes
  - create lots of flavors

Recap of Today

- Opportunity Costs
- Sunk Costs
- Cost Curves: Total Cost = Fixed Cost + Variable Cost
- Average Cost and Marginal Cost
- Short Run and Long Run Costs
- Economies of Scale (and maybe Scope)

Next Class

- Read GLS Chapter 8
- Skip 8.5