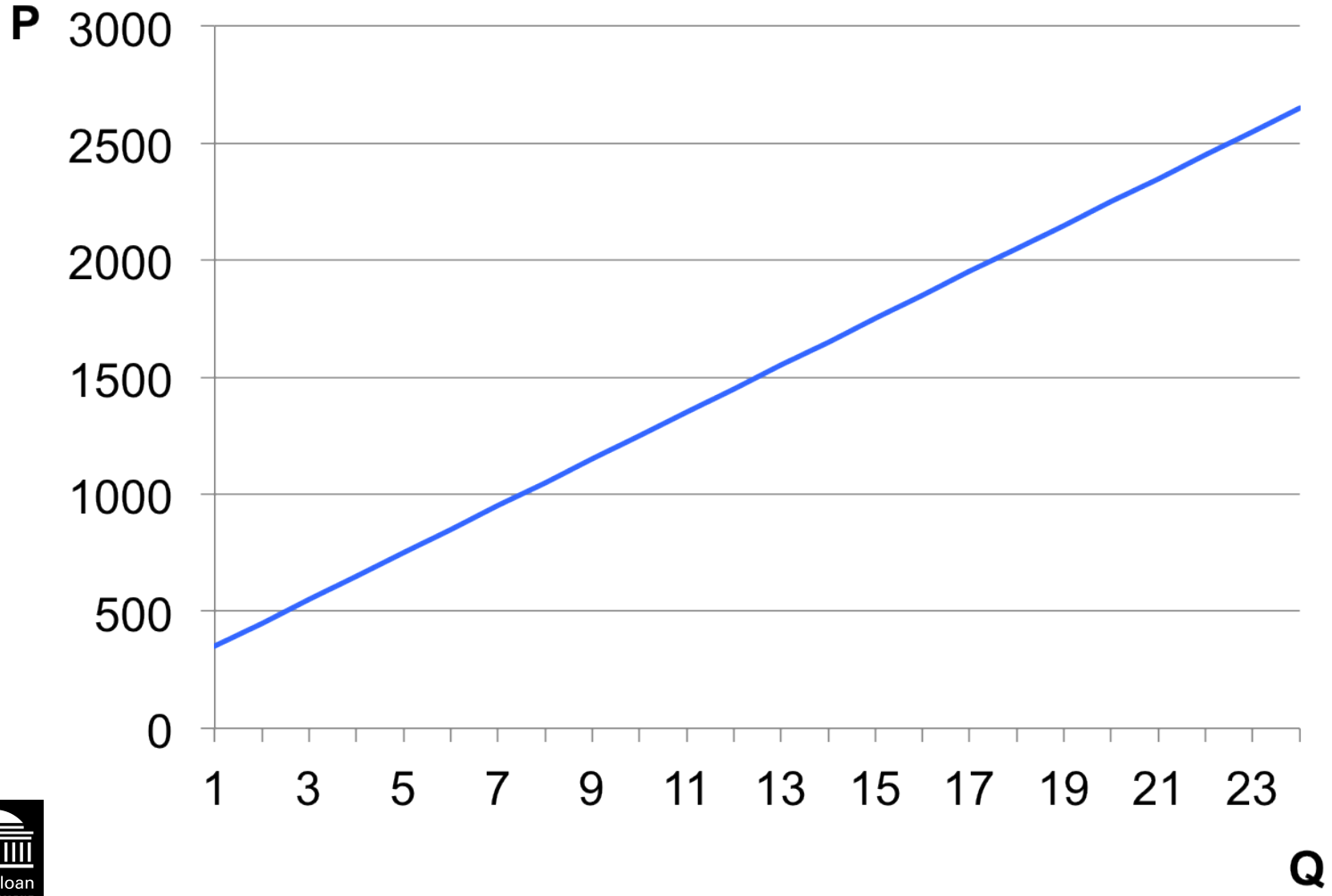
Lecture 2
Supply I

15.011/0111 Economic Analysis for Business Decisions
Oz Shy

(inverse) supply curve



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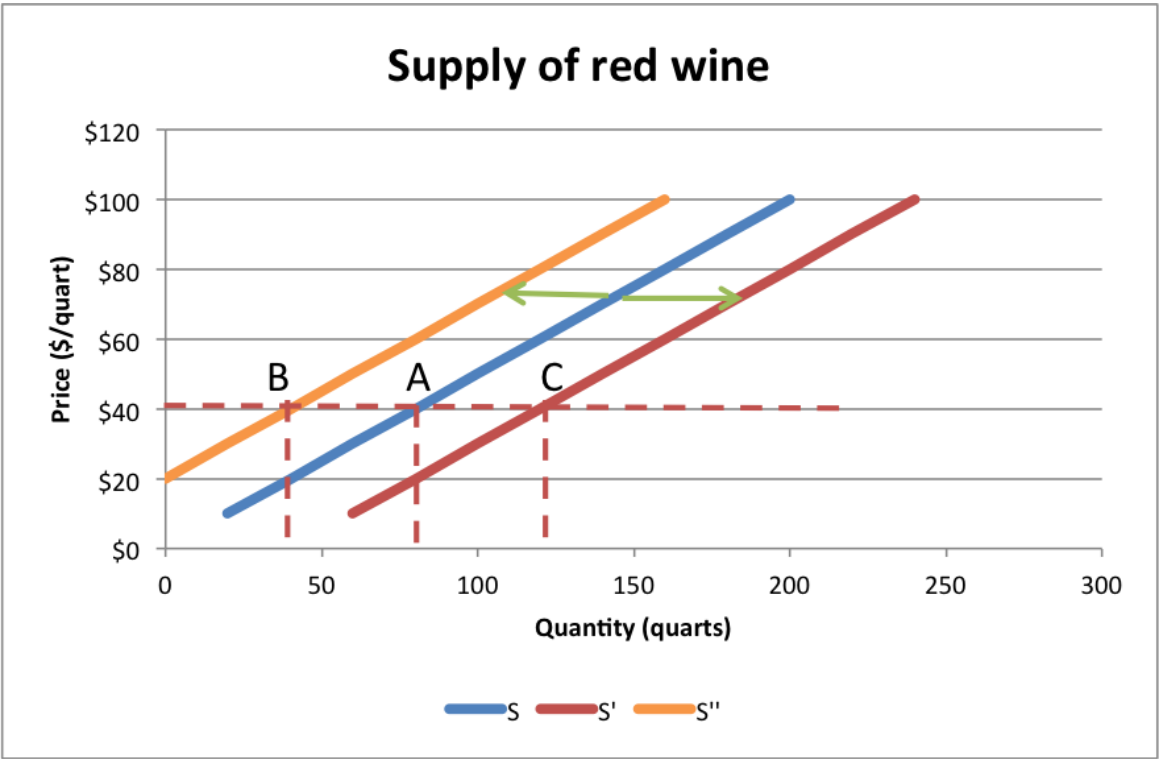
Supply curve

Plots quantity produced at any given price

- Determined by production costs and other factors (firms are price-takers)
- Context important for interpretation (firm, industry, individual)
- Movements along the curve due to a change in price
- Movement of the curve (a shift) due to changes in other parameters



A = Average year

B = Bad year (drought)

C = Good year (good weather)

Supply curve: Input and output prices formulation

- A farmer grows and sells corn
- 2 inputs (factors of production): Fuel and Soybeans

$$Q^S_{corn} = 9 + 5P_{corn} - 2P_{fuel} - 1.25P_{soybean}$$

  - Price of corn increases $\Longrightarrow$ Quantity supplied increases (movement along the curve)
  - An increase in an input price $\Longrightarrow$ supply decreases (curve shifts upward and leftward)

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Classifications of cost

- A supply function is derived from a cost function (part of the marginal cost curve, to be specific)
- We subdivide cost into 3 components: Sunk, fixed, and variable

1. Variable cost: Varies with the production level
   Examples: Electricity, water (both increase with production)
2. Fixed cost: Independent of the production level, but equals to zero if production stops (i.e., fixed cost is *avoidable*)
   Examples: Rental cost (assuming a short-term lease)
3. Sunk cost: Same as fixed, except that it has already been paid for, so cost is borne even if production ceases
   Examples: Advertising, giving away free samples, consulting services, attorney's fees

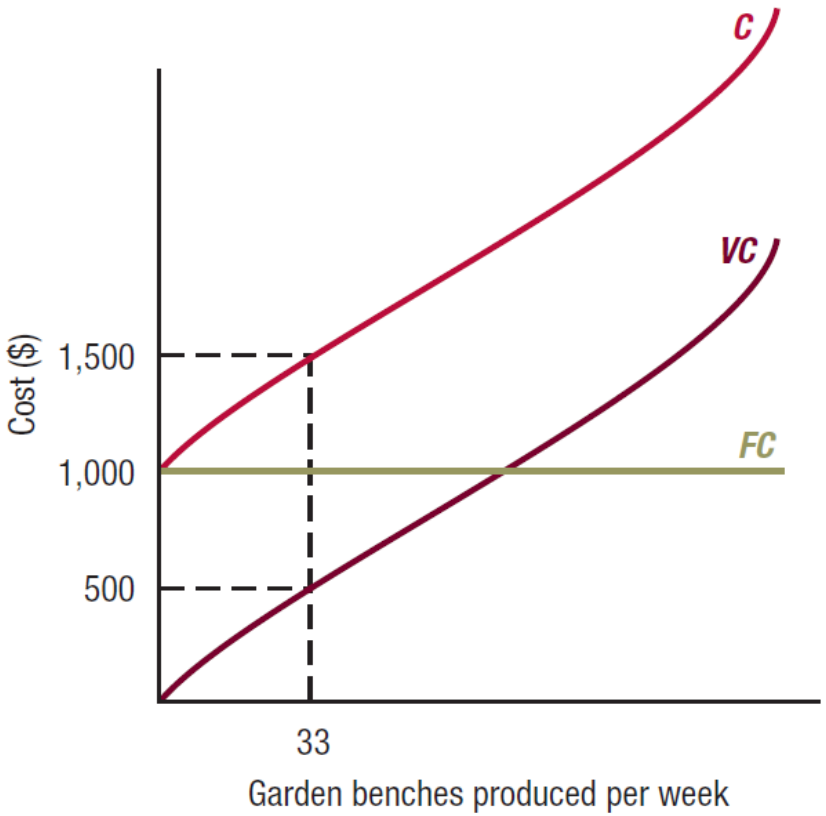
Classifications of cost: Discussion

Expenses & Production

	2014Q1	2014Q2	2014Q3	2014Q4	2015Q1	2015Q2
Labor	496269	611849	720496	837796	984820	1110117
Energy	62033	76481	90062	104724	123102	138764
Rent	85296	85296	85296	85296	85296	85296
Materials	48851	60228	70923	82470	96943	109277
Leases	31016	31016	31016	31016	31016	31016
Transportation	38774	74892	108843	145501	191446	230601
Quantity	45613	55646	64134	72465	81498	88646

Algebraic formulation of cost curves

Ignoring sunk cost, let Q denote the firm's output level. Then, $TC(Q) = FC + VC(Q)$



In this example, a fixed cost of $1,000 shifts the TC curve upward by $1,000.

Fixed cost does not vary with output (horizontal line)

Variable cost is upward sloping

Some cost considerations

- The distinction between fixed and variable cost generally depend on the time frame
- If a rental lease expires in 5 years, the cost is sunk. If it expires in 1 year, it may be classified as fixed

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Opportunity cost

Please evaluate the following statement: "Buying a house is a good deal because it saves me paying rent."

Actually, there shouldn't be any difference between the two options because:

Living in your own house is costly because you could have rent it to others (foregone income)

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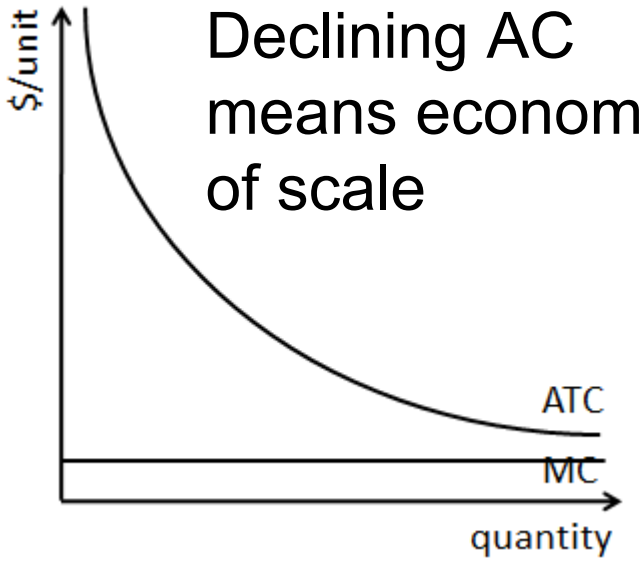
Average cost curves

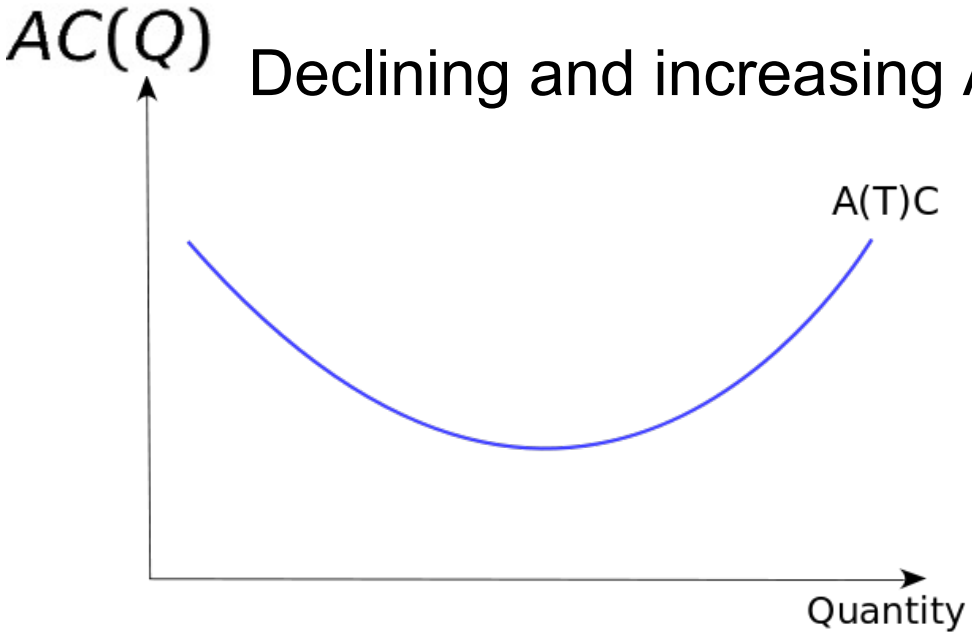
$$AC(Q) = \frac{TC(Q)}{Q} = \frac{FC}{Q} + \frac{VC(Q)}{Q}$$

Cost per unit of output

Note: FC/Q becomes negligible at high output levels (fixed cost is spread out over many units of output

Declining AC means economies of scale





Declining and increasing AC

Marginal cost curves

$$MC(Q) = \frac{dTC(Q)}{dQ} \approx \frac{\Delta TC(Q)}{\Delta Q}$$

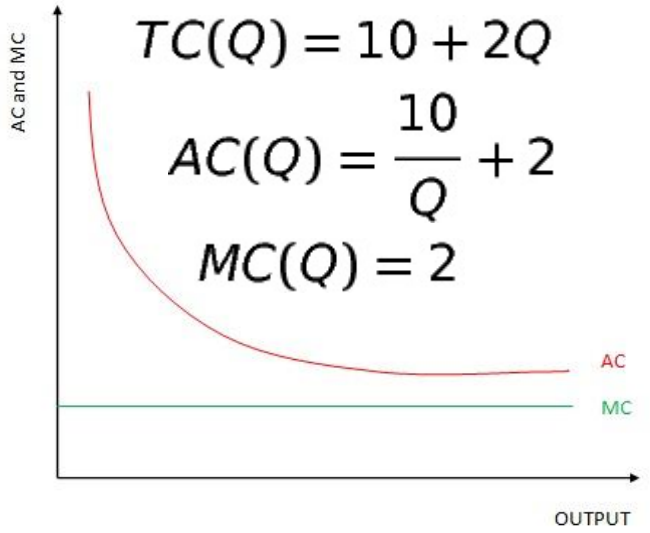
Cost of producing an additional unit of output

Declining AC, constant MC

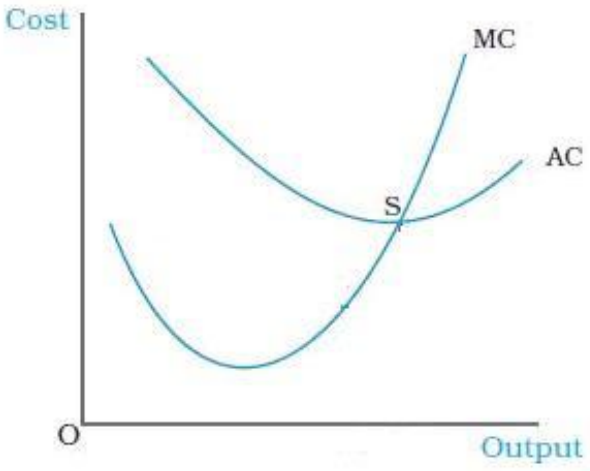
$$TC(Q) = 10 + 2Q$$

$$AC(Q) = \frac{10}{Q} + 2$$

$$MC(Q) = 2$$



Declining and increasing AC and MC curves

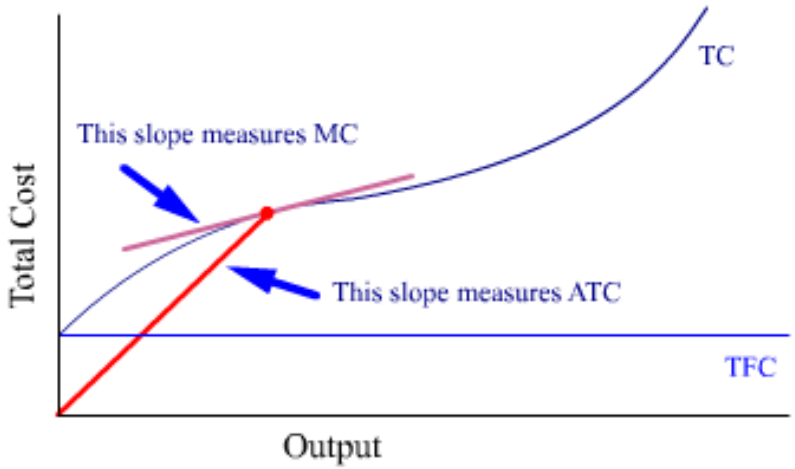


$$TC(Q) = 10 + 2Q^2$$

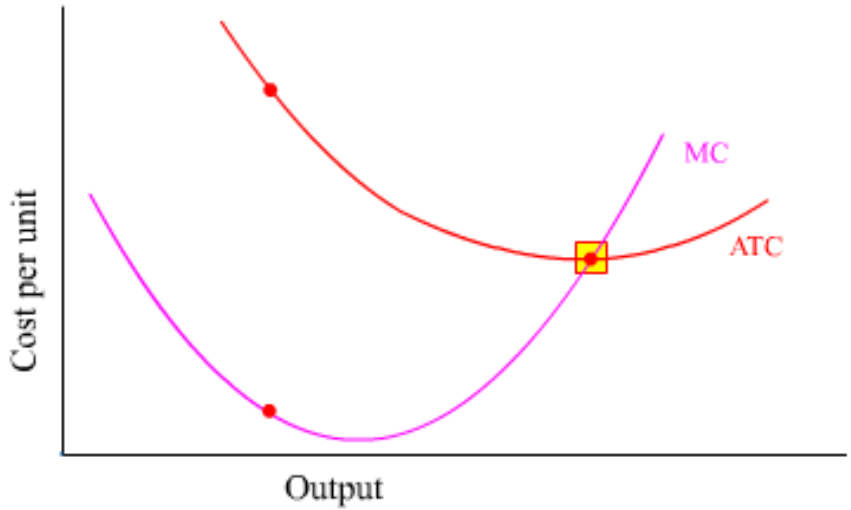
$$AC(Q) = \frac{10}{Q} + 2Q$$

$$MC(Q) = 4Q$$

How to draw AC and MC curves using the TC curve



Average cost is the slope of a ray from the origin to the TC curve at a given level of output



Marginal cost is the slope of the TC curve at a given level of output

The relationship between the MC (Q) and ATC(Q) functions

The previous slide showed that at the output level where ATC(Q) is minimized, MC(Q) = ATC(Q). Note: You don't have to know the following proof:

At min ATC, the slope of the ATC curve equals zero. Therefore,

$$0 = \frac{dATC(Q)}{dQ} = \frac{d\left(\frac{TC(Q)}{Q}\right)}{dQ} = \frac{\frac{dTC(Q)}{dQ} \cdot Q - 1 \cdot TC(Q)}{Q^2}$$

$$0 = \frac{MC(Q) \cdot Q - TC(Q)}{Q^2} \Rightarrow MC(Q) = \frac{TC(Q)}{Q} = ATC(Q)$$

Remark: In the above, Q refers to a particular output level where ATC is minimized

Finding a firm's profit-maximizing output level: The revenue side

Revenue: $R(Q) = P(Q) \cdot Q$ price time unit sold

Note: A competitive firm is a price taker, hence $P(Q) = P$
that is, price does not fall when output expands

Therefore, $R(Q) = P \cdot Q$

and marginal revenue is: $MR(Q) = \frac{dR(Q)}{dQ} \approx \frac{\Delta R(Q)}{\Delta Q} = P$

Simple intuition: A competitive firm (price taker) sells each additional unit of output at a given (unchanging) price P

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Note: MR(Q) = P only for a competitive firm (price taker). Not the case for a monopoly firm

Finding a firm's profit-maximizing output level (con't)

The question: How many units should a firm product and sell?

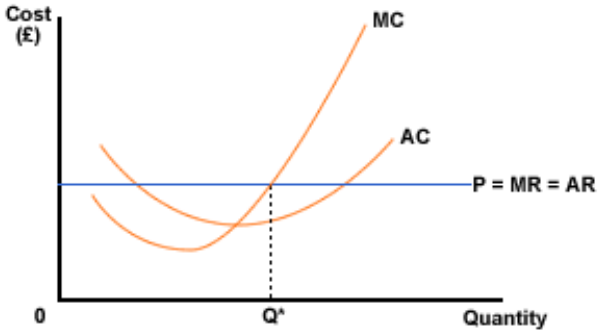
Profit = Revenue *minus* cost $\Pi(Q) = R(Q) - TC(Q)$

And, for a competitive firm (price-taker): $\Pi(Q) = P \cdot Q - TC(Q)$

Now, to find the profit-maximizing output solve: $P = MC(Q)$

and make sure that the price is not lower than the average cost:

$P \geq AC(Q)$



Note: The firm's supply curve is the segment of MC(Q) above the AC(Q) curve

Finding a firm's profit-maximizing output level: A numerical example

- A competitive firm can sell each unit for $102
- Total cost: $TC(Q) = 50 + 2Q + Q^2$
- Necessary condition for Q* to be the profit-max output is: $P = MC(Q^*) \Rightarrow \$102 = 2 + 2Q \Rightarrow Q^* = 50$
- To make it "sufficient" we verify that the price (per unit) exceeds the average cost (cost per unit)
- $$P = \$102 > AC(Q) = \frac{50}{Q} + 2 + Q = \$53$$

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Economies and diseconomies of scope

The question: Should a firm diversify its production and produce totally different products?

Examples of diversification: Microsoft buys Nokia's mobile division, Microsoft buys Skype, Google buys Nest (thermostats)

Examples of specialization: IBM sells its PC division to Lenovo, eBay separates from PayPal, Nokia sells its phone division to Microsoft

Definition: Consider 2 different products (1 & 2). Production exhibits economies of scope if:

$$TC(Q_1, Q_2) < TC(Q_1, 0) + TC(0, Q_2)$$

That is, joint production is less costly

Mergers and acquisitions

Mergers and acquisitions

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American & US Airways

Neither American Airlines nor US Airways alone serves a sufficient number of U.S. and international cities to compete effectively with United and Delta for the corporate accounts that are an essential part of the customer mix for every major carrier. Nor are either American or US Airways large enough, individually, to achieve the economies of scale available to their larger competitors.

Bob Crandall
Fmr Chair of American
WSJ August 2013

Mergers and acquisitions

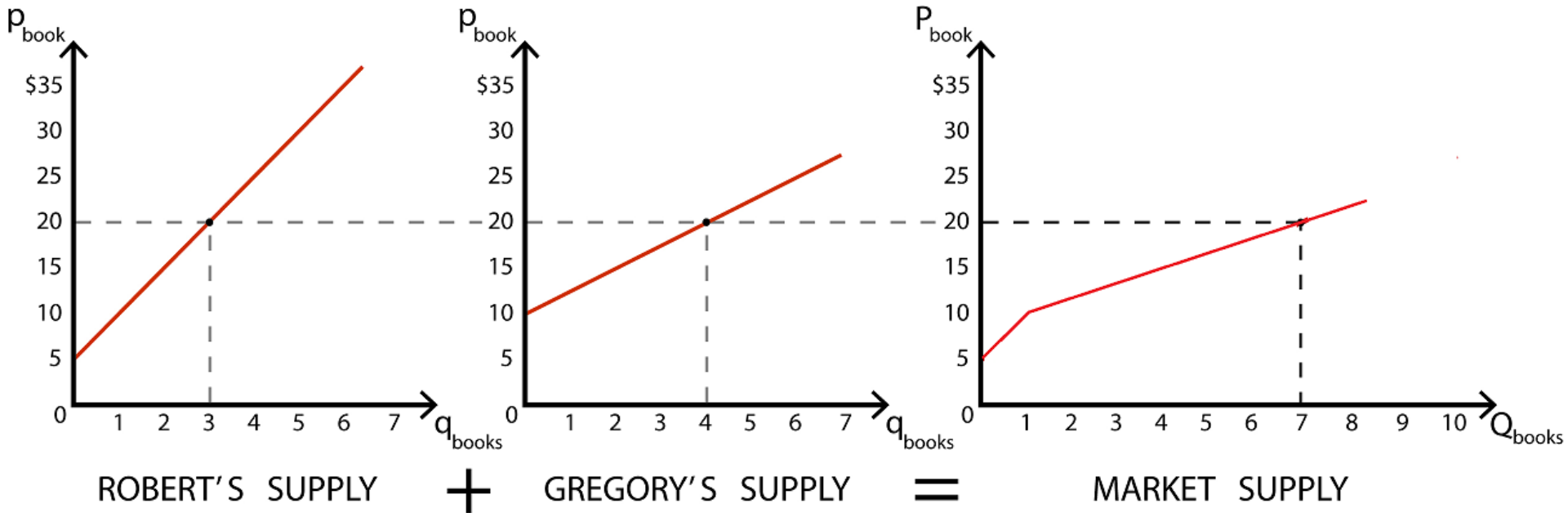
THE WALL STREET JOURNAL.

Hot Wash: Electrolux Seeks U.S. Growth With GE Appliances Buy

Sep 8, 2014

The appliance industry is becoming more and more about economies of scale. "New features need to be introduced at an ever increasing pace and this acquisition means Electrolux's R&D investments can be applied to larger volumes," Johan Eliason, an analyst at Kepler Cheuvreux, said.

Mergers and acquisitions: Aggregating supply curves



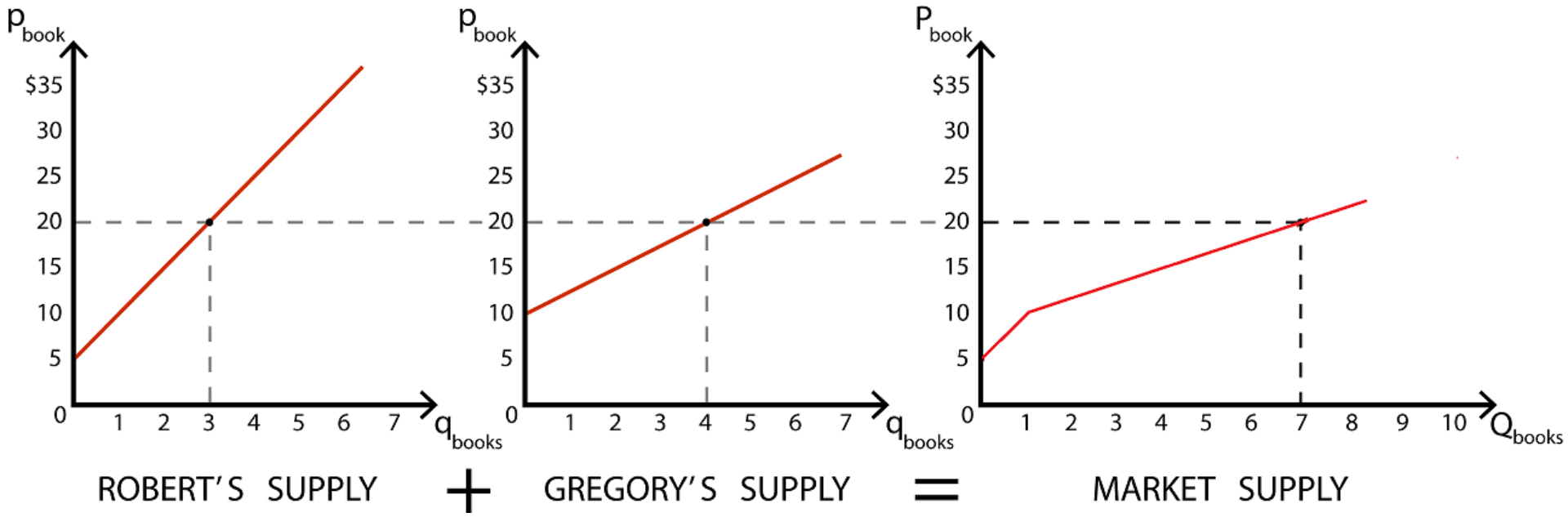
'Horizontal' summation: For every given price, sum up quantity supplied by each firm

Remark 1: The kink at p = $10 where Greg's firm enters the market

Remark 2: If p=$20 is the market price and Rob and Greg merge, Rob should produce 3 and Greg 4

Why? Hint: $MC_{Rob}(3) = MC_{Greg}(4) = \$20$

Profit-maximizing output levels of a competitive multi-plant firm: Solution



We need 2 equations to solve for 2 variables: Q_{Rob} and Q_{Greg}

(1) $p = MC_{Rob}(Q_{Rob})$, and

(2) (2) $MC_{Rob}(Q_{Rob}) = MC_{Greg}(Q_{Greg})$

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“Open” economy: Domestic supply and international trade

Assume a (perfectly elastic) world supply curve at P*

“Closed” economy (autarky)

“Open” economy (free trade)

Trade restriction: Import quota: Import limited to Q*