

Managerial Economics & Business Strategy

Baye Chapters 4-5

Edited by DF 1/07



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Overview

- I. Consumer Behavior
 - Indifference Curve Analysis
 - Consumer Preference Ordering
- II. Constraints
 - The Budget Constraint
 - Changes in Income
 - Changes in Prices
- III. Consumer Optimum
- IV. Generating Demand Curves
 - Individual Demand
 - Market Demand

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Consumer Behavior

- Consumer Opportunities
 - The possible goods and services consumer can afford to consume.
- Consumer Preferences
 - The goods and services consumers actually consume.
- Given the choice between 2 bundles of goods a consumer either
 - Prefers bundle A to bundle B: $A \succ B$, or $U(A) > U(B)$
 - Prefers bundle B to bundle A: $A \prec B$, or $U(A) < U(B)$
 - Is indifferent between the two: $A \sim B$, or $U(A) = U(B)$

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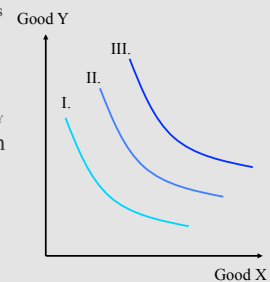
Indifference Curve Analysis

Indifference Curve

- A curve that defines the combinations of 2 or more goods that give a consumer the same level of satisfaction.
- Represented by $U(X, Y)$, whose partial derivatives are denoted U_X , U_Y

Marginal Rate of Substitution

- The rate at which a consumer is willing to substitute one good for another and maintain the same satisfaction level.
- $MRS = U_X/U_Y$



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Consumer Preference Ordering Properties

- Complete—everything can be compared
- Monotone—More is Better
- Diminishing Marginal Rate of Substitution
- Transitive

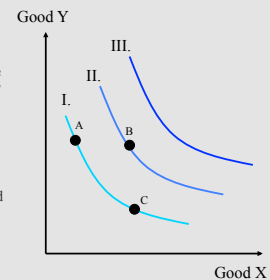
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Complete Preferences

Completeness Property

- Consumer is capable of expressing preferences (or indifference) between all possible bundles. ("I don't know" is NOT an option!)
 - If the only bundles available to a consumer are A, B, and C, then the consumer
 - is indifferent between A and C (they are on the same indifference curve).
 - will prefer B to A.
 - will prefer B to C.



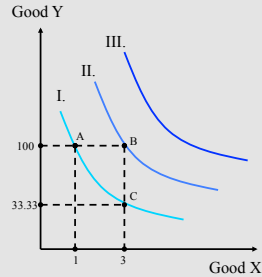
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More Is Better!

• More Is Better Property

- Bundles that have at least as much of every good and more of some good are preferred to other bundles.
 - Bundle B is preferred to A since B contains at least as much of good Y and strictly more of good X.
 - Bundle B is also preferred to C since B contains at least as much of good X and strictly more of good Y.
- More generally, all bundles on IC_{III} are preferred to bundles on IC_{II} or IC_I . And all bundles on IC_{II} are preferred to IC_I .



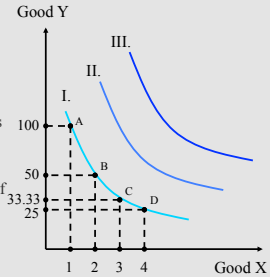
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Diminishing Marginal Rate of Substitution

• Marginal Rate of Substitution

- The amount of good Y the consumer is willing to give up to maintain the same satisfaction level decreases as more of good X is acquired.
- The rate at which a consumer is willing to substitute one good for another and maintain the same satisfaction level.
- To go from consumption bundle A to B the consumer must give up 50 units of Y to get one additional unit of X.
- To go from consumption bundle B to C the consumer must give up 16.67 units of Y to get one additional unit of X.
- To go from consumption bundle C to D the consumer must give up only 8.33 units of Y to get one additional unit of X.



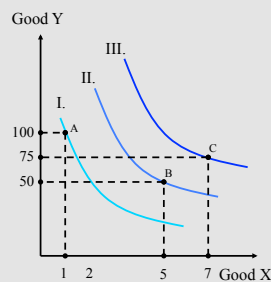
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Consistent Bundle Orderings

• Transitivity Property

- For the three bundles A, B, and C, the transitivity property implies that if $C \succ B$ and $B \succ A$, then $C \succ A$.
- Transitive preferences along with the more-is-better property imply that
 - indifference curves will not intersect.
 - the consumer will not get caught in a perpetual cycle of indecision.



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The Budget Constraint

• Opportunity Set

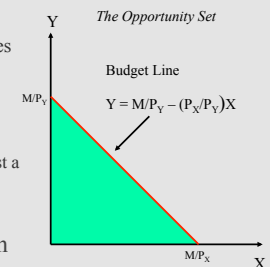
- The set of consumption bundles that are affordable.
 - $P_X X + P_Y Y \leq M$.

• Budget Line

- The bundles of goods that exhaust a consumer's income.
 - $P_X X + P_Y Y = M$.

• Market Rate of Substitution

- The slope of the budget line
 - $-P_X / P_Y$



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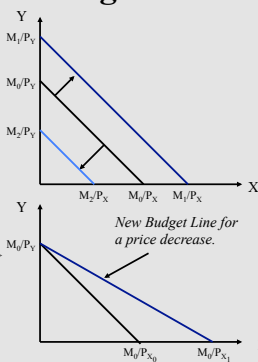
Changes in the Budget Line

• Changes in Income

- Increases lead to a parallel, outward shift in the budget line ($M_1 > M_0$).
- Decreases lead to a parallel, downward shift ($M_2 < M_0$).

• Changes in Price

- A decrease in the price of good X rotates the budget line counter-clockwise ($P_{X_0} > P_{X_1}$).
- An increase rotates the budget line clockwise (not shown).



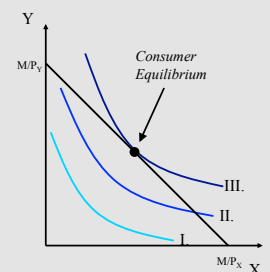
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Consumer Optimum

- The optimal bundle is an affordable bundle that yields the highest level of satisfaction.

- Consumer equilibrium occurs at a point where $MRS = P_X / P_Y$.
- Equivalently, the slope of the indifference curve equals the budget line.
- Or else the optimum is at a corner



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Price Changes and Consumer Equilibrium

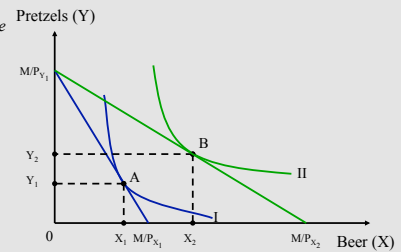
- Substitute Goods
 - An increase (decrease) in the price of good X leads to an increase (decrease) in the consumption of good Y.
 - Examples:
 - Coke and Pepsi.
 - Verizon Wireless or T-Mobile.
- Complementary Goods
 - An increase (decrease) in the price of good X leads to a decrease (increase) in the consumption of good Y.
 - Examples:
 - DVDs and DVD players.
 - Computer CPUs and monitors.

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Complementary Goods

When the price of good X falls and the consumption of Y rises, then X and Y are complementary goods. ($P_{X1} > P_{X2}$)



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Income Changes and Consumer Equilibrium

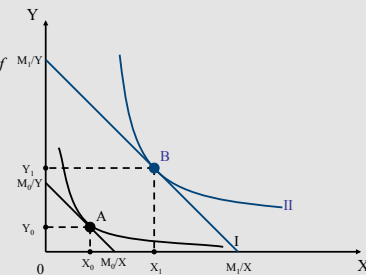
- Normal Goods
 - Good X is a normal good if an increase (decrease) in income leads to an increase (decrease) in its consumption.
- Inferior Goods
 - Good X is an inferior good if an increase (decrease) in income leads to a decrease (increase) in its consumption.

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Normal Goods

An increase in income increases the consumption of normal goods. ($M_0 < M_1$)



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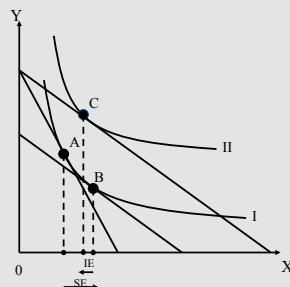
Decomposing the Income and Substitution Effects

Initially, bundle A is consumed. A decrease in the price of good X expands the consumer's opportunity set.

The substitution effect (SE) causes the consumer to move from bundle A to B.

A higher "real income" allows the consumer to achieve a higher indifference curve.

The movement from bundle B to C represents the income effect (IE). The new equilibrium is achieved at point C.

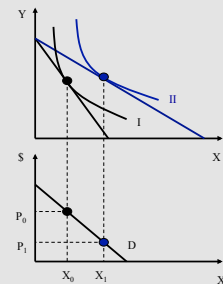


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Individual Demand Curve

- An individual's demand curve is derived from each new equilibrium point found on the indifference curve as the price of good X is varied.

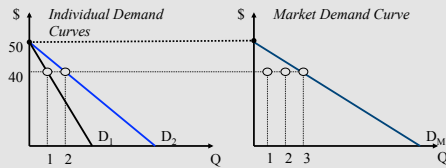


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Market Demand

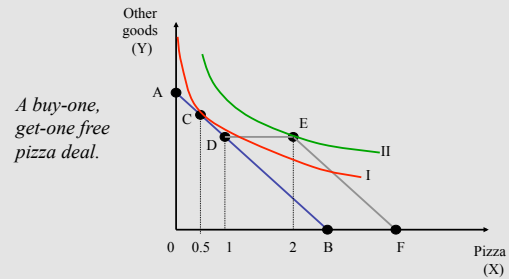
- The market demand curve is the horizontal summation of individual demand curves.
- It indicates the total quantity all consumers would purchase at each price point.



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A Classic Marketing Application



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Conclusion

- Indifference curve properties reveal information about consumers' preferences between bundles of goods.
 - Completeness.
 - More is better.
 - Diminishing marginal rate of substitution.
 - Transitivity.
- Indifference curves along with price changes determine individuals' demand curves.
- Market demand is the horizontal summation of individuals' demands.

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Production and Cost: Overview

I. Production Analysis

- Total Product, Marginal Product, Average Product
- Isoquants
- Isocosts
- Cost Minimization

II. Cost Analysis

- Total Cost, Variable Cost, Fixed Costs
- Cubic Cost Function
- Cost Relations

III. Multi-Product Cost Functions

IV. Learning Curve

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Production Analysis

- Production Function
 - $Q = F(K, L)$
 - The maximum amount of output that can be produced with K units of capital and L units of labor.
- Short-Run vs. Long-Run Decisions
- Fixed vs. Variable Inputs

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Total Product

- Cobb-Douglas Production Function
- Example: $Q = F(K, L) = K^{.5} L^{.5}$
 - K is fixed at 16 units.
 - Short run production function:

$$Q = (16)^{.5} L^{.5} = 4 L^{.5}$$
 - Production when 100 units of labor are used?

$$Q = 4 (100)^{.5} = 4(10) = 40 \text{ units}$$

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Marginal Productivity Measures

- Marginal Product of Labor: $MP_L = dQ/dL$
 - Measures the output produced by the last worker.
 - Slope of the short-run production function (with respect to labor).
- Marginal Product of Capital: $MP_K = dQ/dK$
 - Measures the output produced by the last unit of capital.
 - When capital is allowed to vary in the short run, MP_K is the slope of the production function (with respect to capital).

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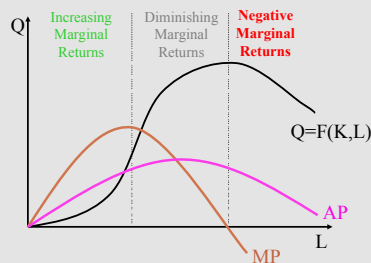
Average Productivity Measures

- Average Product of Labor
 - $AP_L = Q/L$.
 - Measures the output of an “average” worker.
 - Example: $Q = F(K, L) = K^{0.5} L^{0.5}$
 - If the inputs are $K = 16$ and $L = 16$, then the average product of labor is $AP_L = [(16)^{0.5}(16)^{0.5}]/16 = 1$.
- Average Product of Capital
 - $AP_K = Q/K$.
 - Measures the output of an “average” unit of capital.
 - Example: $Q = F(K, L) = K^{0.5} L^{0.5}$
 - If the inputs are $K = 16$ and $L = 16$, then the average product of labor is $AP_L = [(16)^{0.5}(16)^{0.5}]/16 = 1$.

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Increasing, Diminishing and Negative Marginal Returns



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Guiding the Production Process

- Producing on the production function
 - Aligning incentives to induce maximum sustainable worker effort.
- Employing the right level of inputs
 - When labor or capital vary in the short run, to maximize profit a manager will hire
 - labor until the value of marginal product of labor equals the wage: $VMP_L = w$, where $VMP_L = P \times MP_L$.
 - capital until the value of marginal product of capital equals the rental rate: $VMP_K = r$, where $VMP_K = P \times MP_K$.

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Isoquant

- The combinations of inputs (K, L) that yield the producer the same level of output.
- The shape of an isoquant reflects the ease with which a producer can substitute among inputs while maintaining the same level of output.

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Marginal Rate of Technical Substitution (MRTS)

- The rate at which two inputs are substituted while maintaining the same output level.

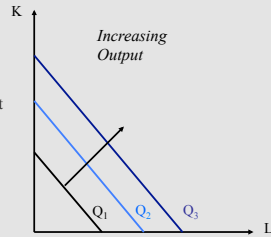
$$MRTS_{KL} = \frac{MP_L}{MP_K}$$

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Linear Isoquants

- Capital and labor are perfect substitutes
 - $Q = aK + bL$
 - $MRTS_{KL} = b/a$
 - Linear isoquants imply that inputs are substituted at a constant rate, independent of the input levels employed.

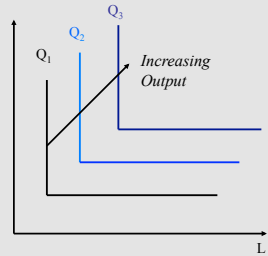


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Leontief Isoquants

- Capital and labor are perfect complements.
- Capital and labor are used in fixed-proportions.
- $Q = \min \{bK, cL\}$
- Since capital and labor are consumed in fixed proportions there is no input substitution along isoquants (hence, no $MRTS_{KL}$).

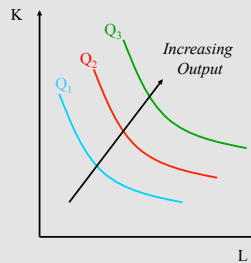


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Cobb-Douglas Isoquants

- Inputs are not perfectly substitutable.
- Diminishing marginal rate of technical substitution.
 - As less of one input is used in the production process, increasingly more of the other input must be employed to produce the same output level.
- $Q = K^a L^b$
- $MRTS_{KL} = MP_L / MP_K$



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Isocost

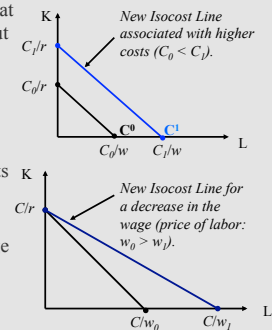
- The combinations of inputs that produce a given level of output at the same cost:

$$wL + rK = C$$

- Rearranging,

$$K = (1/r)C - (w/r)L$$

- For given input prices, isocosts farther from the origin are associated with higher costs.
- Changes in input prices change the slope of the isocost line.



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Cost Minimization

- Marginal product per dollar spent should be equal for all inputs:

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

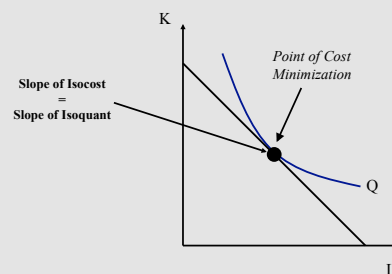
- But, this is just

$$MRTS_{KL} = \frac{w}{r}$$

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Cost Minimization

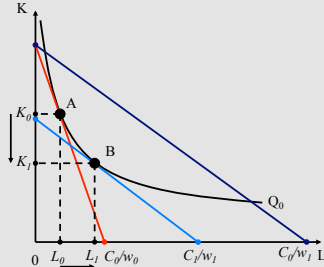


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Optimal Input Substitution

- A firm initially produces Q_0 by employing the combination of inputs represented by point A at a cost of C_0 .
- Suppose w_0 falls to w_1 .
 - The isocost curve rotates counterclockwise, which represents the same cost level prior to the wage change.
 - To produce the same level of output, Q_0 , the firm will produce on a lower isocost line (C_1) at a point B.
 - The slope of the new isocost line represents the lower wage relative to the rental rate of capital.



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Cost Analysis

Types of Costs

- Fixed costs (FC)
- Variable costs (VC)
- Total costs (TC)
- Sunk costs



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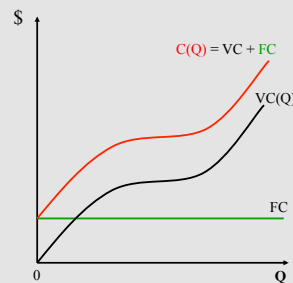
Total and Variable Costs

$C(Q)$: Minimum total cost of producing alternative levels of output:

$$C(Q) = VC(Q) + FC$$

$VC(Q)$: Costs that vary with output.

FC : Costs that do not vary with output.



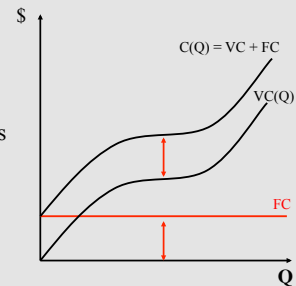
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Fixed and Sunk Costs

FC : Costs that do not change as output changes.

Sunk Cost: A cost that is forever lost after it has been paid.



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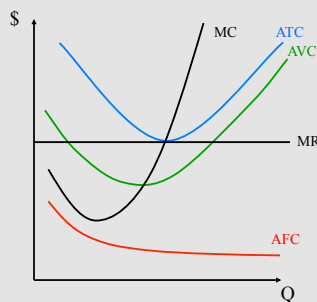
Some Definitions

Average Total Cost
 $ATC = AVC + AFC$
 $ATC = C(Q)/Q$

Average Variable Cost
 $AVC = VC(Q)/Q$

Average Fixed Cost
 $AFC = FC/Q$

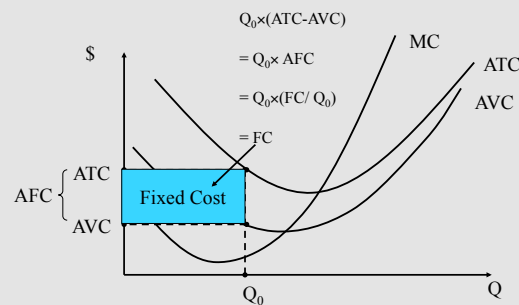
Marginal Cost
 $MC = \Delta C / \Delta Q$



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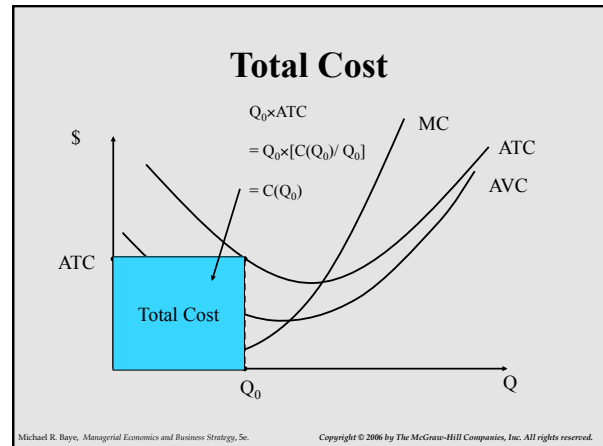
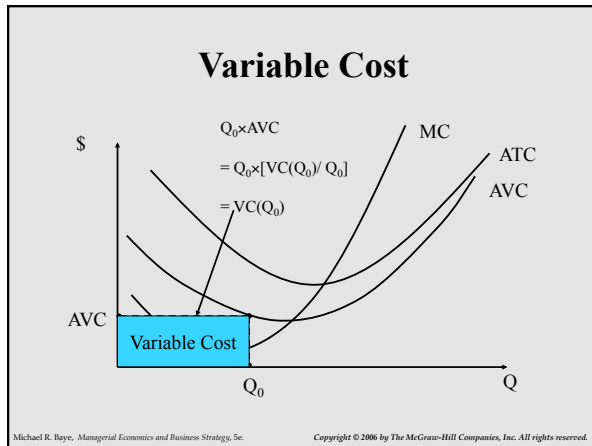
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Fixed Cost



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Cubic Cost Function

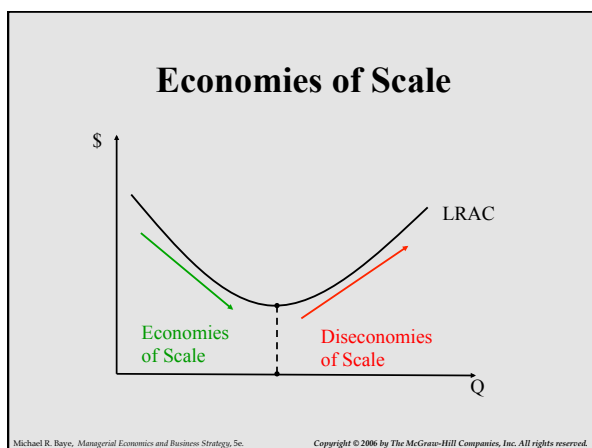
- $C(Q) = f + aQ + bQ^2 + cQ^3$
- Marginal Cost?
 - Memorize:
 $MC(Q) = a + 2bQ + 3cQ^2$
 - Calculus:
 $dC/dQ = a + 2bQ + 3cQ^2$

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An Example

- Total Cost: $C(Q) = 10 + Q + Q^2$
- Variable cost function:
 $VC(Q) = Q + Q^2$
- Variable cost of producing 2 units:
 $VC(2) = 2 + (2)^2 = 6$
- Fixed costs:
 $FC = 10$
- Marginal cost function:
 $MC(Q) = 1 + 2Q$
- Marginal cost of producing 2 units:
 $MC(2) = 1 + 2(2) = 5$

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Multi-Product Cost Function

- $C(Q_1, Q_2)$: Cost of jointly producing two outputs.
- General function form:

$$C(Q_1, Q_2) = f + aQ_1Q_2 + bQ_1^2 + cQ_2^2$$

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Economies of Scope

- $C(Q_1, 0) + C(0, Q_2) > C(Q_1, Q_2)$.
 - It is cheaper to produce the two outputs jointly instead of separately.
- Example:
 - It is cheaper for Time-Warner to produce Internet connections and Instant Messaging services jointly than separately.

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Cost Complementarity

- The marginal cost of producing good 1 declines as more of good two is produced:

$$\Delta MC_1(Q_1, Q_2) / \Delta Q_2 < 0.$$

- Example:
 - Cow hides and steaks.

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Quadratic Multi-Product Cost Function

- $C(Q_1, Q_2) = f + aQ_1Q_2 + (Q_1)^2 + (Q_2)^2$
 - $MC_1(Q_1, Q_2) = aQ_2 + 2Q_1$
 - $MC_2(Q_1, Q_2) = aQ_1 + 2Q_2$
 - Cost complementarity: $a < 0$
 - Economies of scope: $f > aQ_1Q_2$
- $$C(Q_1, 0) + C(0, Q_2) = f + (Q_1)^2 + f + (Q_2)^2$$
- $$C(Q_1, Q_2) = f + aQ_1Q_2 + (Q_1)^2 + (Q_2)^2$$
- $f > aQ_1Q_2$: Joint production is cheaper

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A Numerical Example:

- $C(Q_1, Q_2) = 90 - 2Q_1Q_2 + (Q_1)^2 + (Q_2)^2$
- Cost Complementarity?
 - Yes, since $a = -2 < 0$
 - $MC_1(Q_1, Q_2) = -2Q_2 + 2Q_1$
- Economies of Scope?
 - Yes, since $90 > -2Q_1Q_2$

Michael R. Baye, *Managerial Economics and Business Strategy*, 5e.

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Learning Curve

- Cost declines with *accumulated* output A
- $A = \sum Q_s$, $s=0$ to t .
- Idea: efficiency improves with experience due to individual learning and better team coordination.
- Original examples: aircraft and ship building in WWII.
- Recent examples: microprocessors, fuel cells
- $\ln MC = a - b \ln A$ is usual functional form
- The incremental cost decreases $b\%$ when accumulated output increases 1%

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Conclusion

- To maximize profits (minimize costs) managers must use inputs such that the value of marginal of each input reflects price the firm must pay to employ the input.
- The optimal mix of inputs is achieved when the $MRTS_{KL} = (w/r)$.
- Cost functions are the foundation for helping to determine profit-maximizing behavior in future chapters.

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