Managerial Economics & Business Strategy
Baye Chapters 4-5
Edited by DF 10/12

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

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 > B, or U(A)>U(B)
  ▪ Prefers bundle B to bundle A: A < B, or U(A)<U(B)
  ▪ Is indifferent between the two: A ~ B, or U(A)=U(B)

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

Consumer Preference Ordering Properties
• Complete—everything can be compared
• Monotone—More is Better
• Diminishing Marginal Rate of Substitution
• Transitive

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.
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 IC2 are preferred to bundles on IC1 or IC3. And all bundles on IC3 are preferred to IC2.

Consistent Bundle Orderings

- Transitivity Property
  - For the three bundles A, B, and C, the transitivity property implies that if C > B and B > A, then C > 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.

Changes in the Budget Line

- Changes in Income
  - Increases lead to a parallel outward shift in the budget line (M1 > M0).
  - Decreases lead to a parallel downward shift (M1 < M0).

- Changes in Price
  - A decrease in the price of good X rotates the budget line counterclockwise (P0X > P1X).
  - An increase rotates the budget line clockwise (not shown).

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 a certain 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.

The Budget Constraint

- Opportunity Set
  - The set of consumption bundles that are affordable.
    - P0X + P1Y ≤ M0.

- Budget Line
  - The bundles of goods that exhaust a consumer's income.
    - P0X + P1Y = M0.

- Market Rate of Substitution
  - The slope of the budget line
    - -P0X/P1Y

Consumer Optimum

- The optimal bundle is an affordable bundle that yields the highest level of satisfaction.
  - Consumer equilibrium occurs at a point where
    - MRS = P0X/P1Y.
  - Equivalently, the slope of the indifference curve equals the budget line.
  - Or else the optimum is at a corner.
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 AT&T.

• 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.

Complementary Goods

When the price of good X falls and the consumption of Y rises, then X and Y are complementary goods. ($P_X_1 > P_X_2$).

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.

Normal Goods

An increase in income increases the consumption of normal goods. ($M_Y > M_X$).

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.

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.
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.

Individual Demand Curves
Market Demand Curve

Q $ Q $ Q

D D D

1 2 3

40 50

A Classic Marketing Application

A buy-one, get-one free pizza deal.

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

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

Total Product

• Cobb-Douglas Production Function
• Example: Q = F(K,L) = K^0.5 L^0.5
  ▪ K is fixed at 16 units in short run.
  ▪ Short run production function:
    Q = (16)^0.5 L^0.5 = 4 L^0.5
  ▪ Output when 100 units of labor are used?
    Q = 4 (100)^0.5 = 4(10) = 40 units

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.
Marginal Productivity Measures

- Marginal Product of Labor: \( MP_L = \frac{dQ}{dL} \)
  - Measures the output produced by the last worker.
  - Slope of the short-run production function (with respect to labor).
- Marginal Product of Capital: \( MP_K = \frac{dQ}{dK} \)
  - 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).

Average Productivity Measures

- Average Product of Labor
  - \( AP_L = \frac{Q}{L} \)
  - Measures the output of an average worker.
- Average Product of Capital
  - \( AP_K = \frac{Q}{K} \)
  - Measures the output of an average unit of capital.

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 \( VMP_K = P \times MP_K \).

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.

Marginal Rate of Technical Substitution (MRTS)

- The rate at which two inputs are substituted while maintaining the same output level.
  \[ MRTS_{KL} = \frac{MP_L}{MP_K} \]
Linear Isoquants

- Capital and labor are perfect substitutes
  - \( Q = aK + bL \)
  - \( \text{MRTS} = \frac{b}{a} \)
  - Linear isoquants imply that inputs are substituted at a constant rate, independent of the input levels employed.

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.
  - \( Q = K^aL^b \)
  - \( \text{MRTS} = \frac{MP_L}{MP_K} \)

Isocost

- The combinations of inputs that produce a given level of output at the same cost:
  - \( wL + rK = C \)
- Rearranging, \( K = \frac{(1/r)C - (w/r)L}{K} \)
- 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.

Cost Minimization

- Marginal product per dollar spent should be equal for all inputs used:
  - \( \frac{MP_L}{w} = \frac{MP_K}{r} \leq \frac{MP_K}{r} = \frac{w}{r} \)
- But, this is just
  - \( \text{MRTS} = \frac{w}{r} \)

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).

Isocost

- New isocost line for a decrease in the wage (price of labor: \( w_0 > w_1 \)).
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.

Cost Analysis

- Types of Costs
  - Fixed costs (FC)
  - Variable costs (VC)
  - Total costs (TC)
  - Sunk costs

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.

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.
- Avoidable FC is the rest.

Some Definitions

- Average Total Cost
  $$ ATC = AVC + AFC $$

- Average Variable Cost
  $$ AVC = V(Q)/Q $$

- Average Fixed Cost
  $$ AFC = FC/Q $$

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

Fixed Cost

- $Q_B$:
  $$ ATC - AVC = Q_B \times AFC $$
  $$ = Q_B (FC/Q_B) $$
  $$ = FC $$

Variable Cost

\[ Q_0 \times AVC = Q_0 \left( \frac{VC(Q_0)}{Q_0} \right) = VC(Q_0) \]

Total Cost

\[ Q_0 \times ATC = Q_0 \left( \frac{C(Q_0)}{Q_0} \right) = C(Q_0) \]

Cubic Cost Function

- \[ C(Q) = f + aQ + bQ^2 + cQ^3 \]
- Marginal Cost?
  - Memorize:
    \[ MC(Q) = a + 2bQ + 3cQ^2 \]
  - Calculus:
    \[ \frac{dC}{dQ} = a + 2bQ + 3cQ^2 \]

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:
  \[ MC(2) = 1 + 2(2) = 5 \]

Economies of Scale

- \[ C(Q_1, Q_2): \text{Cost of jointly producing two outputs.} \]
- General function form:
  \[ C(Q_1, Q_2) = f + aQ_1Q_2 + bQ_1^2 + cQ_2^2 \]
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 Big Creek Lumber to produce 2x4s and sawdust mulch jointly than separately.

Cost Complementarity

- The marginal cost of producing good 1 declines as more of good two is produced:
  \[ \frac{\Delta MC_1(Q_1, Q_2)}{\Delta Q_2} < 0. \]
- Example:
  - Cow hides and steaks.

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: \( f > aQ_1Q_2 \)
  - Joint production is cheaper

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 \( 90 > -2Q_1Q_2 \)

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 \( 1\% \)

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.