Managerial Economics
Unit 1: Demand Theory

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OBJECTIVES

- Explain the importance of market demand in the determination of profit.
- Understand the many factors that influence demand.
  - Elasticity: Measures the percentage change in one factor given a small (marginal) percentage change in another factor
  - Demand elasticity: Measures the percentage change in quantity demanded given a small (marginal) percentage change in another factor that is related to demand
- The role of managers in controlling and predicting market demand.
  - Managers can influence demand by controlling price, advertising, product quality, and distribution strategies.
Role of managers (Continued)

- Managers cannot control, but need to understand, elements of the competitive environment that influence demand.
  - This includes the availability of substitute goods, their pricing, and advertising strategies employed by others.
- Managers cannot control, but need to understand how the macroeconomic environment influences demand.
  - This includes interest rates, taxes, and both local and global levels of economic activity.
THE MARKET DEMAND CURVE

- Market demand schedule: Table showing the total quantity of the good purchased at each price
- Market demand curve: Plot of the market demand schedule on a graph
  - Price (the X variable) is on the vertical and quantity demanded (the Y variable) is on the horizontal axis.
### TABLE 2.1

**Market Demand Schedule for Laptops, 2008**

<table>
<thead>
<tr>
<th>Price per Laptop (Dollars)</th>
<th>Quantity Demanded (Thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000</td>
<td>800</td>
</tr>
<tr>
<td>2,750</td>
<td>975</td>
</tr>
<tr>
<td>2,500</td>
<td>1,150</td>
</tr>
<tr>
<td>2,250</td>
<td>1,325</td>
</tr>
<tr>
<td>2,000</td>
<td>1,500</td>
</tr>
</tbody>
</table>
THE MARKET DEMAND CURVE

- Characteristics of the market demand curve
  - Quantity demanded is for output of the entire market, not of a single firm.
  - For most products and services, a higher price results in lower demand.
  - Quantity demanded is defined with regard to a particular time period.

- Determinants of the position and shape of the market demand curve
  - Consumer tastes
    - Example: Increase in preference for laptop computers causes an increase in demand for laptop computers.
Effect of an Increased Preference on the Market Demand Curve for Laptops

![Graph showing the effect of an increased preference on the demand curve for laptops.](image)

FIGURE 02-02
THE MARKET DEMAND CURVE

- Consumer income
  - Normal (superior) or inferior goods
  - Example: Increase in income causes an increase in demand for laptop computers.
  - More specific: for each given price, demand is higher

- Population size in the market
Effect of an Increase in Per Capita Income on the Market Demand Curve for Laptops

FIGURE 02-03
Market demand function: The relationship between the quantity demanded and the various factors that influence this quantity

- Quantity of X \( (Q) = f(\text{factors}) \)
- Factors include
  - price of X
  - incomes of consumers
  - tastes of consumers
  - prices of other goods
  - population
  - advertising expenditures
Example: $Q = b_1 P + b_2 I + b_3 S + b_4 A$

- Assumes that population is constant and that the demand function is linear
- $P =$ price of laptops
- $I =$ per capita disposable income
- $S =$ average price of software
- $A =$ amount spent on advertising
- $b_1, b_2, b_3$ and $b_4$ are parameters that are estimated using statistical methods
Interpretation of Parameters:

- $Q = b_1 P + b_2 I + b_3 S + b_4 A$
- E.g. $b_1$: if Price changes by one unit, quantity demanded changes by $b_1$ units under the condition that all other variables (i.e. price of Software) are held constant
- Example:
  - $Q = -700P + 200I - 500S + 0.01A$
The firm’s demand curve

- Negative slope with regard to price
  - Slope may not be the same as that of the market demand curve.
- Represents a portion of market demand
  - Market share
  - Responds to same market and macroeconomic factors as the market demand curve
- Directly related to the prices of substitute goods provided by competitors
  - Increase in competitor’s price will cause a decrease in a firm’s demand.
The price elasticity of a demand function is the percentage change in quantity demanded in response to a 1 percent increase in price.

- Typically negative
- Price elasticity generally is different at different prices and on different markets.

\[ \eta = \left( \frac{P}{Q} \right) \frac{\Delta Q}{\Delta P} \]
Own-price elasticity of demand (Continued)

- Price elasticity demand is symbolized by $\eta$.
- $0 \geq \eta \geq -\infty$
  - When $|\eta| > 1$, demand is elastic.
  - When $|\eta| < 1$, demand is inelastic.
  - When $|\eta| = 1$, demand is unitary.
Some extreme cases:

- When $\eta = 0$, demand is perfectly inelastic and the demand curve is vertical.
  - Quantity demanded is the same at all prices.

- When $\eta = -\infty$, demand is perfectly elastic and the demand curve is horizontal.
  - Price is the same for all quantities demanded.
  - If price rises, quantity demanded falls to zero.
  - If price falls, quantity demanded increases without limit.

What market is this?
Demand Curves with Zero and Infinite Price Elasticities of Demand
Looks simple, but...

- this is the most important insight of this lecture:
  - Typically demand curve is downward sloping
  - That means, we are in a market, which is not fully competitive
  - If this were not the case (i.e. perfect competition), everything would be boring:
    - Marketing, pricing, ... would make no sense
Example: linear demand curves

- The slope of a linear demand curve is constant.
- Price elasticity will differ depending on price.
  - At the midpoint of a linear demand curve, \( \eta = -1 \), with \( \eta \) approaching zero as price approaches the vertical intercept.
  - At prices above the midpoint, demand is elastic, with \( \eta \) approaching negative infinity as price approaches zero.
  - At prices below the midpoint, demand is inelastic.
Values of the Price Elasticity of Demand at Various Points along a Linear Demand Curve

- \( \eta \) approaches negative infinity as \( Q \) approaches zero.
- Demand is price elastic.
  \( \eta < -1 \)
- Demand is of unitary elasticity.
  \( \eta = -1 \)
- Demand curve: \( P = a - bQ \)
- Demand is price inelastic.
  \( \eta > -1 \)
- \( \eta \) approaches zero as \( P \) approaches zero.

FIGURE 02-06
Knowing the elasticity

- Every manager must know elasticity of demand for main products
- How can we do that?
- Very easy to calculate
Calculating elasticities

- **Point estimate:** (demand function is known); calculated at a specific point of demand.

  Use statistic regression analysis

  - If more data are available

- **Arc elasticity:** uses average values of Q and P as reference points (if only two data points are known)

  \[
  \eta = \frac{\Delta Q}{\Delta P} \frac{P}{Q} = \frac{(Q_2 - Q_1)}{(P_2 - P_1)} \frac{(P_1 + P_2) / 2}{(Q_1 + Q_2) / 2}
  \]
USING THE DEMAND FUNCTION TO CALCULATE THE PRICE ELASTICITY

Given

- \( Q = -700P + 200I - 500S + 0.01A \)
- \( Q \) = Quantity demanded of computers
- Price = \( P \) = 3,000
- Income = \( I \) = 13,000
- Software = \( S \) = 400
- Advertising = \( A \) = 50,000,000
**USING THE DEMAND FUNCTION TO CALCULATE THE PRICE ELASTICITY**

- Derive the demand curve
  - \( Q = -700P + (200)(13000) - (500)(400) + (0.01)(50000000) \)
  - \( Q = 2900000 - 700P \)

- Determine \( Q \)
  - \( Q = 2900000 - (700)(3000) = 800000 \)

- \( \eta = (-700)(3000/800000) = -2.62 \)
If you increase the price, how will your revenue react?

- Total Revenue $TR = PQ$
- now we increase the price
  - $TR = PQ$
  - $dTR/dP = Q(dP/dP) + P(dQ/dP)$
    - Simplify
  - $(1/Q)(dTR/dP) = (dP/dP) + (P/Q)(dQ/dP) = 1 + \eta$
If you increase the price, how will your revenue react?

(1/Q is positive): Implications:

- If $\eta = -1$, $dTR/dP = 0$, so total revenue is at a maximum and a change in P will have no effect on total revenue.
- If $\eta > -1$ (inelastic), $dTR/dP < 0$, so an increase in P will increase total revenue.
- If $\eta < -1$ (elastic), $dTR/dP > 0$, so an increase in P (and consequent decrease in Q) will decrease total revenue.
Recap: What are the important issues?

- Markets are not perfect; therefore pricing and advertising is important
- Know the demand curve
- Price elasticity: do not set price, where demand is inelastic
- Optimal pricing rule
Example: FUNDING PUBLIC TRANSIT

Given

- Price (fare) elasticity of demand for public transit in the United States is about -0.3.
- Many public transit systems lose money.
- Public transit systems are funded by federal, state, and local governments, all of which have budget issues.
Which transit systems have the most difficult time getting public funding?

- Revenue from sales will increase if fares are increased, because demand is inelastic.
- Costs will likely decrease if fares are increased, because quantity demanded (ridership) will fall.
- Managers of public transit will therefore increase fares if they do not receive enough public funds to balance their budgets.
- Public funding seems necessary to prevent price hikes.
DETERMINANTS OF OWN-PRICE ELASTICITY OF DEMAND

- Number and similarity of available substitutes
- Product price relative to a consumer’s total budget
- Time period available for adjustment to a price change
  - Ex: Cell phone contracts, gasoline prices
#### TABLE 2.4

**Own Price Elasticities of Demand, Selected Goods, and Services from Global Locations**

<table>
<thead>
<tr>
<th>Good/Service</th>
<th>Elasticity</th>
<th>Good/Service</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural products</td>
<td></td>
<td>Cigarettes [U.S.]^7</td>
<td>-0.107</td>
</tr>
<tr>
<td>Apples [U.S.]^1</td>
<td>-1.159</td>
<td>Bread [U.K.]^3</td>
<td>-0.26</td>
</tr>
<tr>
<td>Potatoes [U.K.]^3</td>
<td>-0.13</td>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td>Oranges [U.S.]^2</td>
<td>-0.62</td>
<td>Gasoline—short run [Canada]^8</td>
<td>-0.01 to -0.2</td>
</tr>
<tr>
<td>Lettuce [U.S.]^2</td>
<td>-2.58</td>
<td>Gasoline—long run [Canada]^8</td>
<td>-0.4 to -0.8</td>
</tr>
<tr>
<td>Products from animals/fish</td>
<td></td>
<td>Transportation</td>
<td></td>
</tr>
<tr>
<td>1 percent milk [U.S.]^5</td>
<td>-0.54 to -0.74</td>
<td>Domestic cars [U.S.]^9</td>
<td>-0.78</td>
</tr>
<tr>
<td>Cheese [U.K.]^3</td>
<td>-1.36</td>
<td>European cars [U.S.]^9</td>
<td>-1.09</td>
</tr>
<tr>
<td>Cheese [U.S.]^6</td>
<td>-0.595</td>
<td>Other manufactured goods</td>
<td></td>
</tr>
<tr>
<td>Meat [China]^4</td>
<td>-0.06 to -0.18</td>
<td>Clothing and footwear [U.K./Ireland]^{10}</td>
<td>-0.94</td>
</tr>
<tr>
<td>Beef/veal [U.K.]^3</td>
<td>-1.45</td>
<td>Other goods [U.K./Ireland]^{10}</td>
<td>-0.85</td>
</tr>
<tr>
<td>Manufactured agricultural products</td>
<td></td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>Beer and malt beverages [U.S.]^6</td>
<td>-2.83</td>
<td>Child care [North America]^{11}</td>
<td>-0.570</td>
</tr>
<tr>
<td>Wine [U.K./Ireland]^7</td>
<td>-1.12</td>
<td>Government health care [Kenya]^{12}</td>
<td>-0.100</td>
</tr>
<tr>
<td>Wine and brandy [U.S.]^6</td>
<td>-0.198</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example: Strategic pricing of first class ($\eta = -0.45$), regular economy ($\eta = -1.30$) and excursion ($\eta = -1.83$) airline tickets between the United States and Europe

- First class prices should be relatively high because demand is inelastic.
- Regular economy and excursion prices should be relatively low because demand is elastic.
TABLE 2.5

**Elasticities of Demand for Air Tickets between the United States and Europe**

<table>
<thead>
<tr>
<th>Type of Ticket</th>
<th>Price Elasticity</th>
<th>Income Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>First class</td>
<td>−0.45</td>
<td>1.50</td>
</tr>
<tr>
<td>Regular economy</td>
<td>−1.30</td>
<td>1.38</td>
</tr>
<tr>
<td>Excursion</td>
<td>−1.83</td>
<td>2.37</td>
</tr>
</tbody>
</table>
Example: Using differentiation strategies to change the price elasticity of demand for a product

- Differentiation strategies convince consumers that a product is unique, and therefore has fewer substitutes.
- Role of advertising
Example (Continued)

- If consumers perceive that a product has fewer substitutes, then their price elasticity of demand for the product will decrease (become less elastic) in absolute value.
- Differentiation strategies do not require actual differences in products, only a perceived difference.
A firm’s total revenue (TR) is equal to the total amount of money consumers spend on the product in a given time period.

- Linear demand curve: \( P = a - bQ \)
- Corresponding total revenue:
  \[ TR = PQ = aQ - bQ^2 \]
Marginal revenue: The incremental revenue earned from selling the \( n^{th} \) unit of output.

\[
MR = \frac{\Delta TR}{\Delta Q} = \Delta(aQ - bQ^2)/\Delta Q = a - 2bQ
\]

\[
\eta = (-1/b)[(a - bQ)/Q]
\]

- If \( Q = a/2b \), then \( \eta = -1 \)
- If \( Q > a/2b \), then \( \eta \) is inelastic
- If \( Q < a/2b \), then \( \eta \) is elastic
Marginal revenue (Continued)

\[ MR = \Delta TR / \Delta Q = \Delta (PQ) / \Delta Q = \]
\[ = P (\Delta Q / \Delta Q) + Q (\Delta P / \Delta Q) = \]
\[ = P [1 + (Q / P) (\Delta P / \Delta Q)] \]

★ so \[ MR = P (1 + 1/\eta) \]

If product is price elastic (\( \eta < -1 \)), marginal revenue must be positive

Example: what is MR if price is €10 and price elasticity is -2?
\[ 10 (1 + 1/(-2)) = €5. \]

What if product is very price elastic (\( \eta = -\infty \))?
Price setting: two simple rules

- **Do not price so low that demand is price-inelastic** ($\eta > -1$):
  - Marg. Revenue is negative, i.e. by raising price, total revenue will increase and (!) costs will decrease.

- **Optimal Price**:

\[
MC = MR = P(1 + \frac{1}{\eta}) \ldots \text{pricing rule}
\]

\[
\Rightarrow P = MC\left(\frac{1}{1 + \frac{1}{\eta}}\right) \ldots \text{optimal price}
\]

\Rightarrow \text{optimal price depends upon } MC \text{ and price elasticity}

\Rightarrow \text{The higher (the absolute value of) price elasticity, the lower the optimal price}

- Why is this so? In what market are you in?
Elasticity in Use

- Retailer: prices for the exact item may differ substantially in stores of the same chain; why?
  - Elasticity of demand is used to generate optimal prices
  - Rather than marking up cost, benchmarking or guessing, price optimization models use data mining techniques
  - Scanned transaction prices allow estimating a demand curve for each product
- Assuming that the marginal cost is equal across locations, we can equate marginal revenues:
  - $MR_1 = P_1[1 + (1/\mu_1)] = P_2[1 + 1/\mu_2] = MR_2 = (MC)$
  - If the marginal revenue is larger in shop 2 than in shop 1, you would like to shift some sales from shop 1 to shop 2
- Two periods over time, two seats in an airplane, etc.
Relationship between Price Elasticity, Marginal Revenue, and Total Revenue

FIGURE 02-07a
Relationship between Price Elasticity, Marginal Revenue, and Total Revenue

Total revenue = aQ - bQ^2
Total revenue, marginal revenue and price elasticity (the same on one slide)
THE INCOME ELASTICITY OF DEMAND

- Income elasticity of demand ($\eta_I$): The percentage change in quantity demanded ($Q$) resulting from a 1 percent increase in consumers’ income ($I$).
  - Income can be defined as aggregate consumer income or as per capita income, depending on circumstances.
  - $\eta_I = \left( \frac{\Delta Q}{\Delta I} \right) \left( \frac{I}{Q} \right)$
Income elasticity of demand (Continued)

- \( \eta_I > 0 \) for normal goods.
  - On average, goods are normal, since increases in aggregate income are associated with increases in aggregate consumer spending.
- \( \eta_I < 0 \) for inferior goods.
Strategic management and the income elasticity of demand

- The demand for a product with a large income elasticity of demand will vary widely with changes in income caused by economic growth and recessions.
- Portfolio decision: use products with both high and low income elasticity to reduce risk for business downturn.
Strategic management (Continued)

- Managers can lessen the impact of economic changes on such products by limiting fixed costs so that changes in production capacity can be made quickly.
- Managers can forecast demand for products using the income elasticity of demand combined with forecasts of aggregate income.
<table>
<thead>
<tr>
<th>Good</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural products</td>
<td></td>
</tr>
<tr>
<td>Grain [China]¹</td>
<td>−0.12 to +0.15</td>
</tr>
<tr>
<td>Potatoes [U.K.]²</td>
<td>−0.32</td>
</tr>
<tr>
<td>Potatoes [U.S.]³</td>
<td>+0.15</td>
</tr>
<tr>
<td>Oranges [U.S.]³</td>
<td>+0.63</td>
</tr>
<tr>
<td>Apples [U.S.]³</td>
<td>+1.32</td>
</tr>
<tr>
<td>Lettuce [U.S.]³</td>
<td>+0.88</td>
</tr>
<tr>
<td>Animal products</td>
<td></td>
</tr>
<tr>
<td>Meat [China]¹</td>
<td>+0.1 to +1.2</td>
</tr>
<tr>
<td>Milk [U.K.]²</td>
<td>+0.05</td>
</tr>
<tr>
<td>Milk [U.S.]³</td>
<td>+0.50</td>
</tr>
<tr>
<td>Cream [U.S.]³</td>
<td>+1.72</td>
</tr>
<tr>
<td>Eggs [U.K.]²</td>
<td>−0.21</td>
</tr>
<tr>
<td>Eggs [U.S.]³</td>
<td>+0.57</td>
</tr>
<tr>
<td>Processed food products</td>
<td></td>
</tr>
<tr>
<td>Bread [U.K.]²</td>
<td>−0.17</td>
</tr>
<tr>
<td>Other cereal products [U.K.]²</td>
<td>+0.18</td>
</tr>
<tr>
<td>Automobiles</td>
<td></td>
</tr>
<tr>
<td>Domestic cars [U.S.]⁴</td>
<td>+1.62</td>
</tr>
<tr>
<td>European cars [U.S.]⁴</td>
<td>+1.93</td>
</tr>
<tr>
<td>Asian cars [U.S.]⁴</td>
<td>+1.65</td>
</tr>
</tbody>
</table>
CROSS-PRICE ELASTICITIES OF DEMAND

- Cross-Price elasticity of demand ($\eta_{XY}$): The percentage change in quantity demanded of one good ($Q_X$) resulting from a 1 percent increase in the price of a related good ($P_Y$)
- Cross-Price elasticity of demand (Continued)
  - $\eta_{XY} = \left( \frac{\Delta Q_X}{\Delta P_Y} \right) \left( \frac{P_Y}{Q_X} \right)$
  - $\eta_{XY} > 0$ if the two products are substitutes.
    - Example: Wheat and corn
  - $\eta_{XY} < 0$ if the two products are complements.
    - Example: Computers and computer software
Strategic management

- Managers can use information about the cross-price elasticity of demand to predict the effect of competitors’ pricing strategies on the demand for their product.
- Antitrust authorities use the cross-price elasticity of demand to determine the likely effect of mergers on the degree of competition in an industry.
Strategic management

- Antitrust authorities (Continued)
  - A high cross-price elasticity, indicating that two goods are strong substitutes, suggests that a merger would significantly reduce competition in the industry.
  - A low cross-price elasticity, indicating that two goods are strong complements, suggests that a merger might give the merged firm excessive control over the supply chain.
THE ADVERTISING ELASTICITY OF DEMAND

- Advertising elasticity of demand ($\eta_A$): The percentage change in quantity demanded ($Q$) resulting from a 1 percent increase in advertising expenditure ($A$)
  - $\eta_A = \left( \frac{\Delta Q}{\Delta A} \right) \left( \frac{A}{Q} \right)$
  - Example Calculation
    - Given: $Q = 500 - 0.5P + 0.01I + 0.82A$ and $A/Q = 2$
    - $\eta_A = 0.82(2) = 1.64$
### TABLE 2.7

**Cross-Price Elasticity of Demand, Selected Pairs of Commodities, Global**

<table>
<thead>
<tr>
<th>Change of Price of Good</th>
<th>Change of Quantity of Good</th>
<th>Cross-Price Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>European/Asian cars</td>
<td>U.S. domestic cars</td>
<td>+0.28¹</td>
</tr>
<tr>
<td>European/U.S. domestic cars</td>
<td>Asian cars</td>
<td>+0.61¹</td>
</tr>
<tr>
<td>U.S. domestic/Asian cars</td>
<td>European cars</td>
<td>+0.76¹</td>
</tr>
<tr>
<td>Australian public transit</td>
<td>Australian auto ownership</td>
<td>+0.1 to</td>
</tr>
<tr>
<td>+0.3²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irish coal</td>
<td>Irish natural gas</td>
<td>+0.4³</td>
</tr>
<tr>
<td>Irish coal</td>
<td>Irish oil</td>
<td>+0.7³</td>
</tr>
<tr>
<td>Kenyan government-</td>
<td>Mission- or private sector-</td>
<td>+0.023⁴</td>
</tr>
<tr>
<td>provided health care</td>
<td>provided health care in Kenya</td>
<td></td>
</tr>
<tr>
<td>U.S. durum wheat</td>
<td>U.S. hard red spring wheat</td>
<td>+0.04⁵</td>
</tr>
<tr>
<td>U.S. hard red winter wheat</td>
<td>U.S. white wheat</td>
<td>+1.80⁵</td>
</tr>
<tr>
<td>U.K. beef/veal</td>
<td>U.K. pork</td>
<td>0.00⁶</td>
</tr>
<tr>
<td>U.K. mutton/lamb</td>
<td>U.K. beef/veal</td>
<td>+0.25⁶</td>
</tr>
</tbody>
</table>