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**elasticity** A general concept used to quantify the response in one variable when another variable changes.

\[ \text{elasticity of } A \text{ with respect to } B = \frac{\% \Delta A}{\% \Delta B} \]
Price Elasticity of Demand

Slope and Elasticity

**price elasticity of demand**  The ratio of the percentage of change in quantity demanded to the percentage of change in price; measures the responsiveness of quantity demanded to changes in price.

\[
\text{price elasticity of demand} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}}
\]
Price Elasticity of Demand

Types of Elasticity

**perfectly inelastic demand**  Demand in which quantity demanded does not respond at all to a change in price.

**perfectly elastic demand**  Demand in which quantity drops to zero at the slightest increase in price.

A good way to remember the difference between the two perfect elasticities is

[Image: Perfectly Elastic and Perfectly Inelastic]
Price Elasticity of Demand

Types of Elasticity

▲ FIGURE 5.2 Perfectly Inelastic and Perfectly Elastic Demand Curves

Figure 5.2(a) shows a perfectly inelastic demand curve for insulin. Price elasticity of demand is zero. Quantity demanded is fixed; it does not change at all when price changes.

Figure 5.2(b) shows a perfectly elastic demand curve facing a wheat farmer. A tiny price increase drives the quantity demanded to zero. In essence, perfectly elastic demand implies that individual producers can sell all they want at the going market price but cannot charge a higher price.
Price Elasticity of Demand

Types of Elasticity

**elastic demand**  A demand relationship in which the percentage change in quantity demanded is larger than the percentage change in price in absolute value (a demand elasticity with an absolute value greater than 1).

**inelastic demand**  Demand that responds somewhat, but not a great deal, to changes in price. Inelastic demand always has a numerical value between zero and -1.

**unitary elasticity**  A demand relationship in which the percentage change in quantity of a product demanded is the same as the percentage change in price in absolute value (a demand elasticity of -1).
Price Elasticity of Demand

Types of Elasticity

A warning:

You must be very careful about signs. Because it is generally understood that demand elasticities are negative (demand curves have a negative slope), they are often reported and discussed without the negative sign.
Calculating Elasticities

Elasticity Is a Ratio of Percentages

Once the changes in quantity demanded and price have been converted to percentages, calculating elasticity is a matter of simple division. Recall the formal definition of elasticity:

\[
\text{price elasticity of demand} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}}
\]

\[
\varepsilon_D = \frac{\frac{Q_2 - Q_1}{(Q_1 + Q_2)/2}}{\frac{P_2 - P_1}{(P_1 + P_2)/2}}
\]
Calculating Elasticities

The Midpoint Formula

**midpoint formula** A more precise way of calculating percentages using the value halfway between \( P_1 \) and \( P_2 \) for the base in calculating the percentage change in price and the value halfway between \( Q_1 \) and \( Q_2 \) as the base for calculating the percentage change in quantity demanded.

\[
\text{% change in quantity demanded} = \frac{\text{change in quantity demanded}}{(Q_1 + Q_2) / 2} \times 100\% \\
= \frac{Q_2 - Q_1}{(Q_1 + Q_2) / 2} \times 100\%
\]
Calculating Elasticities

The Midpoint Formula

Using the point halfway between $P_1$ and $P_2$ as the base for calculating the percentage change in price, we get

\[
\text{% change in price} = \frac{\text{change in price}}{(P_1 + P_2) / 2} \times 100\%
\]

\[
= \frac{P_2 - P_1}{(P_1 + P_2) / 2} \times 100\%
\]
Calculating Elasticities

The Midpoint Formula

**TABLE 5.1 Calculating Price Elasticity with the Midpoint Formula**

**First, Calculate Percentage Change in Quantity Demanded (\(\%\Delta Q_D\)):**

\[
\text{% change in quantity demanded} = \left(\frac{Q_2 - Q_1}{(Q_1 + Q_2) / 2}\right) \times 100% = \left(\frac{Q_2 - Q_1}{(Q_1 + Q_2) / 2}\right) \times 100%
\]

By substituting the numbers from Figure 5.1(a):

\[
\text{% change in quantity demanded} = \left(\frac{10 - 5}{(5 + 10) / 2}\right) \times 100% = \left(\frac{5}{7.5}\right) \times 100% = 66.7%
\]

**Price elasticity compares the percentage change in quantity demanded and the percentage change in price.**

\[
\frac{\% \Delta Q_D}{\% \Delta P} = \frac{66.7\%}{-40.0\%} = -1.67
\]

**Next, Calculate Percentage Change in Price (\(\%\Delta P\)):**

\[
\text{% change in price} = \left(\frac{P_2 - P_1}{(P_1 + P_2) / 2}\right) \times 100% = \left(\frac{P_2 - P_1}{(P_1 + P_2) / 2}\right) \times 100%
\]

By substituting the numbers from Figure 5.1(a):

\[
\text{% change in price} = \left(\frac{2 - 3}{(3 + 2) / 2}\right) \times 100% = \left(\frac{-1}{2.5}\right) \times 100% = -40.0%
\]

**Demand is elastic.**
TABLE 5.2 Demand Schedule for Office Dining Room Lunches

<table>
<thead>
<tr>
<th>Price (per Lunch)</th>
<th>Quantity Demanded (Lunches per Month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$11</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
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<td>2</td>
<td>18</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>22</td>
</tr>
</tbody>
</table>

* Elasticity of demand is not constant along a Demand Curve.

**FIGURE 5.3** Demand Curve for Lunch at the Office Dining Room
Between points $A$ and $B$, demand is quite elastic at $-6.4$. Between points $C$ and $D$, demand is quite inelastic at $-0.294$. 

CHAPTER 5 APPENDIX

Point Elasticity (Optional)

FIGURE 5A.2 Point Elasticity Changes Along a Demand Curve
Calculating Elasticities

Elasticity and Total Revenue

In any market, $P \times Q$ is total revenue ($TR$) received by producers:

\[
TR = P \times Q
\]

\[\text{total revenue} = \text{price} \times \text{quantity}\]

When price ($P$) declines, quantity demanded ($Q_D$) increases. The two factors, $P$ and $Q_D$, move in opposite directions:

- Effects of price changes on quantity demanded:
  - $P \uparrow \rightarrow Q_D \downarrow$
  - $P \downarrow \rightarrow Q_D \uparrow$

  and

\[\text{and} \]

\[\text{and} \]
Calculating Elasticities

Elasticity and Total Revenue

Because total revenue is the product of $P$ and $Q$, whether $TR$ rises or falls in response to a price increase depends on which is bigger: the percentage increase in price or the percentage decrease in quantity demanded.

Effect of price increase on a product with inelastic demand:

\[
\uparrow P \times Q_D \downarrow = TR \uparrow
\]

If the percentage decline in quantity demanded following a price increase is larger than the percentage increase in price, total revenue will fall.

Effect of price increase on a product with elastic demand:

\[
\uparrow P \times Q_D \downarrow = TR \downarrow
\]
The opposite is true for a price cut. When demand is elastic, a cut in price increases total revenues:

\[
\text{effect of price cut on a product with elastic demand:} \quad \downarrow P \times Q_D \uparrow = TR \uparrow
\]

When demand is inelastic, a cut in price reduces total revenues:

\[
\text{effect of price cut on a product with inelastic demand:} \quad \downarrow P \times Q_D \uparrow = TR \downarrow
\]
The Determinants of Demand Elasticity

Availability of Substitutes

Perhaps the most obvious factor affecting demand elasticity is the availability of substitutes.

The Importance of Being Unimportant

When an item represents a relatively small part of our total budget, we tend to pay little attention to its price.

The Time Dimension (Long-run vs. Short-run)

The elasticity of demand in the short run may be very different from the elasticity of demand in the long run. In the longer run, demand is likely to become more elastic, or responsive, simply because households make adjustments over time and producers develop substitute goods.
Elasticities at a Delicatessen in the Short Run and Long Run

The graph shows the expected relationship between long-run and short-run demand for Frank’s sandwiches.

Notice if you raise prices above the current level, the expected quantity change read off the short-run curve is less than that from the long-run curve.
**Other Important Elasticities**

**Income Elasticity of Demand**

**income elasticity of demand** A measure of the responsiveness of demand to changes in income.

\[
\text{income elasticity of demand} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in income}}
\]

\[
\varepsilon_I = \frac{Q_2 - Q_1}{(Q_1 + Q_2)/2}
\]

\[
= \frac{I_2 - I_1}{(I_1 + I_2)/2}
\]
Other Important Elasticities

Cross-Price Elasticity of Demand

cross-price elasticity of demand A measure of the response of the quantity of one good demanded to a change in the price of another good.

\[ \varepsilon_{X,Y} = \frac{\frac{Q_2^Y - Q_1^Y}{(Q_1^Y + Q_2^Y) / 2}}{\frac{P_2^X - P_1^X}{(P_1^X + P_2^X) / 2}} \]
Other Important Elasticities

Elasticity of Supply

**elasticity of supply** A measure of the response of quantity of a good supplied to a change in price of that good. Likely to be positive in output markets.

\[
\varepsilon_S = \frac{\frac{Q_2^S - Q_1^S}{(Q_1^S + Q_2^S) / 2}}{\frac{P_2 - P_1}{(P_1 + P_2) / 2}}
\]
Other Important Elasticities

Elasticity of Supply

\[ \text{elasticity of labor supply} = \frac{\text{% change in quantity of labor supplied}}{\text{% change in the wage rate}} \]
Looking Ahead

The purpose of this chapter was to convince you that measurement is important. If all we can say is that a change in one economic factor causes another to change, we cannot say whether the change is important or whether a particular policy is likely to work. The most commonly used tool of measurement is elasticity, and the term will recur as we explore economics in more depth.

We now return to the study of basic economics by looking in detail at household behavior. Recall that households demand goods and services in product markets but supply labor and savings in input or factor markets.
### REVIEW TERMS AND CONCEPTS

<table>
<thead>
<tr>
<th>Cross-price elasticity of demand</th>
<th>Inelastic demand</th>
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<td>Perfectly elastic demand</td>
</tr>
<tr>
<td>Elasticity of labor supply</td>
<td>Perfectly inelastic demand</td>
</tr>
<tr>
<td>Elasticity of supply</td>
<td>Price elasticity of demand</td>
</tr>
<tr>
<td>Income elasticity of demand</td>
<td>Unitary elasticity</td>
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