Elasticity

Definition of the Price Elasticity of Demand:

The law of demand states that the quantity demanded of a good will vary inversely with the price of the good during a given time period, but it does not tell how much that the quantity demanded will change in response to a price change. To measure the responsiveness of the quantity demanded of a good to a change in the price of the good, a measurement called price elasticity is used.

The price elasticity of demand\(^1\) is defined as the percentage change in the quantity demanded of a good that is caused by a 1% change in the price of the good. Since demand curves are downward sloping, the percentage change in the quantity demanded of a good is always of an opposite sign as the percentage change in the price of the good so the elasticity is a negative number. In practice, it is customary to ignore the negative sign and report the elasticity of a good as a positive number.

Formula for Elasticity:

Get the elasticity for a price change from \(P_0\) to \(P_1\). Assume that the quantity demanded changes from \(Q_0\) to \(Q_1\) as the price changes from \(P_0\) to \(P_1\).

\[
\varepsilon_d = \frac{\% \Delta \text{ Quantity Demanded}}{\% \Delta \text{ in Price}} = \frac{(Q_1 - Q_0)}{Q_0} \times \frac{P_0}{(P_1 - P_0)} = \frac{(Q_1 - Q_0)}{(P_1 - P_0)} \times \frac{P_0}{Q_0}.
\]

Types of Elasticity:

\[\varepsilon_d = \infty\]

\[\varepsilon_d = 0\]

\(^1\) The price elasticity of demand is usually referred to as elasticity.
Determinants of Elasticity:

1. **Availability of Substitutes.** A demand curve for a good becomes relatively more elastic as the number of substitutes for the good increases. For example, there were few substitutes for White-Out when it was first introduced so its demand curve was steep or relatively inelastic. As other liquid correcting fluids were introduced, the demand curve for White-Out became flatter or more elastic. While a change in the price of White-Out had a small affect on the quantity demanded of White-Out when it was first introduced, it has a much larger affect on the quantity demanded today because of the flatter or relatively more elastic demand curve. The availability of substitutes is the main factor that affects the elasticity of a demand curve.

2. **Length of the Adjustment Period.** A demand curve becomes relatively more elastic as the adjustment period increases. For example, a demand curve for water is likely to be very steep or relatively inelastic in the short run. As the adjustment period increases, people become adjusted to using less water (e.g. wash the car less) so the demand curve becomes flatter or relatively elastic. While a change in the price of water will have a small affect on the quantity demanded of water in the short run, it will have a larger effect on the quantity demanded in the long run because of the relatively elastic demand curve.

3. **Proportion of Budget that a Good Represents.** A demand curve for a good becomes relatively more elastic as the proportion of the budget that the good represents becomes larger. For example, the demand curve for salt is very steep or relatively inelastic while the demand curve for yachts is much flatter or more elastic. While a change in the price of salt will have a small affect on the quantity demanded of salt, a change in the price of yachts will have a larger affect on the quantity demanded of yachts because of the relatively elastic demand curve.
Relationship Between Elasticity and Total Revenue:

<table>
<thead>
<tr>
<th>Price</th>
<th>Total Revenue</th>
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<tbody>
<tr>
<td>(</td>
<td>\varepsilon_d</td>
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Revenue maximized when \( |\varepsilon_d| = 1 \).

Note:
- \( P \uparrow \Rightarrow Q \downarrow \Rightarrow TR \uparrow \) if in the inelastic region
- \( P \uparrow \Rightarrow Q \downarrow \Rightarrow TR \downarrow \) if in the elastic region
- \( P \downarrow \Rightarrow Q \uparrow \Rightarrow TR \uparrow \) if in the elastic region
- \( P \downarrow \Rightarrow Q \uparrow \Rightarrow TR \downarrow \) if in the inelastic region
**Definition of Income Elasticity of Demand:**

The income elasticity of demand is the percentage change in the quantity demanded of a good that results from a one percent change in income. It measures the responsiveness of demand to changes in income.

**Formula for Income Elasticity:**

Get the income elasticity for an income change from $I_0$ to $I_1$. Assume that the quantity demanded changes from $Q_0$ to $Q_1$ as income changes from $I_0$ to $I_1$.

\[
\varepsilon_I = \frac{\% \Delta \text{Quantity Demanded}}{\% \Delta \text{in Income}} = \frac{(Q_1 - Q_0)}{Q_0} \times \frac{I_0}{(I_1 - I_0)}
\]

where $I_0 = \text{initial income}$ and $I_1 = \text{new level of income}$.

**Income Elasticity and Types of Goods:**

1. $\varepsilon_I > 0 \Rightarrow \text{Normal Good}$. That is, the quantity demanded of the good varies directly with income.

2. $\varepsilon_I < 0 \Rightarrow \text{Inferior Good}$. That is, the quantity demanded of the good varies inversely with income.

3. $\varepsilon_I > 1 \Rightarrow \text{Luxury Good}$. That is, the percent change in the quantity demanded of the good is greater than the percent change in income.

4. $\varepsilon_I < 1 \Rightarrow \text{Necessity}$. That is, the percent change in the quantity demanded of the good is less than the percent change in income.
Engle Curves:

A Engle curve is a plot of the relationship between the quantity consumed of a good and income. See the Demand handout for a review of normal and inferior goods.

Definition of the Price Elasticity of Supply:

The price elasticity of supply is the percentage change in the quantity supplied of a good that results from a one percent change in the price of the good. It measures the responsiveness of supply to changes in price. In general, supply becomes more elastic with time.

Formula for the Price Elasticity of Supply:

Get the price elasticity of supply for a price change from $P_0$ to $P_1$. Assume that the quantity supplied changes from $Q_0$ to $Q_1$ as the price changes from $P_0$ to $P_1$.

$$\varepsilon_S = \frac{\% \Delta \text{Quantity Supplied}}{\% \text{Change in Price}} = \frac{(Q_1 - Q_0)}{(Q_0)} \div \frac{(P_1 - P_0)}{(P_0)} = \frac{(Q_1 - Q_0)}{Q_0} \times \frac{P_0}{(P_1 - P_0)}.$$
Types of Supply Elasticity:

![Supply Curves](image)

Rules:

1. If the supply curve intercepts the price axis, the elasticity of supply is \( \varepsilon_s > 1 \).
2. If the supply curve intercepts the quantity axis, the elasticity of supply is \( \varepsilon_s < 1 \).
3. If the supply curve goes through the origin, the elasticity of supply is \( \varepsilon_s = 1 \).

![Perfectly Elastic](image)

![Perfectly Inelastic](image)

\( \varepsilon_s = \infty \)

\( \varepsilon_s = 0 \)
Definition of the Cross Price Elasticity:

The cross price elasticity of demand is the percentage change in the quantity demanded of one good that results from a one percent change in the price of another good.

Formula for the Cross Price Elasticity:

Get the cross price elasticity of good x for a price change in good y from P₀ to P₁. Assume that the quantity demanded of good x changes from Q₀ to Q₁ as the price of good y changes from P₀ to P₁.

\[ \varepsilon_{cp} = \frac{\% \Delta \text{ Quantity Demanded}}{\% \Delta \text{ in Price}} = \frac{(Q_{x1} - Q_{x0})}{(P_{y1} - P_{y0})} \cdot \frac{Q_{x0}}{P_{y0}} = \left( \frac{Q_{x1} - Q_{x0}}{Q_{x0}} \right) \cdot \frac{P_{y0}}{(P_{y1} - P_{y0})} . \]

Cross Price Elasticity and Types of Goods:

1. \( \varepsilon_{cp} > 0 \Rightarrow \) Substitutes. That is, the quantity demanded of one good varies directly with the price and consumption of the other good.

2. \( \varepsilon_{cp} < 0 \Rightarrow \) Complements. That is, the quantity demanded of one good varies inversely with the price of the other good and directly with the consumption of the other good.

3. \( \varepsilon_{cp} = 0 \Rightarrow \) Independent goods. That is, the quantity demanded of one good is not related to the price and consumption of the other good.