What Are Elasticities?

- Measure of the relationship between two variables

\[
\text{Elasticity} = \frac{\text{Percentage change in } y}{\text{Percentage change in } x}
\]

- Elastic vs. inelastic
- Arc vs. point

Alfred Marshall

- Popularized concepts
  – Changed the name and face of economics

- Quirks

- Elasticities
Elasticities of Demand

• Own-price elasticity of demand
  – responsiveness of changes in quantity associated with a change in the good's own price

• Income elasticity of demand
  – responsiveness of changes in quantity associated with a change in income

• Cross-price elasticity of demand
  – responsiveness of changes in quantity associated with a change in price of another good

Own-Price Elasticity of Demand

Own-price elasticity of demand

\[ \text{Own-price elasticity} = \frac{(Q_A - Q_b)/(Q_A + Q_b)/2}{(P_A - P_b)/(P_A + P_b)/2} \]

= \frac{\Delta Q}{\frac{\Delta P}{P}} = \frac{\Delta Q}{\frac{\Delta P}{P}} = \frac{\Delta Q}{\Delta P} \frac{P}{Q} \]

• Interpretation -- 1% increase in price leads to a x% change in quantity purchased over this arc

Own-Price Elasticity

• Consumer bundle B to A
• Change in quantity 2 to 1
• Change in price 9 to 10
• What is the own-price elasticity of demand at this arc?
Math Details

- Recall change in quantity = 2 to 1 and price 9 to 10

\[
\% \text{ change in quantity} = \frac{(1-2)/((1+2)/2)}{} = -0.667
\]
\[
\% \text{ change in own price} = \frac{(10-9)/((10+9)/2)}{} = 0.105
\]

- or

\[
\frac{\Delta Q}{\Delta P} = \frac{(1-2)}{(10-9)} \cdot \frac{(10+9)/2}{(1+2)/2} = \frac{-1}{1} \cdot \frac{9.5}{1.5} = -6.33
\]

- Interpretation -- 1% increase in price leads to a 6.33% decrease in quantity purchased over this arc

Own-Price Elasticity

- Bundles C to D

\[
\% \text{ change in quantity} = \frac{(5-6)/(5+6)/2}{} = -0.18
\]
\[
\% \text{ change in own price} = \frac{(6-5)/(6+5)/2}{} = -1.00
\]

Unitary Elasticity -- 1% increase in price leads to a 1% decrease in quantity purchased over this arc

Own-Price Elasticity

- Bundles E to F

\[
\% \text{ change in quantity} = \frac{(8-9)/(8+9)/2}{} = -0.117
\]
\[
\% \text{ change in price} = \frac{(3-2)/(3+2)/2}{} = -0.40
\]

Interpretation -- 1% increase in price leads to a 0.29% decrease in quantity purchased over this arc
Generally elasticities vary over the curve and are generally negative. The law of demand states that a decrease in price will lead to an increase in quantity demanded. A linear demand curve is specific to elasticity and can be expressed as:

\[ \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q} \]

- Elastic where \( \% \Delta Q > \% \Delta P \)
- Unitary elastic where \( \% \Delta Q = \% \Delta P \)
- Inelastic where \( \% \Delta Q < \% \Delta P \)

**Own-Price Elasticity**

<p>| If value of the | Demand is said to be | %\Delta in quantity is |</p>
<table>
<thead>
<tr>
<th>elasticity</th>
<th>coefficient is</th>
<th>price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than -1.0</td>
<td>Elastic</td>
<td>Greater than %\Delta in price</td>
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**Use - example**

What is arc elasticity for corn between the prices of $15 (6 corn) and $20 (5 corn) / dozen?

[Diagram of Demand Curve for Corn]

\[ \text{Demand Curve for Corn} \]
Calculation of arc elasticity

- % change in Price = \( \frac{(20-15)}{(20+15)/2} \) = 0.28
- % change in Q = \( \frac{(5-6)}{(5+6)/2} \) = -0.18
- Own-price elasticity = \( \frac{-0.18}{0.28} \) = -0.63

Elastic or inelastic
- Why?

Goal is to increase revenues. The current price is $17.50 / dozen, should you increase or decrease price?

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Revenue Implications - Know

- Necessary information from earlier calculations
  - Price increase from 15 to 20
  - Quantity decreases from 6 to 5
  - Own-price elasticity = \( \frac{-0.18}{0.28} \) = -0.63
- Current price $17.50 with Q = 5.5
- Goal is to increase revenues
  - Current TR = 17.5 x 5.5 = 96.25
  - Increase price TR = 20 x 5 = 100
  - Decrease price TR = 15 x 6 = 90
Revenue Implications – Why?

**Unit Elasticity Demand Curve**
Brings about the same increase in the quantity demanded – definition of unit elasticity

![Diagram of unit elasticity demand curve]

Revenue = price \times quantity = consumer expenditures
Before change = area \( P_b C Q_b O \)
Cut in price
After Revenue = area \( P_a D Q_a O \)

Revenue Implications – Why?

**Unit Elasticity Demand Curve**
Loss in revenue due to price change = Gain in revenue due to quantity change

What about a price increase?

![Diagram of unit elasticity demand curve]

Revenue = price \times quantity = consumer expenditures
Before change = area \( P_b C Q_b O \)
Cut in price
After Change = area \( P_a D Q_a O \)

Revenue Implications – Why?

**Inelastic Demand Curve**
Brings about a smaller increase in the quantity demanded – definition of inelastic

![Diagram of inelastic demand curve]
Revenue Implications – Why?

**Inelastic Demand Curve**

Producer revenue **falls** since \( \% \Delta P \) is greater than \( \% \Delta Q \).

Revenue **before** the change was \( 0P_bCQ_b \).

Revenue **after** the change was \( 0P_aDQ_a \).

---

Revenue Implications – Why?

**Inelastic Demand Curve**

Producer revenue **falls** since the loss is greater than the gain.

---

Revenue Implications

**Elastic Demand Curve**

Cut in price brings about a larger increase in the quantity demanded.
Producer revenue **increases** since %ΔP is less than %ΔQ.

Revenue before the change was 0P, 0Q.
Revenue after the change was 0P, 0Q.

Revenue Implications - **Know**

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Relative Elasticities

- Perfectly inelastic
- Perfectly elastic

Quantity

Relative Elasticities

- Relatively more inelastic
- Relatively more elastic

Quantity

Long vs. Short-Run

- Demand curves tend to be more elastic (flatter) over time as consumers adjust to changing prices – Why?
Consumer Surplus

Gain in consumer surplus after the price cut is area $P_aP_bCD$.

Inelastic Demand Curve

Consumer surplus increased by area $P_aP_bCD$.

Income Elasticity of Demand

\[
\text{Income Elasticity of Demand} = \frac{\text{Percentage change in quantity}}{\text{Percentage change in income}} = \frac{(Q_b - Q_a)/[(Q_a + Q_b)/2]}{(I_b - I_a)/[(I_a + I_b)/2]}
\]

- Interpretation -- 1% increase in income leads to a $x\%$ change in quantity purchased over this arc.

Income Elasticity Example

- Income and Corn
  - Income change 200 to 400
  - Corn quantity change 5 to 9

- What is arc income elasticity of demand?

  \[
  \% \text{ change in quantity} = \frac{(9-5)/[9+5]/2}{(200-200)/[(400+200)/2]} = 0.66
  \]

  \[
  \% \text{ change in income} = \frac{0.66}{0.57} = 1.16
  \]

  Interpretation?
Interpreting the Income Elasticity of Demand - Know

<table>
<thead>
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<th>If the income elasticity is</th>
<th>The good is classified as</th>
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<td>Greater than 1.0</td>
<td>A luxury and a normal good</td>
</tr>
<tr>
<td>Less than 1.0 but greater than 0.0</td>
<td>A necessity and a normal good</td>
</tr>
<tr>
<td>Less than 0.0</td>
<td>An inferior good!</td>
</tr>
</tbody>
</table>

Interpreting the Income Elasticity of Demand

Cross-Price Elasticity of Demand

\[
\text{Cross-price elasticity} = \frac{\text{Percentage change in quantity of good } C}{\text{Percentage change in price of good } D} = \frac{(Q_{CA} - Q_{CB})/[(Q_{CA} + Q_{CB})/2]}{(P_{DA} - P_{DB})/[(P_{DA} + P_{DB})/2]}
\]

- Interpretation -- 1% increase in price of good D leads to a x% change in quantity purchased of good C over this arc

Cross-Price Elasticity Example

- Steak quantity and corn price
  - Corn price change from $20 to $15 / dozen
  - Steak quantity changes from 2.5 to 2.75 pounds
- What is arc cross-price elasticity of demand for steak?

\[
\frac{\text{% change in quantity steak}}{\text{% change in corn price}} = \frac{(2.75 - 2.5)/[(2.75 + 2.5)/2]}{(15 - 20)/[(15 + 20)/2]} = \frac{0.1}{-0.28} = -0.33
\]

Interpretation?
If the cross price elasticity is | The goods are classified as
---|---
Positive | Substitutes
Negative | Complements
Zero | Independent

Interpreting the Cross Price Elasticity of Demand - Know

Stimulus Bill Example

- 2009 Stimulus Bill
  - Included a up to a $1500 tax credit for insulation and energy efficient windows, doors, HVAC units

- What is a tax credit?

- Why pass the bill and potential economic effects? - nonpolitical

Stimulus Bill Insulation

- Assume you have calculated the following elasticities for insulation
  - Income elasticity of demand = 1.2
  - Own-price elasticity = -0.4
  - Cross price elasticity with lumber = -0.02
  - Cross price elasticity with energy = 0.09

- What is the effect of the stimulus bill given these elasticities? Recession has decreased incomes by 10%
**Stimulus Bill Insulation**

- Decrease in insulation sales – recession
  - \(-10\% \times 1.2 = -12\%\) - decrease in insulation sales
- Increase in insulation sales – stimulus bill
  - \(-30\% \times 0.4 = 12\%\) - increase in insulation sales
- Change in lumber sales – stimulus bill
  - \(-30\% \times 0.02 = 0.6\%\) - increase in lumber sales
- Change in energy use – stimulus bill
  - \(-30\% \times 0.09 = -2.7\%\) - decrease in energy use

**Costs of the Bill**

- Decrease in tax revenues – insulation tax credit
- Increase in tax revenues – increase in insulation sales
- Increase in tax revenues – increase in lumber sales
- Decrease in tax revenues – decrease in energy use
- Environmental / other
- Overall ?

**Price Flexibility of Demand**

- **Price flexibility** is the reciprocal of own price elasticity
  - Price flexibility = \(1/(\text{own price elasticity})\)

\[
\text{Price Flexibility of Demand} = \frac{\text{Percentage change in price}}{\text{Percentage change in quantity}}
\]

- Rearrange
  - \(\% \Delta \text{price} = \text{price flexibility} \times \% \Delta \text{quantity}\)
Price Flexibility Use Example

- If the calculated elasticity is -0.25, then the price flexibility = \( \frac{1}{-0.25} = 4.0 \)
- Useful concept to producers to help form price expectations
- Example USDA projects an additional 2% of supply will come on the market, what happens to price.

\[
\%\Delta \text{Price} = \text{price flexibility} \times \%\Delta \text{Quantity}
\]

\[
= -4.0 \times (+2\%) = -8\%
\]

If supply increases by 2%, price would fall by 8%.

Revenue Implications – Demand Elasticity and Changes in Supply

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Characteristic of agriculture

Summary - Know

- Know how to interpret all three elasticities
- Know how to interpret a price flexibility
- Understand revenue implications for producers if prices are cut (raised)
- Understand the welfare implications for consumers if prices are cut (raised)