3. Quantitative Demand Analysis

Key Concepts

- Elasticity
  - Price elasticity of demand $E_{Q_X^d, P_X}$
  - Price elasticity of supply $E_{Q_X^s, P_X}$
  - Cross-price elasticity $E_{Q_X^d, P_Y}$
  - Income elasticity $E_{Q_X^d, M}$
    - Normal goods
    - Inferior goods
  - Other elasticities
    - (Own) advertising elasticity
    - Cross-advertising elasticity between goods X and Y
- Econometrics
- Linear regression

Elasticity

Elasticity

A measure of responsiveness of one variable to changes in another variable.
The **percentage change** in one variable resulting from a **1% change** in another variable.
It is a **unit-free** measure.

∑ General Formula for Elasticity

In general, the elasticity between two variables G and S is given by:

$$\boxed{E_{G,S} = \frac{\%\Delta G}{\%\Delta S}} = \frac{dG/G}{dS/S} = \boxed{\frac{dG}{dS} \cdot \frac{S}{G}}$$

Own Price Elasticity of Demand

Price Elasticity of Demand

The **price elasticity of demand** measures the responsiveness of a percentage change in quantity demanded of a good X to a 1% change in its own price P_X.

∑ Price Elasticity of Demand

$$\boxed{E_{Q_X^d, P_X} = \frac{\%\Delta Q_X^d}{\%\Delta P_X} = \frac{dQ_X^d}{dP_X} \cdot \frac{P_X}{Q_X^d}}$$

By **law of demand**,

$$\boxed{E_{Q_X^d, P_X} < 0}$$

Categories of Price Elasticity of Demand

$$\begin{aligned} \textbf{Elastic demand}: & \quad |E_{Q_X^d,P_X}| > 1 \\ \textbf{Unitary elastic demand}: & \quad |E_{Q_X^d,P_X}| = 1 \\ \textbf{Inelastic demand}: & \quad |E_{Q_X^d,P_X}| < 1 \end{aligned}$$

Rule

- A **necessity** good is in**elastic**:

$$|E_{Q_X^d,P_X}| < 1$$

- A **luxury** good is **elastic**:

$$|E_{Q_X^d,P_X}| > 1$$

Graphical Interpretation (demand curve)

The price elasticity of demand is closely related to the slope of the demand curve.

Rule

The **flatter** the curve, the **bigger** the elasticity (in absolute value).
The **steeper** the curve, the **smaller** the elasticity (in absolute value).

Rule

Horizontal demand curve

- $E_{Q_X^d,P_X} = \frac{dQ_X^d}{dP_X} \cdot \frac{P_X}{Q_X^d} = -$
- **Perfectly elastic demand**
- Horizontal demand curve

Vertical demand curve

- $E_{Q_X^d,P_X} = \frac{dQ_X^d}{dP_X} \cdot \frac{P_X}{Q_X^d} = 0$
- **Perfectly inelastic demand**
- Vertical demand curve

!! Note that **elasticity varies along a linear demand curve** !!

Factors affecting Price Elasticity of Demand

Factors affecting Elasticity of Demand

1. **Availability of substitutes**:
   - **More substitutes more elastic** demand
     - Because consumers can easily switch to another good if the price of the good rises
   - *Broad* vs *narrow* definition
     - **Narrowly defined more elastic** demand because more substitutes
     - **Broadly defined more inelastic** demand because fewer substitutes
2. **Time horizon**:
   - E.g. gasoline
     - **Short run: inelastic** demand because few substitutes
     - **Long run: elastic** demand because more substitutes (e.g. electric cars, public transport)
3. **Necessities vs luxuries**:
   - **Necessities inelastic** demand
   - **Luxuries elastic** demand
   - *E.g. insulin vs vacations*
4. **Expenditure share**:
   - Small expenditure share inelastic demand
   - Large expenditure share elastic demand (price increase of a good with a large expenditure share significantly affects the consumer's budget, leading to a larger change in quantity demanded.)
   - *E.g. salt vs cars*

Price Elasticity and Total Revenue

Recall that

$$\text{Total Revenue} = P \times Q^d$$

The effect of a price change on total revenue **depends on the price elasticity of demand**.

Effect of Price Change on Total Revenue

Demand is **elastic**

- $|E_{Q_X^d, P_X}| > 1$
- Price increase leads to a decrease in total revenue
- $\boxed{\text{Price} \uparrow \qquad \text{Total Revenue} \downarrow}$

Demand is **inelastic**

- $|E_{Q_X^d, P_X}| < 1$
- Price increase leads to an increase in total revenue
- $\boxed{\text{Price} \uparrow \qquad \text{Total Revenue} \uparrow}$

Demand is **unitary elastic**

- $|E_{Q_X^d, P_X}| = 1$
- **Total revenue is maximized**
- $\boxed{\text{Price} \uparrow \qquad \text{Total Revenue unchanged}}$

Rule

Total revenue is maximized if is unitary elastic!

Cross-Price Elasticity

Cross-Price Elasticity

The **cross-price elasticity** measures the responsiveness of a percentage change in quantity demanded of a good X to a 1% change in the price of another good Y.

∑ Cross-Price Elasticity

$$\boxed{E_{Q_X^d,P_Y} = \frac{\%\Delta Q_X^d}{\%\Delta P_Y} = \frac{dQ_X^d}{dP_Y} \cdot \frac{P_Y}{Q_X^d}}$$

Categories of Cross-Price Elasticity

X and Y are:

$$\begin{aligned} \textbf{stittes}: &\quad E_{Q_X^d,P_Y} > 0 \\ \textbf{mlements}: &\quad E_{Q_X^d,P_Y} < 0 \\ \textbf{Unrelated ds}: &\quad E_{Q_X^d,P_Y} = 0 \end{aligned}$$

Income Elasticity

Income Elasticity

The **income elasticity** measures the responsiveness of a percentage change in quantity demanded of a good X to a 1% change in **income** M**.**

∑ Income Elasticity

$$\boxed{E_{Q_X^d,M} = \frac{\%\Delta Q_X^d}{\%\Delta M}}$$

Categories of Income Elasticity

Good X is:

$$\begin{aligned} \textbf{rmal d}: &\quad E_{Q_X^d,M} > 0 \\ \textbf{Inerir d}: &\quad E_{Q_X^d,M} < 0 \end{aligned}$$

Other Elasticities

(Own) Advertising Elasticity

The **(own) advertising elasticity** of demand for good X is the ratio of the percentage change in the consumption of X to the percentage change in advertising expenditure on X.

Cross-Advertising Elasticity between Goods X and Y

The **cross-advertising elasticity** between goods X and Y would measure the percentage change in the consumption of good X resulting from a 1% change in advertising expenditure on good Y.

Elasticities for (Non-)Linear Demand Functions

Linear Demand Function

Given a linear demand function:

$$Q_X^d = \alpha_0 + \alpha_X P_X + \alpha_Y P_Y + \alpha_M M + \alpha_H H$$

We have

$$\begin{aligned}
\textbf{n rice elasticity: } & \alpha_X \cdot \frac{P_X}{Q_X^d} \\
\textbf{rssrice elasticity: } & \alpha_Y \cdot \frac{P_Y}{Q_X^d} \\
\textbf{Incme elasticity: } & \alpha_M \cdot \frac{M}{Q_X^d}
\end{aligned}$$

Log-Linear Demand Function

One non-linear demand function is the **log-linear demand function**:

$$\boxed{\ln Q_X^d = \beta_0 + \beta_X \ln P_X + \beta_Y \ln P_Y + \beta_M \ln M + \beta_H \ln H}$$

We have

$$\begin{aligned}
\textbf{n rice elasticity: } & \beta_X \\
\textbf{rssrice elasticity: } & \beta_Y \\
\textbf{Incme elasticity: } & \beta_M
\end{aligned}$$

Econometrics

Econometrics

Econometrics is about how we can use theory and data from economics, business and the social sciences, along with tools from statistics, to **answer "how much" questions**.

An economic model consists of

- **systematic part**
- **random, unpredictable component e = random error**

Linear Regression

Trivial.