Chapter 5: Demand Estimation

🟩 1. Interview and Experimental Methods

🗣️ Consumer Interview Method

- Useful when **market data is scarce**.
- Example: Comparing awareness of price differences across brands can reveal **price sensitivity**.
- ❗ Beware: **Consumer opinion ≠ actual behavior**.

🔬 Experimental Method

- Controlled experiments vary factors like price or packaging in similar markets.
- Example: BP testing fuel price changes in London vs Paris.
- Can analyze effects of **demographics** (income, education, etc.).
- ⚠️ **Limitations**:
  - Expensive, **low confidence**, **uncontrolled external variables** (e.g., strikes or snowstorms).
  - May not be generalizable.
  - **Lost customers** during price changes might not return.

🟩 2. Simple Demand Curve Estimation

🔁 Linear Demand Function Example

Manchester United Ticket Pricing

- Price dropped: £200 → £180
- Sales rose: 32,000 → 40,000

Inverse demand equation:

$$P = a + bQ$$

$$b = \Delta P / \Delta Q = (180 - 200)/(40000 - 32000) = -0.0025$$

Solve for a:

$$a = 280$$

Demand Function:

$$P = 280 - 0.0025Q$$

$$Q = 112,000 - 400P$$

Total Revenue (TR):

$TR = PQ = (280 - 0.0025Q)Q = 280Q - 0.0025Q^2$

Marginal Revenue (MR):

$MR = d(TR)/dQ = 280 - 0.005Q$

Set $MR = 0$:

$Q = 56,000,\ P = 140,\ TR = £7,840,000$

🎯 **Conclusion**: Optimal revenue when price = £140 and Q = 56,000. Fixed cost → profit maximization too.

🟩 3. Market Demand Curve Estimation

- **Market demand** = sum of individual demand quantities.
  - Add **quantities**, not prices.
- Example (Bayer AG):

Domestic:

$P_D = 100 - 0.001Q_D \rightarrow Q_D = 100,000 - 1000P$

Foreign:

$P_F = 80 - 0.004Q_F \rightarrow Q_F = 20,000 - 250P$

Total:

$Q_T = Q_D + Q_F = 120,000 - 1250P$

$\rightarrow P = 96 - 0.0008Q_T$

📈 Profit Maximization

Given:

$TC = €1,200,000 + €24Q$

$MR = 96 - 0.0016Q,\ MC = 24$

Set $MR = MC$:

$Q = 45,000,\ P = €60$, Profit = €420,000

🟩 4. Identification Problem

- Difficulty arises due to **simultaneous changes** in supply/demand.
- A shift in either can **distort** the true demand curve.
- ❓ **Can AB line represent demand curve?**
  - No, if **non-price factors** are changing at each point.

🎯 **Key Issue**: Can't determine if movements are **along** the curve or **between equilibria**.

🟩 5. Regression Analysis

📊 Deterministic vs. Statistical

- **Deterministic**: known by definition (e.g., TR = P×Q)
- **Statistical**: estimated from data (e.g., demand regression)

🧮 Regression Model Specification

Basic form:

$$Y_t = b_0 + b_x X_t + u_t$$

- **Residual** u_t: deviation from actual value.
- **Goal**: minimize $\sum u_t^2$

📌 Regression Assumptions:

- Normal errors
- Mean error = 0
- Constant variance (homoscedasticity)
- No autocorrelation

🟩 6. Non-Linear Demand Functions

📄 Multiplicative Model

$$Q = b_0 P^{b_1} A^{b_2} I^{b_3}$$

In log form:

$$\log Q = \log b_0 + b_1 \log P + b_2 \log A + b_3 \log I$$

Where:

- b_1: price elasticity
- b_2: advertising elasticity
- b_3: income elasticity

🟩 7. Model Evaluation Metrics

📏 Standard Error of Estimate (SEE):

- Measures **scatter** around regression line.

📐 Goodness of Fit

- **Correlation coefficient (r)**: strength of relationship
- R^2: % of variance in Y explained by X
- **Adjusted R^2**: corrects R^2 for sample size

🧪 F-statistic:

- Tests **overall model** significance

🧪 t-statistic:

- Tests individual variable significance:
  $t = \frac{\text{Estimated Coefficient}}{\text{Standard Error}}$
- If $t > 2$: 95% confidence
- If $t > 3$: 99% confidence

🟩 8. Problems in Regression

❗ Multicollinearity

- Explanatory variables are highly correlated.
- Effects:
  - High SE, low t-values
  - Unreliable significance

Fixes:

1. Increase sample
2. Drop a variable
3. Use prior info
4. Transform function

❗ Heteroscedasticity

- Error variance changes with X.
- Common in **cross-sectional** data.

Fixes:

- Use logs
- Weighted least squares

❗ Autocorrelation

- Consecutive errors correlated (mostly in **time-series** data)

Durbin-Watson Test:

- $d = 2$ → No autocorrelation
- $d < 2$ → Positive autocorrelation
- $d > 2$ → Negative (rare)

📌 Final Summary

Metric	Meaning
R^2	Fit of model
F-Test	Overall model significance
t-Test	Variable significance
P-Value	Accuracy of each coefficient