ELASTICITY

- A measure of responsiveness or sensitivity
- The responsiveness of the dependent variable (quantity) to changes in the independent variable (price)
- The importance of the responsiveness is the percentage change in each variable.
- Elasticity = $\frac{\%\text{ change in dependent variable}}{\%\text{ change in independent variable}}$
- 4 types of elasticity:
  - Price elasticity of demand
  - Income elasticity of demand
  - Cross elasticity of demand
  - Price elasticity of supply
- Price elasticity of demand = the % change in quantity demanded if the price of a good changes, ceteris paribus
- Calculation of price elasticity of demand:

$$ep = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in price of good}}$$

- Example:

$\%\,\Delta P = 5\%$

$\%\,\Delta Qd = 10\%$

$ep = \frac{\%\,\Delta Qd}{\%\,\Delta P}$

$$(-1) \quad \frac{\% \Delta Q}{\% \Delta P}$$

$$= (-1) \frac{10}{-5}$$

$$= \underline{2}$$

5. The coefficient of elasticity is <u>not</u> a percentage

- Calculation of price elasticity of demand
  - Calculate % ΔQd
  - Calculate % ΔP
  - $\% \Delta Qd = \frac{\Delta Qd}{Qd} \times \frac{100}{1}$

Where P = Price
ΔP = Change in price

- Price elasticity of demand (ep)

$$\frac{\% \Delta Qd}{\% \Delta P}$$

$$\frac{\frac{\Delta Qd}{Qd} \times \frac{100}{1}}{\frac{\Delta P}{P} \times \frac{100}{1}}$$

$$= \frac{\frac{\Delta Qd}{Q}}{\frac{\Delta P}{P}}$$

$$= \frac{\Delta Qd}{Q} \times \frac{P}{\Delta P}$$

$$ep = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

➢ **Example:**

CD player	:	Price R400
ΔP	=	R50
New price	=	R350
Quantity	=	800
ΔQ	=	200
New quantity	=	1 000

➢ Calculation of ep:

$$\frac{\frac{\Delta Q}{Q} \times 100}{\frac{\Delta P}{P} \times 100}$$

➢ Linear demand curve means ep varies from infinity (∞) to where D-curve meets axis at zero (0)

$$\frac{10}{5}$$

$$= \frac{2}{}$$

➢ **Note:**

1. Elasticity calculated by % changes
   - Relative changes not absolute changes
   - If % changes are used, the actual units of measure of price and quantity changes do not impact on the result

2. Price elasticity of demand is the ratio of % change in Qd to % change in price
   The ratio: coefficient of elasticity

3. Coefficient of elasticity allows comparisons to be made of how consumers respond to changes in price of different goods/services.
   Example: R1.00 change in price a boat is different to R1.00 change in price of a chocolate.

4. Negative sign of coefficient of price elasticity of demand

P↑ Qd↓

P↓ Qd↑

❖ Ways of dealing with negative sign
   - Include minus sign
   - Ignore minus sign

TOTAL REVENUE AND PRICE CHANGES

PRICE DECREASES -TOTAL REVENUE INCREASES

PRICE INCREASES -TOTAL REVENUE DECREASES

DEMAND IS ELASTIC

PRICE DECREASES – TOTAL REVENUE DECREASES

PRICE INCREASES – TOTAL REVENUE INCREASES

DEMAND IS INELASTIC

PRICE INCREASES

PRICE DECREASES

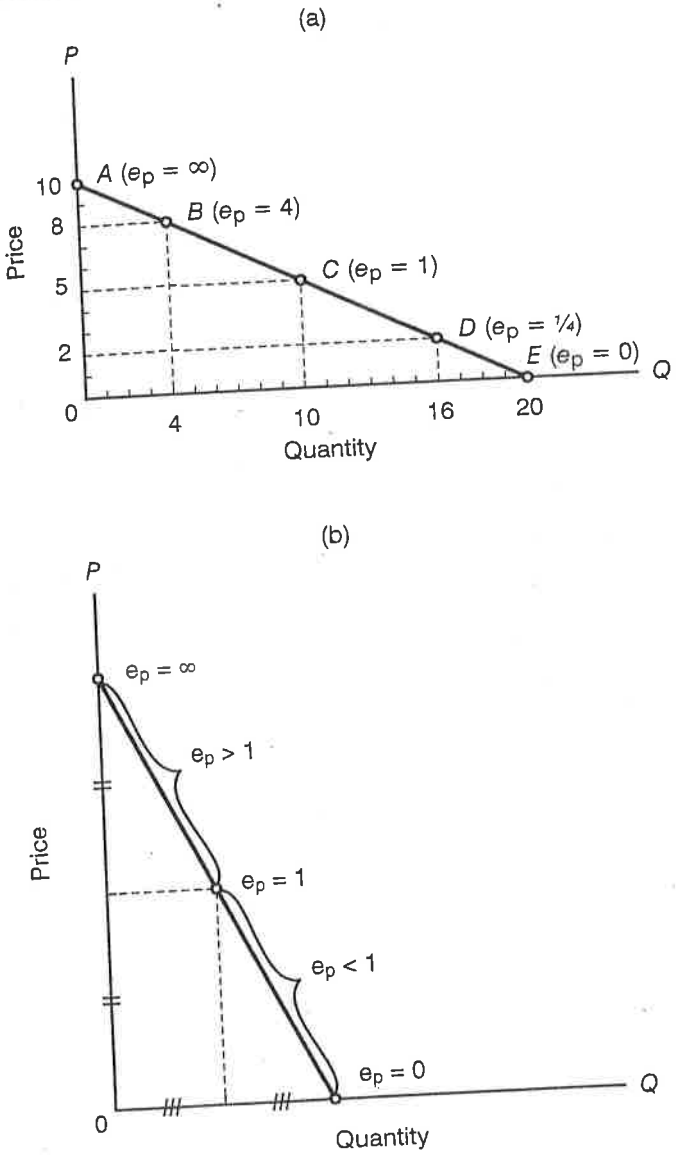
TOTAL REVENUE CONSTANT

DEMAND IS UNITARY

RELATIONSHIP BETWEEN PRICE CHANGES AND TOTAL REVENUE IS IMPORTANT TO BUSINESS.

FIRMS MUST KNOW WHETHER RAISING PRICES WOULD INCREASE OR DECREASE REVENUE

FIRMS MUST ALSO KNOW WHETHER CUTTING PRICES WOULD INCREASE OR DECREASE REVENUE



URE 8-7 Price elasticity of demand at different points along a linear demand curve. *The line through points A, B, C, D and E in (a) represents a linear demand curve. The price elasticity of demand is different at each point along the curve, varying from infinity (∞) where it meets the price axis to zero where it meets the quantity axis. The results are summarised in (b).*

- **The example shows:**
  - **As long as e_p >1 the TR increases as the quantity sold (Q) increases.**
  - **TR reaches a maximum when e_p = 1**
  - **When e_p is <1 then TR falls as the quantity sold (Q) increases.**

- **5 categories of price elasticity of demand**
  - **Perfectly inelastic demand**
    Coefficient is zero
  - **Relatively inelastic demand**
    Coefficient between 0 and 1
  - **Unit elastic demand = unitary elasticity**
    Coefficient = 1
  - **Relatively elastic demand**
    Coefficient between 1 and infinity
  - **Perfectly elastic demand**
    Coefficient is infinity (∞)

➢ **Example:**

TR for pies on campus

Price In Rand	Quantity Demanded	Total Revenue	Price Elasticity Of demand
10	0	0	∞
9	1000	9000	5.5
8	2000	16000	2.1
7	3000	21000	1.9
6	4000	24000	1.45
5	5000	25000	1
4	6000	24000	.8
3	7000	21000	.3
2	8000	16000	.18
1	9000	9000	0

- If ΔP leads to a > ΔQd the coefficient of elasticity is >1 the TR (P x Q) will change in the opposite direction to ΔP.

- If ΔP leads to an equi-proportional (similar) change in quantity demanded. The coefficient elasticity will be =1, then TR (P x Q) will remain unchanged.

- If ΔP leads to a < ΔQd the coefficient of elasticity will be less than 1, then TR (P x Q) will change in the same direction as the price change

Solution:

$$\frac{(5000 - 4000) / (4000 + 5000)}{(2500 - 3000) / (3000 + 2500)}$$

$$= \frac{(1000) / (9000)}{(500) / (5500)}$$

$$= \frac{1000}{9000} \Big/ \frac{500}{5500}$$

$$= \frac{.11}{.09}$$

$$= 1.2$$

Price Elasticity of Demand and Total Revenue

- Price elasticity of demand can be used to determine:
  - By how much total expenditure by consumers on a good changes when the price of that good changes
    = By how much Total Revenue (TR) changes
  - Note: An inverse relationship between price and quantity demanded exists
  - Thus: Any ΔP leads to a ΔQd
    The effect of the ΔP on TR will depend on the relative sizes of the ΔP and ΔQd.

∴ Coefficient of elasticity is >1

- This method of calculating the coefficient is known as Arc Elasticity
- Arc elasticity uses: Average price and Average quantity
- Formula for arc elasticity:

$$ep = \frac{(Q_2 - Q_1) / [(Q_1 + Q_2)/2]}{(P_2 - P_1) / [(P_1 + P_2) / 2]}$$

*Note:
1. The calculation above and below the line are in percentages (100) but the 100's cancel out.
2. The 2's also cancel out.

- Thus:

$$ep = \frac{(Q_2 - Q_1) / (Q_1 + Q_2)}{(P_2 - P_1) / (P_1 + P_2)}$$

- Example:
  - If the price of a Winesap Personal Computer falls from R3 000 each to R2 500 each and the quantity demanded increases from 4 000 to 5 000 per year.
  - Calculate the arc elasticity of demand for Winesap Personal Computers.

- Average quantity: $\frac{2000 + 4000}{2} = 3000$

- $\% \Delta P = \frac{6}{21} \times \frac{100\%}{1}$

  $= \frac{600\ \%}{21}$

  $= \underline{28.6\%}$

- $\% \Delta Qd = \frac{2000}{3000} \times \frac{100\ \%}{1}$

  $= \frac{200}{3}$

  $= \underline{66.7\%}$

- $ep = \frac{\frac{200}{3}}{\frac{600}{21}}$

  $= \frac{200}{3} \times \frac{21}{600}$

  $= \frac{4200}{1800}$

  $= \frac{7}{3}$

  $= \underline{2.33}$

- In theory the 2 diagrams (fig. 8-7 a + b) are correct but such a presentation is not realistic because:
  - Prices hardly fall to zero
  - Prices seldom rise to such a high level that demand is zero

- If a graph is used to represent the price of beef and the quantity demanded
  - At A the price is R24 per kg
    Quantity demanded is 2kg
  - At a price of R30 no beef is demanded
  - At a price of R15 per kg
    Quantity demanded is 5kg
    - The coefficient of elasticity is = 1
    - At prices above R15 per kg the coefficient of elasticity is >1
    - At prices below R15 per kg the coefficient of elasticity is <1

- If the price only varies between R18 and R24 per kg. Which is realistic – the relevant part is between point A and B.
  - At any point between A and B the e_p is >1

- $e_p = \frac{\% \Delta Qd}{\% \Delta P}$

  - Questions: Which price?
    Which quantity?

  - Solution: Average price = mid-point
    Average quantity – mid-point

- Average price : $\frac{(R18 + 24)}{} = R21$

- The slope of the demand curve is

$$\frac{\Delta P}{\Delta Qd}$$

  - First part of right hand side of the equation $\frac{\Delta Q}{\Delta P}$ represents the inverse of the slope of a linear D-curve
  - Since the slope of a straight line is constant The inverse of the slope is also constant
  - Second part of right hand side of equation ($\Delta Q/\Delta P$) represents ratio between price (P) and quantity (Q) at a point on D-curve
  - This ratio varies along D-curve, the price elasticity of demand will be different at each point on D-curve

- Numerical example:

Fig. 8.7 (a)

- Linear demand curve with a constant slope of ½
- Inverse of slope is 2 and is also constant
- Applying the formula: $\frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$
- To calculate multiply 2 by P The ratio of P to Q
- At Δ the price is 10 and quantity is 0. Ratio of P to Q is $\frac{10}{0}$ which is infinity (∞)

- Infinity multiplied by 2 = infinity
  - At B the price is 8 and the quantity is 4
    Thus P/Q = $\frac{8}{4} = 2$
    and ep = 2 x 2 = 4
  - At C the price is 5 and the quantity is 10
    Thus P/Q = $\frac{5}{10} = \frac{1}{2}$
    ep = 2 x ½ = 1
  - At D the price is 2 and the quantity is 16
    Thus P/Q = $\frac{2}{16} = \frac{1}{8}$
    ep = 2 x ⅛ = ¼

- Average quantity: $\frac{2000 + 4000}{2} = 3000$

- $\% \Delta P = \frac{6}{21} \times \frac{100\%}{1}$

$= \frac{600\ \%}{21}$

$= \underline{28.6\%}$

- $\% \Delta Qd = \frac{2000}{3000} \times \frac{100\ \%}{1}$

$= \frac{200}{3}$

$= \underline{66.7\%}$

- $ep = \frac{\frac{200}{3}}{\frac{600}{21}}$

$= \frac{200}{3} \times \frac{21}{600}$

$= \frac{4200}{1800}$

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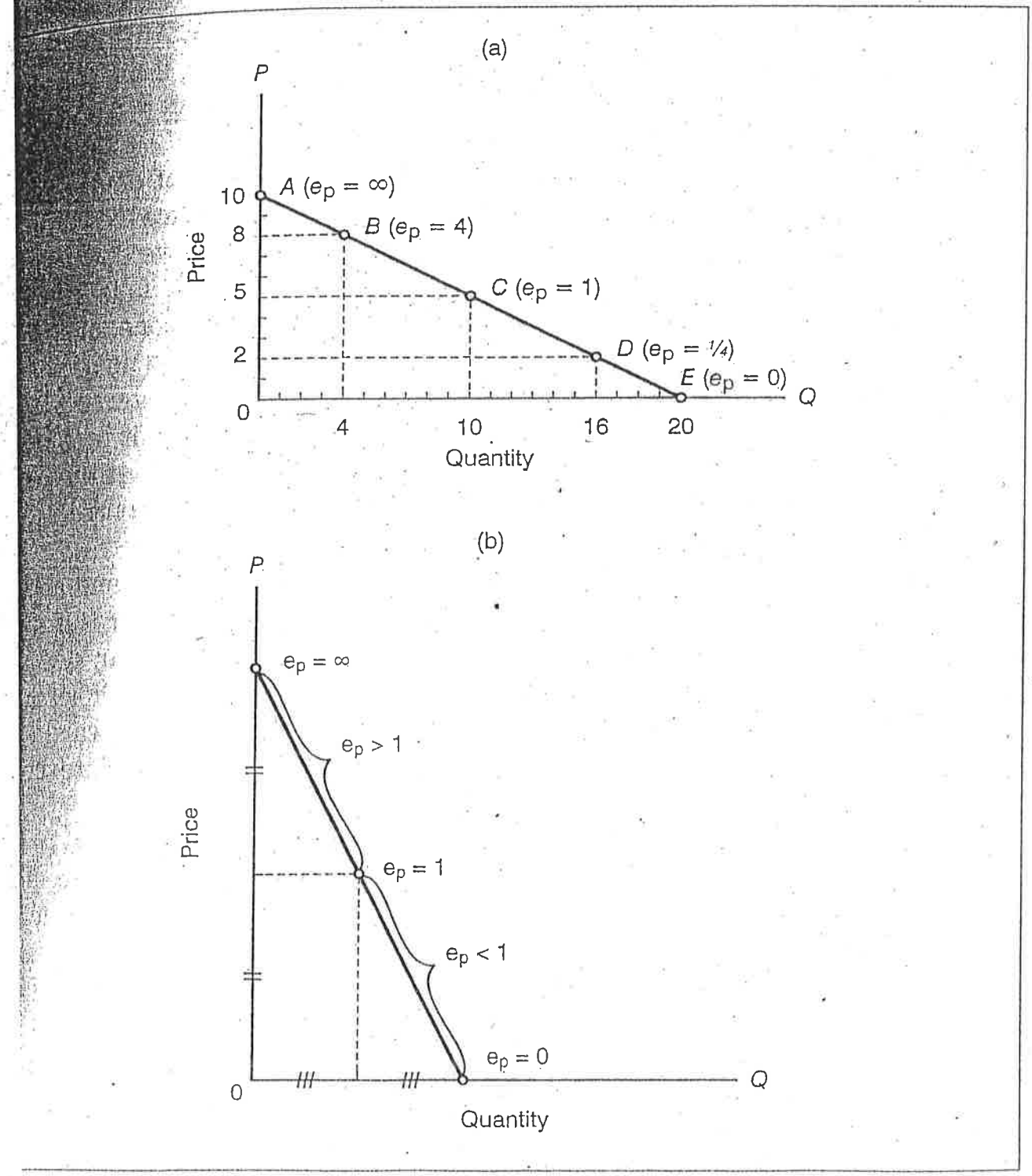

URE 8-7 Price elasticity of demand at different points along a linear

➢ Numerical example:

$$ep = \frac{(19 - 17) / 17 + 19)}{(8 - 10) / (10 + 8)}$$

$$= \frac{2/36}{2/18}$$

$$= \frac{2}{36} \div \frac{2}{18}$$

$$= \frac{2}{36} \times \frac{18}{2}$$

$$= \frac{1}{2}$$

$$\frac{\frac{200}{800} \times 100}{\frac{50}{400} \times 100}$$

$$= \frac{200}{50} \times \frac{400}{800}$$

$$\frac{4}{1} \times \frac{1}{2}$$

$$= 2$$

- 2 = the coefficient of elasticity
  = not a percentage

$$= \frac{\frac{\Delta Qd}{Q}}{\frac{\Delta P}{P}}$$

$$= \frac{\Delta Qd}{Q} \times \frac{P}{\Delta P}$$

$$ep = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

➢ Example:

CD player	:	Price R400
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➢ Calculation of ep:

$$\frac{\frac{\Delta Q}{Q} \times 100}{\frac{\Delta P}{P} \times 100}$$

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$$(-1) \quad \frac{\% \Delta Q}{\% \Delta P}$$

$$= (-1) \frac{10}{-5}$$

$$= \underline{2}$$

5. The coefficient of elasticity is <u>not</u> a percentage

- Calculation of price elasticity of demand
  - Calculate % ΔQd
  - Calculate % ΔP
  - $\% \Delta Qd = \frac{\Delta Qd}{Qd} \times \frac{100}{1}$

Where Qd = Quantity demanded
ΔQd = Change in quantity demanded

- $\% \Delta P = \frac{\Delta P}{P} \times \frac{100}{1}$

Where P = Price
ΔP = Change in price

- Price elasticity of demand (ep)

$$\frac{\% \Delta Qd}{\% \Delta P}$$

$$\frac{\frac{\Delta Qd}{Qd} \times \frac{100}{1}}{\frac{\Delta P}{P} \times \frac{100}{1}}$$

$$\frac{10}{5}$$

$$= \frac{2}{}$$

➢ Note:

1. Elasticity calculated by % changes
   - Relative changes not absolute changes
   - If % changes are used, the actual units of measure of price and quantity changes do not impact on the result

2. Price elasticity of demand is the ratio of % change in Qd to % change in price
   The ratio: coefficient of elasticity

3. Coefficient of elasticity allows comparisons to be made of how consumers respond to changes in price of different goods/services.
   Example: R1.00 change in price a boat is different to R1.00 change in price of a chocolate.

4. Negative sign of coefficient of price elasticity of demand

   P↑ Qd↓

   P↓ Qd↑

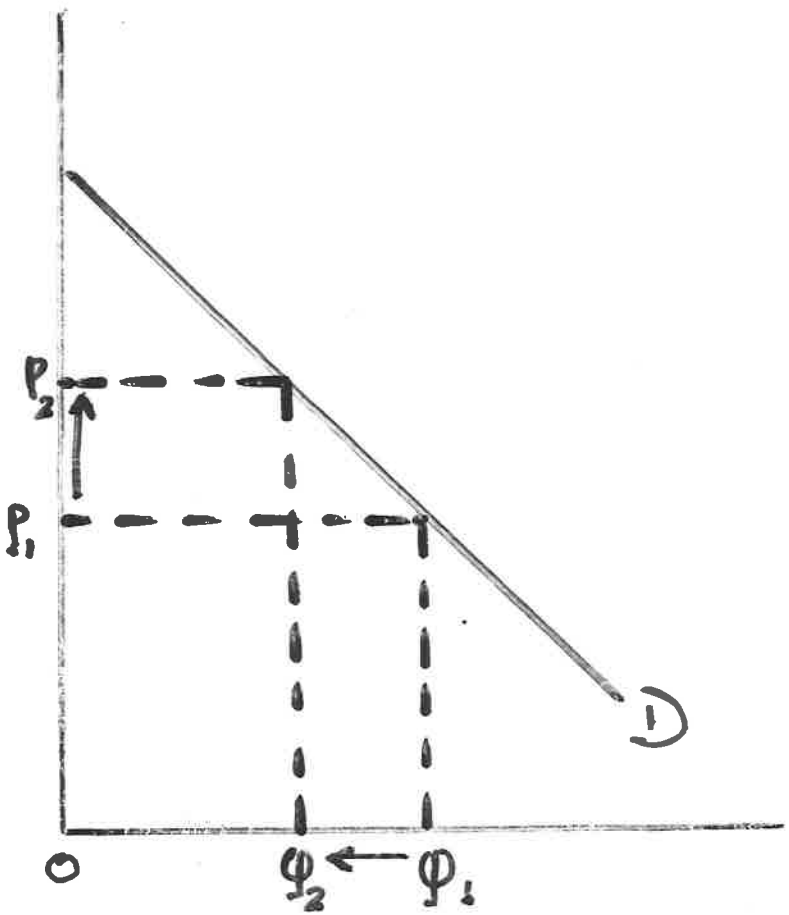
   ❖ Ways of dealing with negative sign
   - Include minus sign
   - Ignore minus sign

PRICE ELASTICITY OF SUPPLY

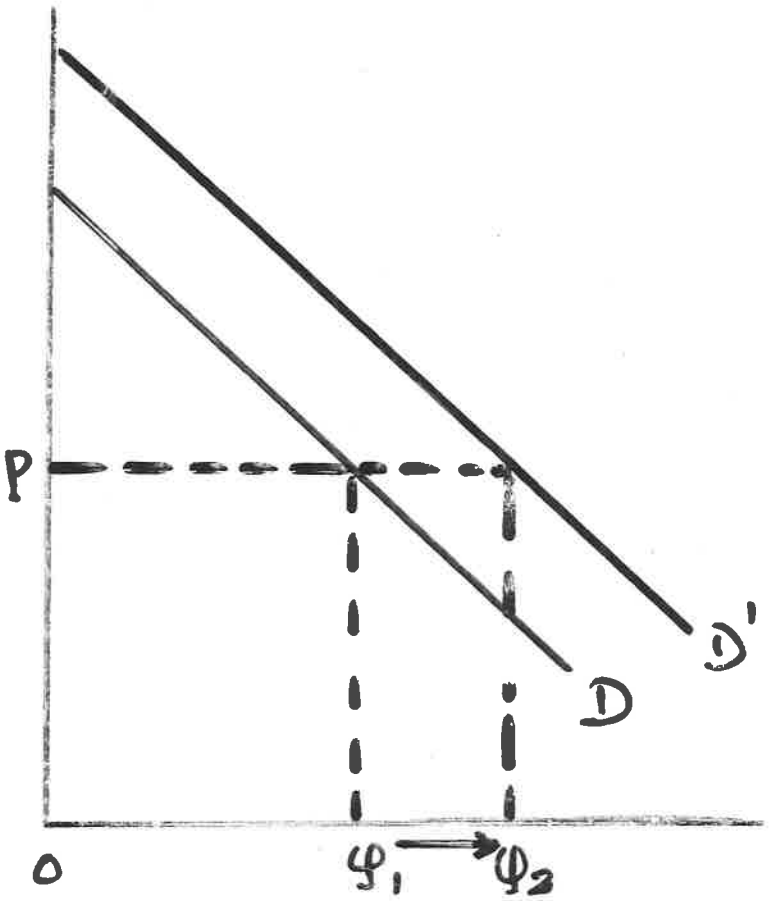
- Measures the responsiveness of the quantity supplied (Qs) to change in price of a good
- Price elasticity of supply (es) is the ratio between the percentage change in quantity supplied of a good to the percentage change in the price of that good
- Qs is the dependent variable and price (P) is the independent variable
- $Es = \frac{\%\Delta Qs}{\%\ \Delta P}$
- Since quantity of a good supplied increases as the price of a good increases price elasticity of supply is easier to interpret that price elasticity of demand
- 5 categories of price elasticity of supply
    - Perfectly inelastic supply (es = 0)
    - Fairly inelastic supply (es = >0 but <1)
    - Unit elasticity of supply (es = 1)
    - Fairly elastic supply (es = ∞)
- Price elasticity of supply depends on the time elapsed since the change in price
- It takes time for the quantity supplied (Qs) to a change in price
- The adjustment may only occur in the long-run

CROSS ELASTICITY OF DEMAND

- The demand for a good will depend on its price but also the price of related goods
- Cross elasticity of demand measures the responsiveness of Qd of a particular good to changes in price of a related good
- Cross elasticity (ec) is the ratio between the %ΔQd of a good and the %ΔP of a related good
- %ΔQd is the dependent variable %ΔP is the dependent variable
- $ec = \frac{\%\Delta Qd \text{ of good A}}{\%\Delta P \text{ of good B}}$
- Cross elasticity will affect 2 types of related goods:
  - Substitutes
  - Complementary goods
- Substitutes are goods used in place of each other – red meat and white meat: beef and chicken
- A change in price of good A (beef) will cause a change in demand for good A



GOOD A: COFFEE



GOOD B: TEA

SUBSTITUTES

- If good B (chicken) is substituted for good A (beef) there will be a change in demand for good B

- An increase in price for good A (beef) will cause a decrease in demand for good A = a movement along the demand curve

- There will be an increase in demand for good B (chicken) – an upward shift in the D-curve

- The change in demand for good B will be in the same direction as the change in price for good A

- $Ec = \frac{\%\Delta Qd \text{ of Good B}}{\%\Delta P \text{ of Good A}}$

    - Example: 5% change in price of Good A
    - 7.5% change in Qd of Good B

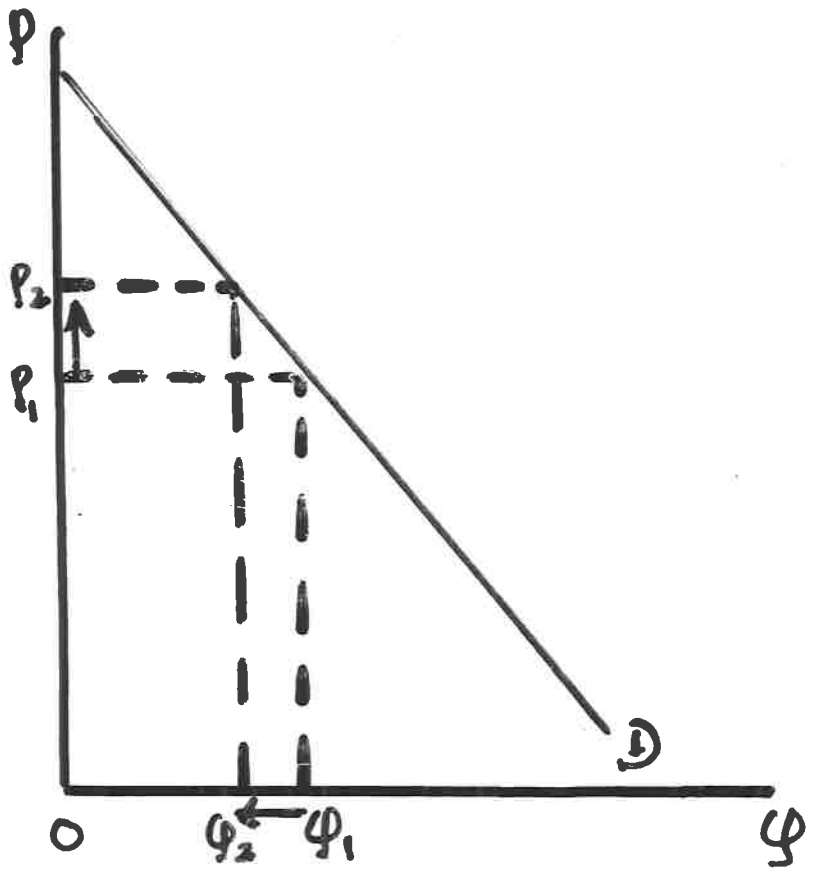
$$= \frac{7.5}{5}$$

$$= \underline{1.5}$$

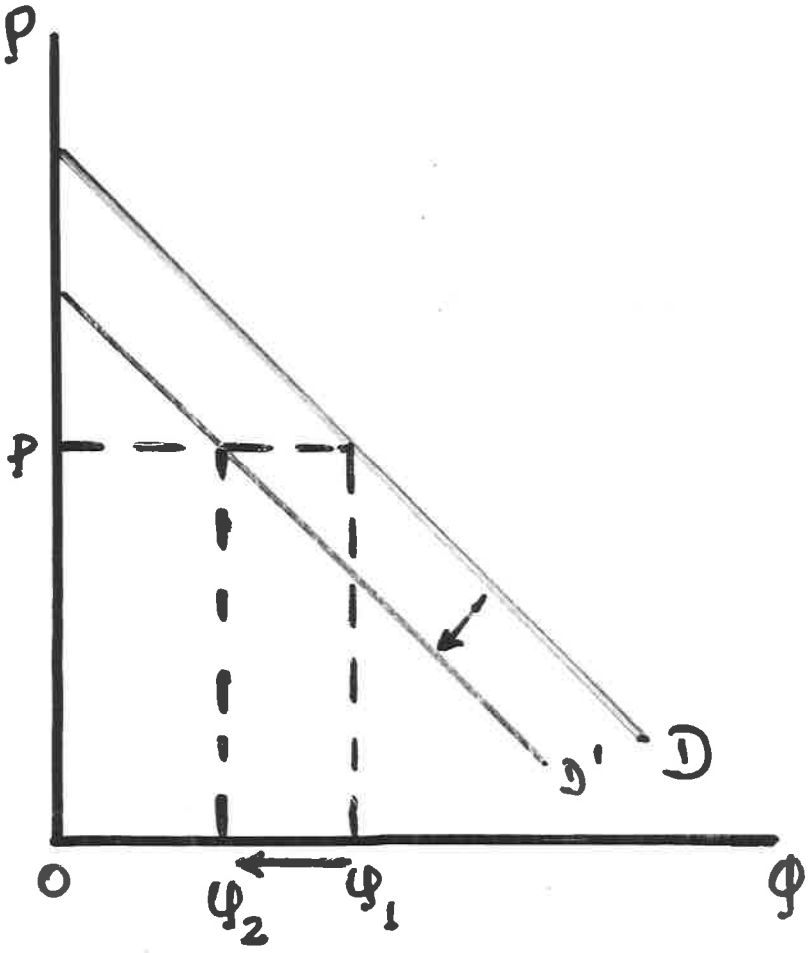
    - Note coefficient of cross elasticity >1

- Cross elasticity of demand is positive

- Cross elasticity of demand for complementary goods



GOOD A: TABLES



GOOD B: CHAIRS

COMPLEMENTARY GOODS

- Complementary goods are goods used jointly
- Example: tables (Good A) and chairs (Good B)

- If price of tables increases demand for tables will decrease – movement along the D-curve

- There will be a corresponding shift in demand for chairs – downward shift of D-curve

- The change in demand for Good B (chairs) in opposite direction to change in price for Good A (tables)

- Cross elasticity of demand is negative

- $Ec = \frac{\%\Delta Qd \text{ of Good B}}{\%\Delta p \text{ of Good A}}$

  - Example: 5% increase in price of Good A
    8% decrease in Qd of Good B

$$= \frac{8}{5}$$

$$= \underline{1.6}$$