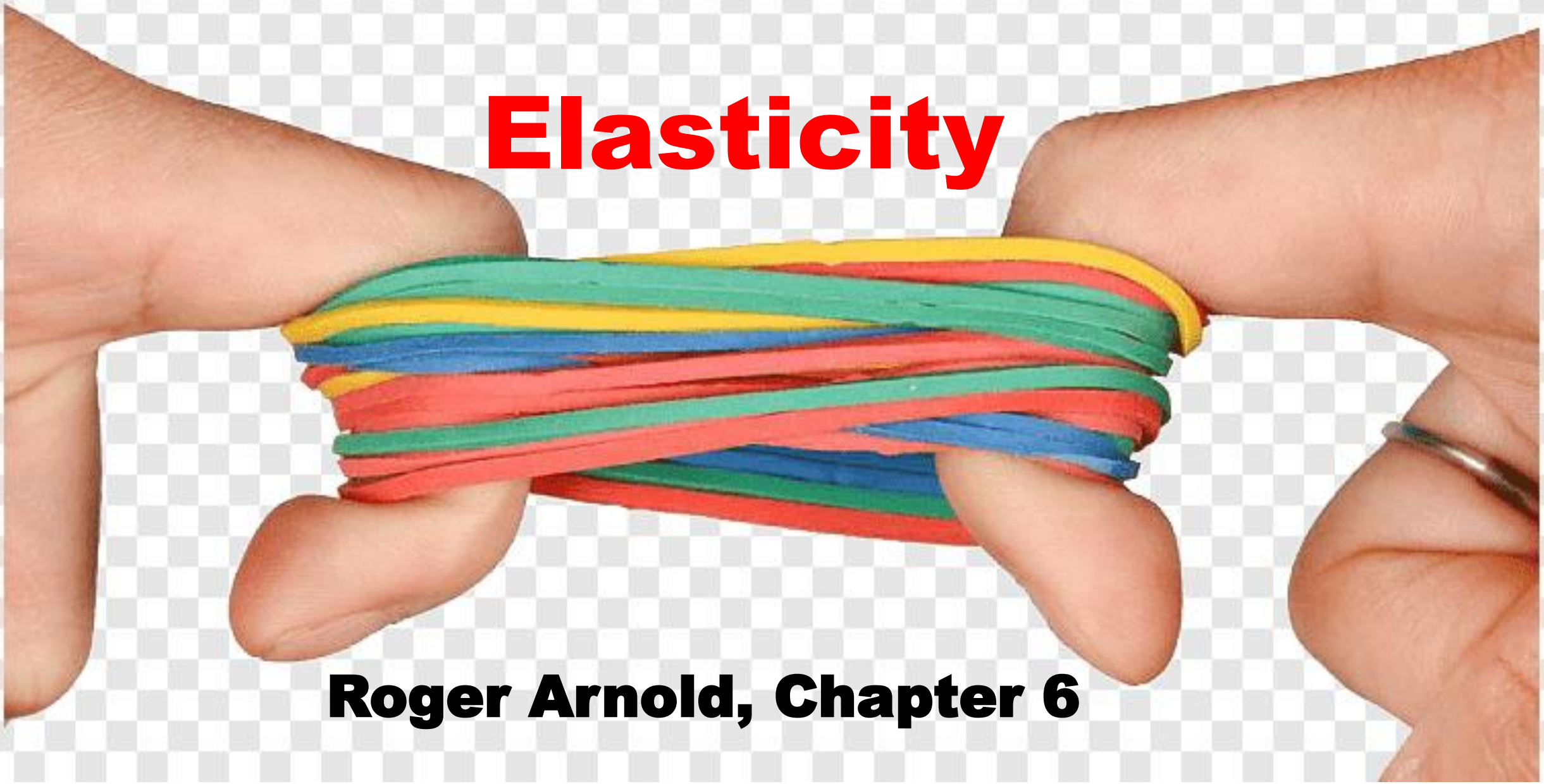
Elasticity



Roger Arnold, Chapter 6

- The LoD states that P and QD are inversely related, *ceteris paribus.*
- But it doesn't tell us by what percentage the QD changes as P changes.

Price Elasticity of Demand (PED) = A measure of the responsiveness of quantity demanded to changes in price.

- **% change in QD for a given % change in P**

Standard Method (Point Elasticity)

$$\%\ \text{change in quantity demanded} = \frac{\text{Change in quantity demanded}}{\text{Initial quantity demanded}} \times 100$$

$$\%\ \text{change in price} = \frac{\text{Change in price}}{\text{Initial price}} \times 100$$

$$\text{Price elasticity of demand} = \frac{\%\ \text{change in quantity demanded}}{\%\ \text{change in price}}$$

The recent rain spoiled the tomato crops, the price of tomatoes increased from 50 taka to 75 taka per kg, and the quantity demanded decreased from 1,000 to 800 kgs. **Calculate PED**.

$$\%\ \text{change in quantity demanded} = \frac{(Q_2 - Q_1)}{Q_1} \times 100\%$$

$$= \frac{(800 - 1000)}{1000} \times 100\%$$

$$= -\frac{200}{1000} \times 100\% = \mathbf{-20\%}$$

$$\%\ \text{change in price} = \frac{(P_2 - P_1)}{P_1} \times 100\% = \frac{(75 - 50)}{50} \times 100\%$$

$$= \frac{25}{50} \times 100\% = \mathbf{50\%}$$

$$E_D = \frac{\%\ change\ in\ QD\ of\ tomatoes}{\%\ change\ in\ Price\ of tomatoes} = \frac{-20\%}{50\%} = -0.4 = \mathbf{0.4}$$

The PED for tomatoes is 0.4, hence tomatoes have inelastic demand.

Midpoint Method (Arc Elasticity)

$$Ed = \frac{\%\ \triangle\ Qd}{\%\ \triangle\ P} = \frac{\dfrac{(Q_2 - Q_1)}{\left(\dfrac{(Q_2 + Q_1)}{2}\right)}}{\dfrac{(P_2 - P_1)}{\left(\dfrac{(P_2 + P_1)}{2}\right)}}$$

$$\% \text{ change in quantity demanded} = \frac{(Q_2 - Q_1)}{(Q_1 + Q_2) / 2} = \frac{(800 - 1000)}{(800+1000) / 2} \text{ x } 100\%$$

$$= -\frac{200}{900} \text{ x } 100\% = \textbf{-22.222\%}$$

$$\% \text{ change in price} = \frac{(P_2 - P_1)}{(P_1 + P_2) / 2} \text{ x } 100\% = \frac{(75 - 50)}{(50+75) / 2} \text{ x } 100\%$$

$$= \frac{25}{62.5} \text{ x } 100\% = \textbf{40\%}$$

$$E_D = \frac{\% \textit{ change in Quantity Demanded of tomatoes}}{\% \textit{ change in Price of tomatoes}} = \frac{-22.222\%}{40\%} = - 0.556 = \textbf{0.556}$$

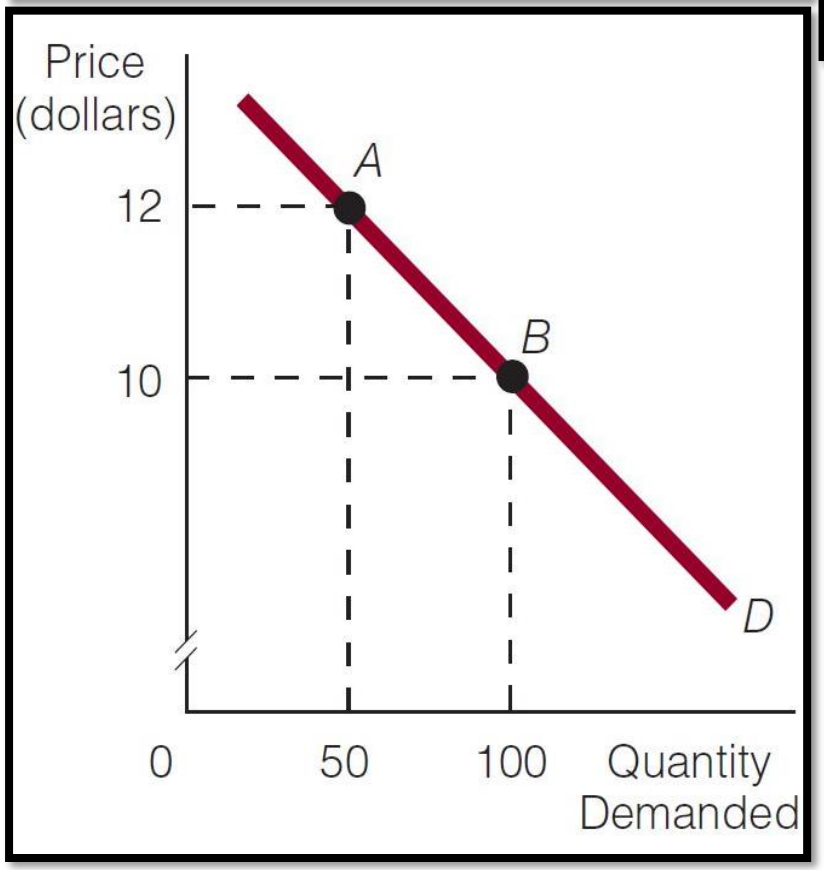
The price elasticity of demand for tomatoes is 0.556, hence tomatoes have inelastic demand.

- ***Things to remember –***
  - Elasticity is unit free
  - The sign doesn’t matter for PED

Slope vs. Elasticity

$$\frac{\text{Change in } y}{\text{Change in } x} = \frac{\Delta y}{\Delta x} = \text{Slope}$$

Point	Price	Quantity Demanded
A	$12	50
B	10	100
C	8	150



Slope between A and B $= \frac{y_2 - y_1}{x_2 - x_1}$

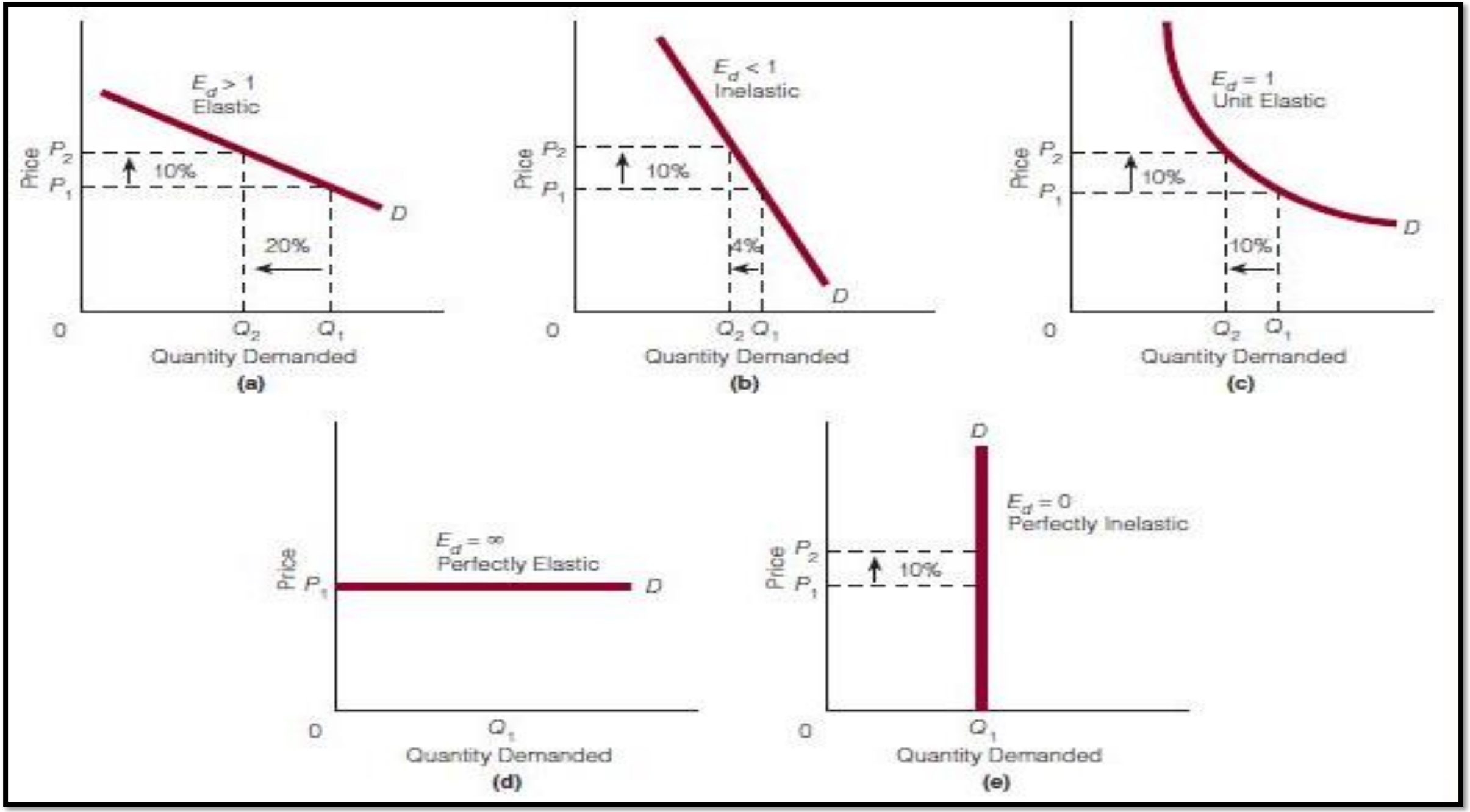
$$= \frac{10 - 12}{100 - 50} = -\frac{2}{50}$$

$$= \mathbf{-0.04}$$

$\mathbf{E_D}$ between A and B $= \frac{\%\ change\ in\ QD}{\%\ change\ in\ P}$

$$= -\frac{100\%}{16.67\%} = -6 = \mathbf{6}$$

Types of PED

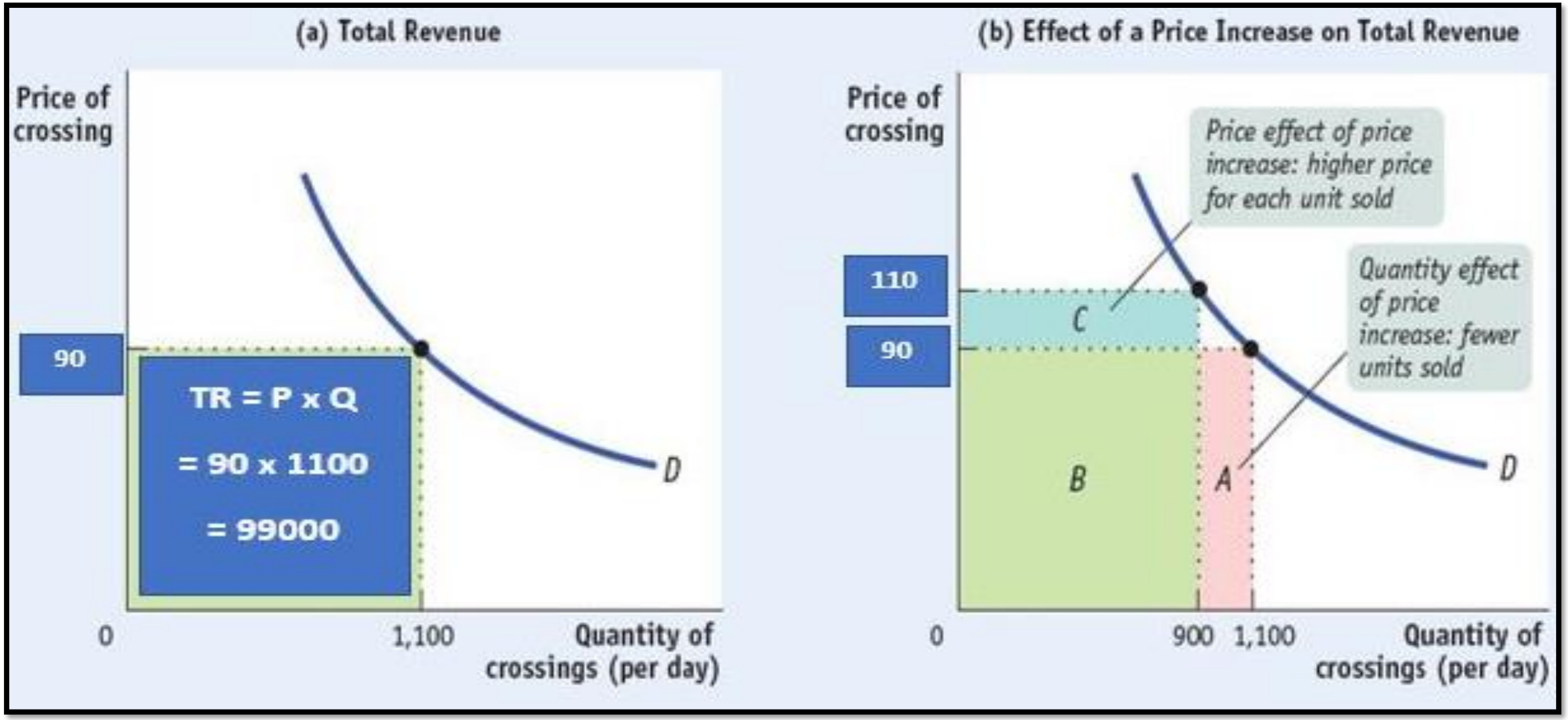

$E_d > 1$
Elastic
Price
P_2
P_1
10%
20%
D
0
Q_2
Q_1
Quantity Demanded
(a)
$E_d < 1$
Inelastic
10%
4%
(b)
$E_d = 1$
Unit Elastic
(c)
$E_d = \infty$
Perfectly Elastic
(d)
$E_d = 0$
Perfectly Inelastic
(e)

Summary

Elasticity Coefficient	Responsiveness of Quantity Demanded to a Change in Price	Terminology
$E_d > 1$	Quantity demanded changes proportionately more than price changes: $\%\Delta Q_d > \%\Delta P$.	Elastic
$E_d < 1$	Quantity demanded changes proportionately less than price changes: $\%\Delta Q_d < \%\Delta P$.	Inelastic
$E_d = 1$	Quantity demanded changes proportionately to price change: $\%\Delta Q_d = \%\Delta P$.	Unit elastic
$E_d = \infty$	Quantity demanded is extremely responsive to even very small changes in price.	Perfectly elastic
$E_d = 0$	Quantity demanded does not change as price changes.	Perfectly inelastic

PED and Total Revenue (TR)

TR = Price (P) x Quantity sold (Q)



- *A **price effect**:* After a price increase (decrease), each unit sold sells at a higher (lower) price, which tends to raise (reduce) revenue.
- *A **quantity effect**:* After a price increase (decrease), fewer (more) units are sold, which tends to lower (raise) revenue.

	P of toll = 90 taka	P of toll = 110 taka
Unit-elastic demand (PED = 1)		
QD	1100	900
TR (taka)	99, 000	99,000
Inelastic demand (PED < 1; = 0.5)		
QD	1050	950
TR (taka)	94,500	104,500
Elastic demand (PED > 1; = 2)		
QD	1200	800
TR (taka)	108,000	88,000

Summary

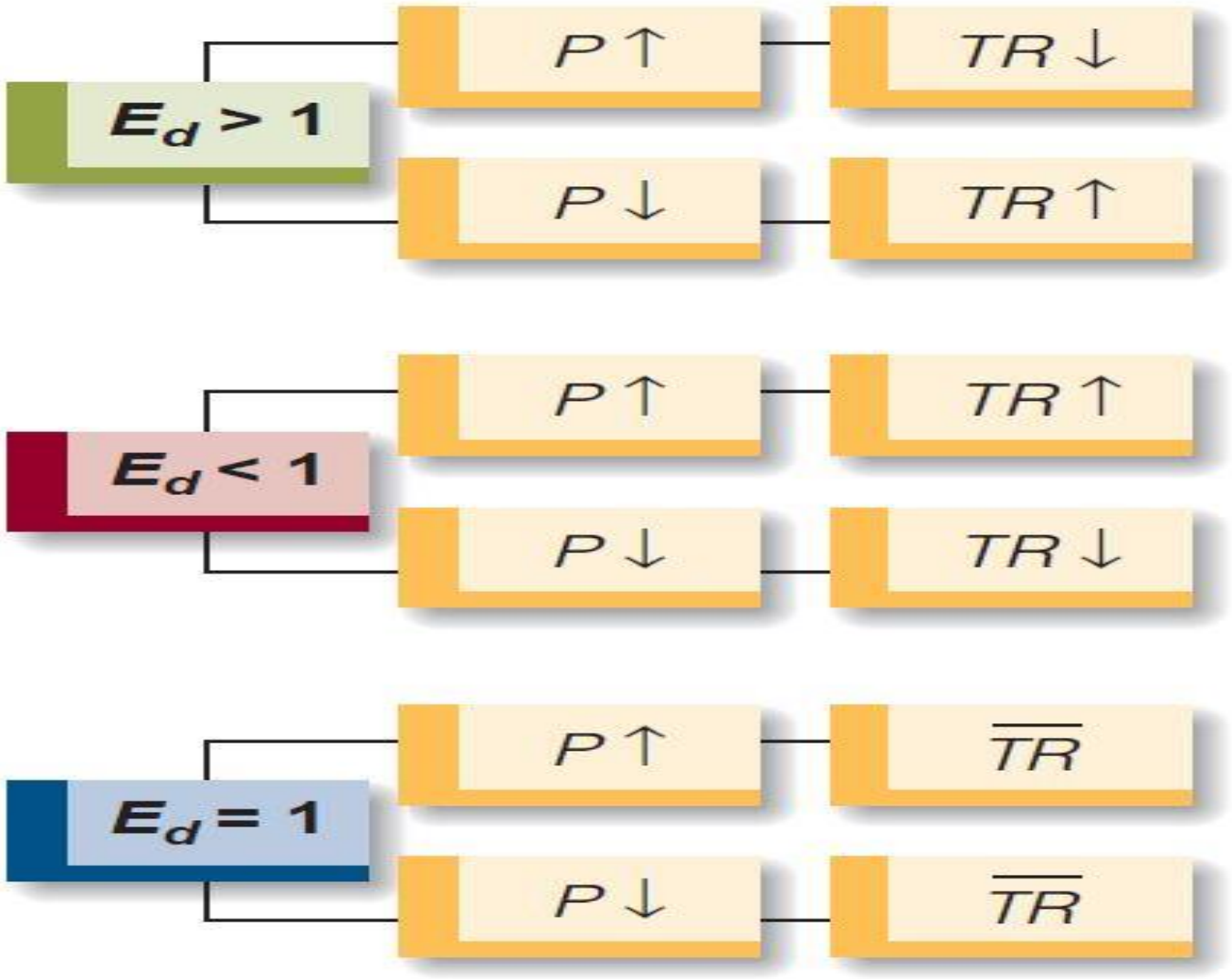
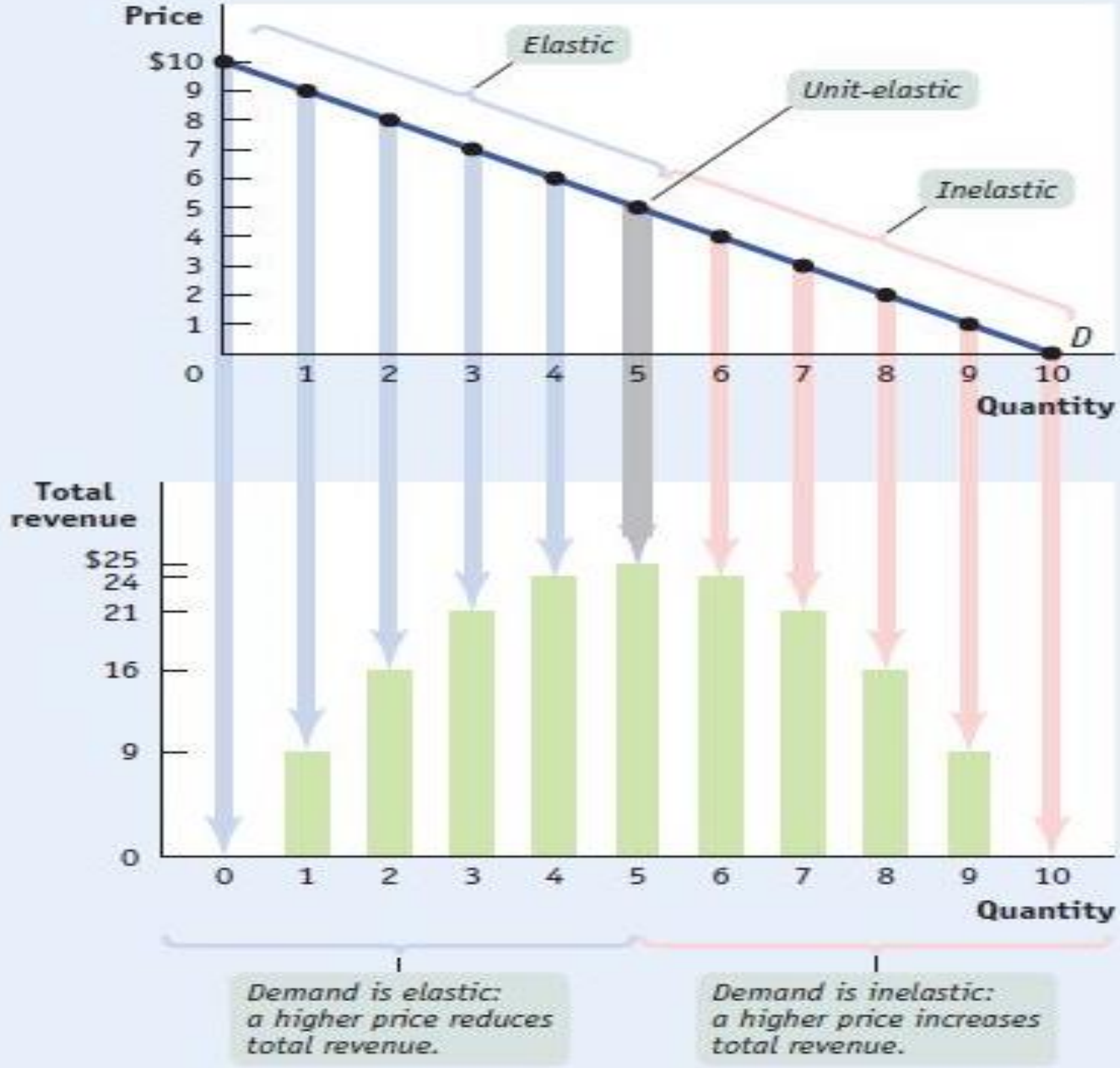


FIGURE 6-5 The Price Elasticity of Demand Changes Along the Demand Curve



Demand Schedule and Total Revenue for a Linear Demand Curve

Price	Quantity demanded	Total revenue
$0	10	$0
1	9	9
2	8	16
3	7	21
4	6	24
5	5	25
6	4	24
7	3	21
8	2	16
9	1	9
10	0	0

The upper panel shows a demand curve corresponding to the demand schedule in the table. The lower panel shows how total revenue changes along that demand curve: at each price and quantity combination, the height of the bar represents the total revenue generated. You can see that at a low price, raising the price increases total revenue. So demand is inelastic at low prices. At a high price, however, a rise in price reduces total revenue. So demand is elastic at high prices.

What Factors Determine the PED?

1) Whether the Good Is a Necessity or a Luxury

2) The Number and Availability of Close Substitutes

3) Share of Income/Budget Spent on the Good

4) Time Elapsed Since Price Change

Other Elasticity Concepts

Cross (Price) Elasticity of Demand (CED)

Cross-price elasticity of demand between goods A and B

$$E_C = \frac{\%\text{ change in quantity of A demanded}}{\%\text{ change in price of B}}$$

CED – A measure of the responsiveness in QD of one good to the changes in the P of another good.

- **We cannot drop the minus sign here!**
- **Ec > 0** = The two goods are **substitutes**
- **Ec < 0** = The two goods are **complements**
- A higher positive Ec = Closer substitutes (strong substitutes)
- A higher negative Ec = Closer complements (strong complements)

Example

- As the price of good X rises from 10 taka to 12 taka, the quantity demanded of good Y rises from 100 units to 114 units. How are X and Y related? *(point elasticity method)*

$$\%\ \text{change in quantity demanded of Y} = \frac{(Q_2 - Q_1)}{Q_1} \times 100\%$$

$$= \frac{(114-100)}{100} \times 100\%$$

$$= \frac{14}{100} \times 100\% = \mathbf{14\%}$$

$$\%\ \text{change in price of X} = \frac{(P_2 - P_1)}{P_1} \times 100\% = \frac{(12-10)}{10} \times 100\%$$

$$= \frac{2}{10} \times 100\% = \mathbf{20\%}$$

$$E_C = \frac{\%\ change\ in\ QD\ of\ Y}{\%\ change\ in\ Price\ of X} = \frac{\mathbf{14\%}}{\mathbf{20\%}} = \mathbf{0.7}$$

The CED for X and Y is 0.7, hence goods X and Y are substitutes.

Income Elasticity of Demand (IED)

- To determine whether a good is a **normal good or an inferior good.**

$$\text{Income elasticity of demand } (E_Y) = \frac{\%\text{ change in quantity demanded}}{\%\text{ change in income}}$$

- ***IED = A measure of the responsiveness of QD to changes in a consumer's income.***

- **We cannot drop the minus sign here!**
- **$E_Y > 0$ = Normal** good
- **$E_Y < 0$ = Inferior** good
- A **normal** good can further be classified as -
- **Income elastic (luxury goods)** if **$E_Y > 1$**
- **Income inelastic (necessity)** if **$E_Y < 1$**
- **Income unit-elastic** if **$E_Y = 1$**

Example

- The QD of good X rises as from 130 to 145 units as the income rises from 20,000 taka to 25,000 taka. What kind of a good is X? *(point elasticity method)*

$$\%\ \text{change in quantity demanded of X} = \frac{(Q_2 - Q_1)}{Q_1} \times 100\%$$

$$= \frac{(145-130)}{130} \times 100\%$$

$$= \frac{15}{130} \times 100\% = \mathbf{11.538\%}$$

$$\%\ \text{change in income} = \frac{(Y_2 - Y_1)}{Y_1} \times 100\% = \frac{(25{,}000 - 20{,}000)}{20{,}000} \times 100\%$$

$$= \frac{5{,}000}{20{,}000} \times 100\% = \mathbf{25\%}$$

$$E_Y = \frac{\%\ change\ in\ QD\ of\ X}{\%\ change\ in\ Income} = \frac{11.538\%}{25\%} = 0.462$$

The IED for X is 0.462, hence X is a normal good.

It is income inelastic, thus can be considered a necessity.

Price Elasticity of Supply (PES)

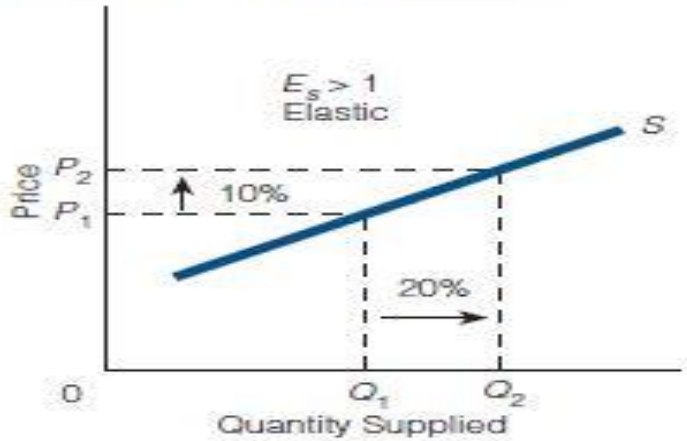
$$\text{Price elasticity of supply (Es)} = \frac{\%\ \text{change in quantity supplied}}{\%\ \text{change in price}}$$

Price Elasticity of Supply (PES) = A measure of the responsiveness of quantity supplied to changes in price.

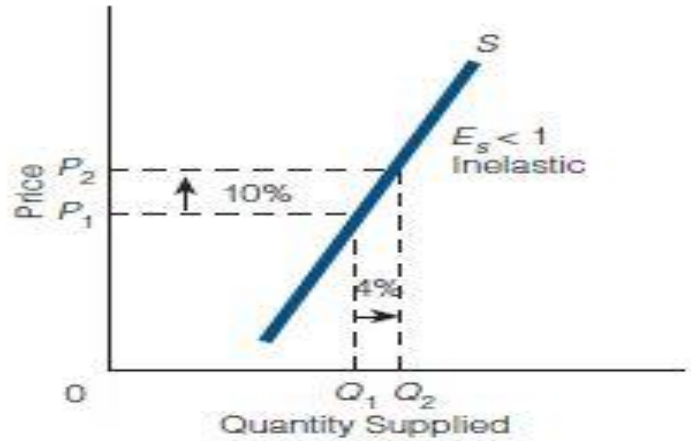
exhibit 8

Price Elasticity of Supply

(a) The percentage change in quantity supplied is greater than the percentage change in price: $E_s > 1$ and supply is elastic. (b) The percentage change in quantity supplied is less than the percentage change in price: $E_s < 1$ and supply is inelastic. (c) The percentage change in quantity supplied is equal to the percentage change in price: $E_s = 1$ and supply is unit elastic. (d) A small change in price changes quantity supplied by an infinite amount: $E_s = \infty$ and supply is perfectly elastic. (e) A change in price does not change quantity supplied: $E_s = 0$ and supply is perfectly inelastic.



(a)



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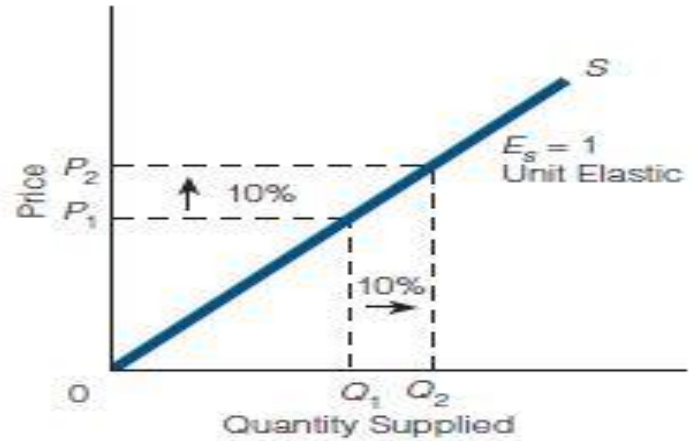
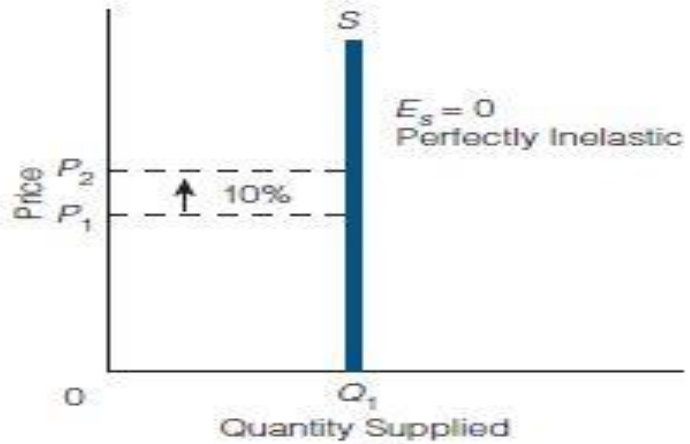


(c)

(d)



(e)

- What Factors Determine the Es?
  - **The Availability of Inputs** – **Es** tends to be large when inputs are readily available
  - **Time** - **Es** tends to grow larger as producers/sellers have more time to respond to a price change.
    - This means that the **long - run** Es is often **higher** than the **short - run** elasticity.