# Index Numbers

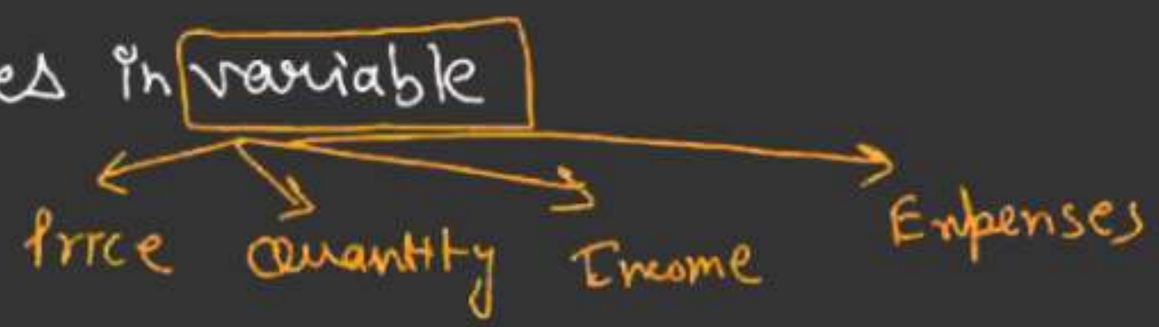
Denoted by $P_{01}$

0 => Base year

1 => Current year

-> Statistical tool

-> measure changes in variable




-> Compare changes over time or places

-> Current year value is compared with Base year value

-> Expressed in percentage

Price index

⇓

measure changes in price

Quantity index

⇓

measure changes in volume consumption, Sales.

# Challenges in construction of index number

-> selection of Base year

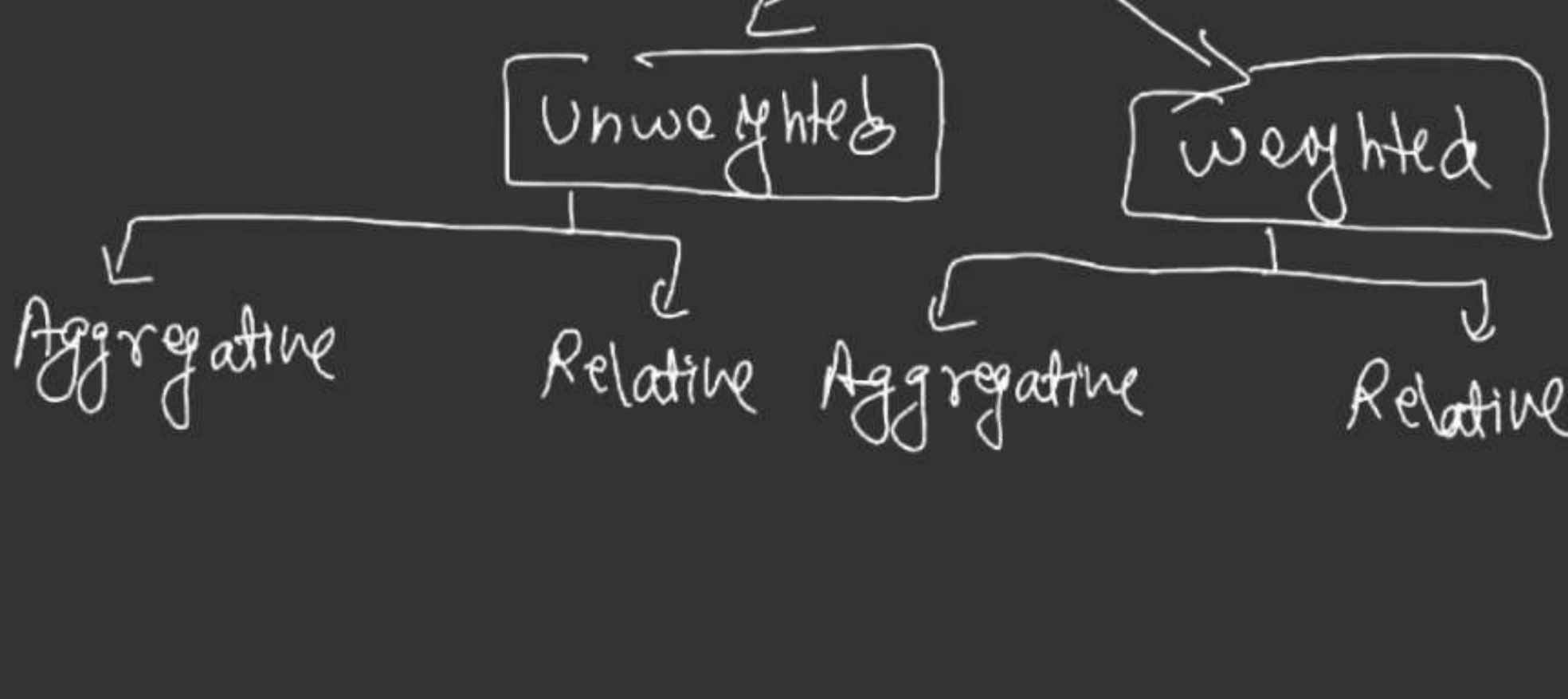
-> Selection of Product

-> Selection of prices

-> Selection of formula

-> Selection of weight

# methods of construction of index number



# Simple Aggregative method

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

# Simple Relative method

$$P_{01}(AM) = \frac{\Sigma \left( \frac{P_1}{P_0} \times 100 \right)}{N}$$

$$P_{01}(GM) = AL\left[ \frac{\Sigma \log \left( \frac{P_1}{P_0} \times 100 \right)}{N} \right]$$

# Weighted Aggregative method

$$P_{01} = \frac{\Sigma P_1 (w)}{\Sigma P_0 (w)} \times 100$$

weight
↓
→ quantity is taken as weight
→ Different statistician take different year quantity

## Laspeyre (Base year quantity)

$$P_{01} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times 100$$

## Paasches (current year quantity)

$$P_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \times 100$$

## Fishers (Geometric mean of L & P)

$$P_{01} = \sqrt{L \times P}$$

$$P_{01} = \sqrt{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}} \times 100$$

## Marshall Edgeworth (Average of Base year & current year quantity)

$$P_{01} = \frac{\Sigma p_1 \left(\frac{q_0 + q_1}{2}\right)}{\Sigma p_0 \left(\frac{q_0 + q_1}{2}\right)}$$

## Dorbish & Bowley (Average of L & P)

$$P_{01} = \frac{L + P}{2} = \left[\frac{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} + \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}}{2}\right] \times 2$$

# weighted Relative method

$$\underset{(AM)}{P_{01}} = \frac{\Sigma w_i \left(\frac{p_1}{p_0} \times 100\right)}{\Sigma w_i} \quad \& \quad \underset{(GM)}{P_{01}} = A.L.\left[\frac{\Sigma w_i \log\left(\frac{p_1}{p_0} \times 100\right)}{\Sigma w_i}\right]$$

# Quantity Index (volume index)

measure changes in consumptions, productions or sales over a period of time or some other character

## Method

- Simple
  - Aggregative
    $$Q_{01} = \frac{\Sigma q_1}{\Sigma q_0} \times 100$$
  - Relative
    $$Q_{01} = \frac{\Sigma \left( \frac{q_1}{q_0} \times 100 \right)}{N}$$
- Weighted
  - Aggregative
    - Laspeyre
      $$Q_0 = \frac{\Sigma q_1 p_0}{\Sigma q_0 p_0} \times 100$$
    - Paasche
      $$Q_{01} = \frac{\Sigma q_1 p_1}{\Sigma q_0 p_1}$$
    - Fisher's
      $$\sqrt{L \times P}$$
    - Bowley
      $$\frac{L + P}{2}$$
    - Marshall
      $$Q_{01} = \frac{\Sigma q_1 \left( \frac{p_0 + p_1}{2} \right)}{\Sigma q_0 \left( \frac{p_0 + p_1}{2} \right)}$$
  - Relative
    $$Q_{01} = \frac{\Sigma \left[ \frac{q_1}{q_0} \times 100 \right]}{N}$$

# Value index

$$V_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0} \times 100$$

# Group index

$$\frac{\Sigma w_i I_i}{\Sigma w_i}$$ where $I_i$ = index of particular item

# Consumer Price index
(cost of Living index)

changes in cost of Living

→ Representative market Basket of goods & services

→ food, clothing, Rent, Health & other Daily expenses

$$CPI = \frac{\text{Total exp. in C.Y.}}{\text{Total exp in B.Y.}}$$
(Laspeyre formula)

or $$CPI = \frac{\Sigma w_i I_i}{\Sigma w_i}$$
(weighted Relative)

# Deflated value (Real value)

$$\text{Deflated value} = \frac{\text{current value}}{\text{Price index}}$$

Eg.

| Year | Index | wages | Real wages |
|---|---|---|---|
| 2010 | 100 | 500 | $\frac{500}{100} \times 100 = 500$ |
| 2011 | 110 | 600 | $\frac{600}{110} \times 100 = 545$ |
| 2012 | 140 | 800 | $\frac{800}{140} \times 100 = 571$ |
| 2013 | 200 | 900 | $\frac{900}{200} \times 100 = 450$ |

# Shifting of Base year

→ when old Base year is not relevant

→ changes in economic policies, global & Domestic market structure

Eg.

| Year | index (Base-2010) |
|---|---|
| 2010 | 100 |
| 2011 | 110 |
| 2012 | 120 |
| 2013 | 140 |

New index (Base-2012)

$\frac{100}{120} \times 100 = 83$

$\frac{110}{120} \times 100 = 92$

$\frac{120}{120} \times 100 = 100$

$\frac{140}{120} \times 100 = 117$

$$\text{Shifted Price index} = \frac{\text{original Price index}}{(\text{index of the year where it has to be shifted})} \times 100$$

# Splicing of Two index series

→ Combining Two index series with different Base year

→ used when * changes in quantity weight
* change in method of calculation
* New product introduction

Eg.

| Year | (Base-2010) Old index | (Base-2012) Revised index | (Base-2010) Spliced index | (Base-2012) Spliced Index |
|---|---|---|---|---|
| 2010 | 100 | | 100 | $\frac{100}{150} \times 100 = 67$ |
| 2011 | 120 | | 120 | $\frac{100}{150} \times 120 = 80$ |
| 2012 | 150 | 100 | 150 | 100 |
| 2013 | | 130 | $\frac{150}{100} \times 130 = 195$ | 130 |
| 2014 | | 160 | $\frac{150}{100} \times 160 = 240$ | 160 |

# # Test of Adequacy

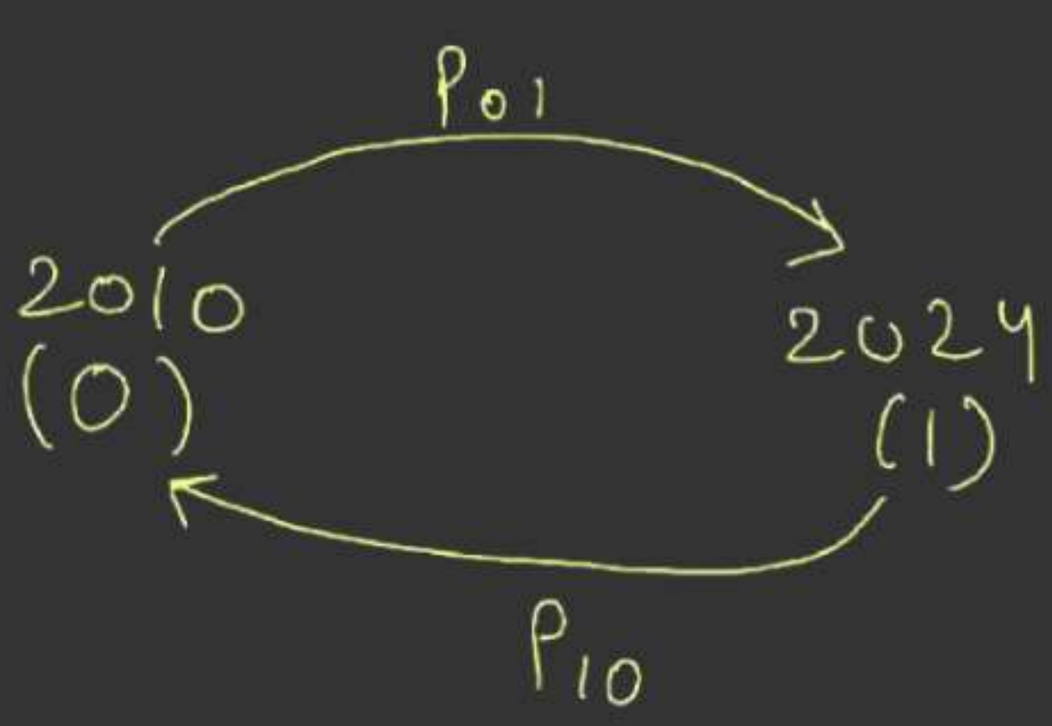
## #1] Unit Test

Formula should be independent of units of price & quantity ) Due to change in units index number should not change

⇒ This test is satisfied by all methods except "simple aggregative method"

## #2] Time Reversal Test

formula should work both ways "forward" & "Backward"




$P_{01} \times P_{10} = 1$

→ Satisfied by

* fishers (um)
* simple Relative (um)
* weighted Relative (um)
* marshall edgeworth

## #3] Factor Reversal Test

$$P_{01} \times Q_{01} = V_{01}$$

or

$$P_{01} \times Q_{01} = \frac{\Sigma P_1 Q_1}{\Sigma P_0 Q_0}$$

Satisfied by "fishers"

## #4] Circular Test → Extension of Time reversal


$$P_{01} \times P_{12} \times P_{21} = 1$$

Satisfied by

→ Simple Price Relative (um)

→ weighted aggregative (fixed weight)