Index number

Index number is a special type of average which provides a measurement of relative changes in price or quantities of commodities in a given year based on base year.

Index number can be of 3 types

1. Price Index (P.I) P_{01}
2. Quantity Index (Q.I) q_{01}
3. Value Index (V.I) $V_{01} \Rightarrow \frac{V_1}{V_0} \Rightarrow \frac{P_1 q_1}{P_0 q_0}$

Base year is Index always taken as 100
Base Period standard Point of comparison.

P_{01} ⇒ 1 on 0 Price Index
P_{10} ⇒ 0 on 1 price Index
q_{01} ⇒ 1 on 0 quantity Index

Methods to find Index Number

- fixed Base year method
  - According to one year fixed
    - Simple method
      - Simple aggregate: $\frac{\Sigma P_1}{\Sigma P_0} \times 100$
      - Simple average: $\frac{\Sigma R}{n}$
    - Weighted method
      - Weighted aggregate: $\frac{\Sigma P_1 W}{\Sigma P_0 W}$
      - Weighted Average: $\frac{\Sigma RW}{\Sigma W}$
  - Acc. to average Period
- Chain Based Method
  - Chain Index

$R = \frac{P_1}{P_0} \times 100$

Relative Price.

Q. Assuming 2007 as a base year calculating P.I of 2009 by simple aggregate method.

2007 P.I - 100

2009 C.I

$P.I \Rightarrow \frac{\Sigma P_i}{\Sigma P_0} \times 100$

$\frac{67}{32} \times 100 \Rightarrow 209.3$

$\Rightarrow 109.3$ ↑ price.

Commodities	P_0 2007 Price	P_1 2009 Price
A	10	12
B	12	30
C	6	11
D	4	14
	32	67

② Simple average.

Assuming 2001 as Base year calculate P.I of 2008 by simple average.

Commodities	P_0 2001 Prices	P_1 2008 Prices	$\frac{\Sigma R}{n}$ R	$R = \frac{P_1}{P_0} \times 100$
A	6	24	$\frac{24}{6} \times 100$	400
B	12	36	$\frac{36}{12} \times 100$	300
C	4	64	$\frac{64}{4} \times 100$	1600
D	15	45	$\frac{45}{15} \times 100$	300
				2600

$\frac{\Sigma R}{n} \Rightarrow \frac{2600}{4} \Rightarrow 650$ So prices increases by 550

→ Weighted method → $\frac{\Sigma P_1 W}{\Sigma P_0 W} \times 100$ - weight.

→ Las payrer. → $\frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$ → Base year

→ Paache → $\frac{\Sigma P_1 q_1}{\Sigma P_0 q_1} \times 100$ → Current year

→ Fisher → $F \Rightarrow \sqrt{2 \times P}$ → G.M.

→ Marshall → $\frac{\Sigma P_1 q_0 + \Sigma P_1 q_1}{\Sigma P_0 q_0 + \Sigma P_0 q_1} \times 100$

→ Dudbish - ① ⇒ $\frac{L+P}{2}$ → A.M.

→ Kelly → $K \Rightarrow \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$

Q. $L = 150$

$P = 120$

fisher ① wudbish

$F = \sqrt{L \times P}$ $① = \frac{L+P}{2}$

$\sqrt{150 \times 120}$ $① = \frac{150+120}{2}$

$F = 134.16$ Ans $① = 135$ Ans

Q. $\Sigma P_1 q_0 = 1079$

$\Sigma P_0 q_0 = 1082$

$\Sigma P_0 q_1 = 979$

$\Sigma P_1 q_1 = 824$

Sol.

$F = \sqrt{\frac{1079}{1082} \times \frac{824}{979}} \times 100$

$F = 91.6$ Ans

$M = \frac{1079 + 824}{1082 + 979} \times 100$

$M = \frac{1903}{2061} \times 100$

$M \Rightarrow 92.33$ Ans

Q. 2004 2004 2005 2005

P_0	q_0	P_1	q_1	P_1q_0	P_0q_0	P_1q_1	P_0q_1
6	4	5	3	20	24	15	18
2	3	2	7	6	6	14	14
7	2	6	9	12	14	54	63
1	4	1	1	4	4	1	1
				42	48	84	96

Sol

$$L = \frac{42}{48} \times 100 \Rightarrow 87.5$$

$$P = \frac{84}{96} \times 100 \Rightarrow P = 87.5$$

$$F = \sqrt{\frac{42}{48} \times \frac{84}{96}} \times 100 \Rightarrow F = 87.5$$

$$M = \frac{42+84}{48+96} \times 100 \Rightarrow M = 87.5$$

$$D = \frac{87.5 \times 87.5}{2} \Rightarrow 87.5$$

Q.

	Price 2004	Price 2005	Quantity 2004	Quantity 2005
Rice	9.3	4.5	100	50
Wheat	6.4	3.7	11	10
Pulse	5.1	2.7	5	2

Sol

P_0	P_1	q_0	q_1	P_1q_0	P_0q_0	P_1q_1	P_0q_1
9.3	4.5	100	90	450	930	405	837
6.4	3.7	11	10	40.7	70.4	37	64
5.1	2.7	5	2	13.15	25.5	8.1	15.2
				504.2	1025.9	450.1	916.3

$$F = \sqrt{\frac{504.2}{1025.9} \times \frac{450.1}{916.3}} \times 100 \qquad M \Rightarrow \frac{504.2 + 450.1}{1025.9 + 916.3} \times 100$$

$F \Rightarrow 49.12$ Ans $\qquad M \Rightarrow 49.125$ Ans

$$\text{SD} = \frac{49.13 + 49.135}{2}$$

$$\text{SD} = 49.132$$

Q. $P_1 q_0 = 1072$

$P_0 q_0 = ?$

$P_1 q_1 = 979$

$\Sigma P_0 q_1 = 882$

2 : P

7 : 8

Sol. $\dfrac{\dfrac{1072 \times 100}{x}}{\dfrac{979}{882} \times 100} = \dfrac{7}{8}$

$$\frac{\frac{1072}{x}}{\frac{979}{882}} = \frac{7}{8}$$

$$\frac{1072 \times 882}{979 \times x} = \frac{7}{8}$$

$$\frac{576 \times 7056}{6853 \times 7x}$$

* Weighted average :-

$$\frac{\Sigma RW}{\Sigma W} \text{ or } \frac{\Sigma IW}{\Sigma W} \text{ or } \frac{\Sigma PW}{\Sigma W}$$

$R = \frac{P_1}{P_0} \times 100$ I = Group Index P = Price Index

w = weight
Expeses
Expenditure
Relative Importance

→ Consumer Price Index (Retail Price)

C.P.I → $\frac{\Sigma RW}{\Sigma W}$

→ Laspeyres

$$I = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

Table given P_0 | P_1 | q_0 | q_1

Cost of living Index C.L.I = $\frac{\Sigma PW}{\Sigma W} / \frac{\Sigma RW}{\Sigma W}$

General Index = $\frac{\Sigma IW}{\Sigma W}$

Q.

P_0	q_0	P_1	q_1
4	5	2	2
7	6	4	3
2	9	2	4

weight average?

Sol

P_0	q_0	P_1	q_1	$R = \frac{P_1}{P_0} \times 100$	w (80)	RW
4	5	2	2	$\frac{2}{4} \times 100 =$	20	$\frac{2 \times 100 \times 20}{4}$ = 1000
7	6	4	3	$\frac{4}{7} \times 100 =$	42	$\frac{4 \times 100 \times 42}{7}$ = 2400
2	9	2	4	$\frac{3}{2} \times 100 =$	18	$\frac{3 \times 100 \times 18}{2}$ = 2700
					80	6100

$$\frac{6100}{80} \Rightarrow 76.25$$

Q.

P_0	q_0	P_1	q_1	$P_1 q_0$	$P_0 q_0$
4	2	3	2	6	8
5	6	4	4	24	30
7	9	5	7	45	63
				75	101

$$C.P.I \Rightarrow \frac{75}{101} \times 100$$

$$C.P.I \Rightarrow 74.25$$

Q. C.P.I ?

Weight	P_0	P_1	R	RW	
10	4	7	$\frac{7}{4} \times 100$	$\frac{7 \times 100 \times 10}{4}$	1750
12	5	2	$\frac{2}{5} \times 100$	$\frac{2 \times 100 \times 12}{5}$	480
15	6	9	$\frac{9}{6} \times 100$	$\frac{9 \times 100 \times 15}{6}$	2250
37					4480

$$\frac{4480}{37} \Rightarrow 121.08$$

Q.

	Expenses	P_0	P_1	R	RW	
food	40%	4	6	$\frac{6}{4} \times 100$	$\frac{6 \times 100 \times 40}{4}$	6000
Rent	10%	5	3	$\frac{3}{5} \times 100$	$\frac{3 \times 100 \times 10}{5}$	600
Cloth	25%	7	9	$\frac{9}{7} \times 100$	$\frac{9 \times 100 \times 25}{7}$	3214.2
other	25%	2	1	$\frac{1}{2} \times 100$	$\frac{1 \times 100 \times 25}{2}$	1250
	100					11064.28

Cost of living Index $\Rightarrow \frac{11064.28}{100}$

$\Rightarrow$ 110.64 Avg

Q.

I Group Index	W Weight	IW
110	4	440
100	5	500
120	7	840
90	2	180
130	3	390
	21	2350

$G.I = \frac{2350}{21}$

$\Rightarrow 111.90$ Ans

Q. Price ↑ by 10%. ↑ by 20%. ↓ by 30%.
relative importance of commodity (W) (6:3:4)
find C.I.I

$C.I.I = \frac{\Sigma PW}{\Sigma W}$

P.I = 110
P.I = 120
P.I = 70

P.	W	PW
110	6	660
120	3	360
70	4	280
	13	1300

$\Rightarrow \frac{1300}{13}$

$\Rightarrow 100$

- Test of Adequacy
  Test of Consistency
  Test of Index number

① Unit test → Unit free

② Time Reversal test → $P_{01} \times P_{10} = 1$ (starting 0 to end 0)

③ factor Reversal test → $P_{01} \times q_{01} \Rightarrow V_{01}$

④ Circular Test → $P_{01} \times P_{12} \times P_{20} = 1$

P_{01} → 1 on 0

P_{10} → 0 on 1

Index	Unit	Time	factor	Circular
L	✓	✗	✗	✗
P	✓	✗	✗	✗
F	✓	✓	✓	✗
D	✓	✗	✗	✗
M	✓	✓	✗	✗
K	✓	✗	✗	✓

Fisher is ideal Index num. So G.M is better average in construction of Index number

- Circular Test is satisfied by,
  1. Simple Geometric mean of price Relation
  2. Weighted aggregative Index with fixed weight.
  3. Chain Index :-

Link relative (L.R) => $\frac{\text{Current year Price (C.Y)}}{\text{Previous year Price (P.Y)}}$

Chain Index => $\frac{\text{Link relative of C.Y} \times \text{chain Index of P.Y}}{100}$

1 year : C.R = 100, C.I = 100

L.R => $\frac{P_n}{P_{n-1}} \times 100$

Year	Price	L.R	C.I
2001	50	100	100
2002	62	$\frac{62}{50} \times 100 = 124$	$\frac{124 \times 100}{100} \Rightarrow 124$
2003	90	$\frac{90}{62} \times 100 = 145.16$	$\frac{14.5 \times 124}{100} \Rightarrow 180$
2004	72	$\frac{72}{90} \times 100 = 80$	$\frac{80 \times 180}{100} \Rightarrow 144$
2005	50	$\frac{50}{72} \times 100 = 69.4$	$\frac{69.4 \times 144}{100} \Rightarrow 100$ (99.93) Ans

* Shifted Price Index :⇒ (S.P.I)

$$S.P.I = \frac{\text{original Price Index} \times 100}{\text{New year P.I}}$$

Q. Shifted B.Y. from 2002 to 2004

Year	P.I	S.P.I
2001	124	$\frac{124}{149} \times 100 \Rightarrow 83.22$
2002	100	$\frac{100}{149} \times 100 = 67.11$
2003	136	$\frac{136}{149} \times 100 = 91.27$
2004	149	$\frac{149}{149} \times 100 = 100$
2005	150	$\frac{150}{149} \times 100 = 100.67$

Q. $\Sigma P_1 q_0 = 1082$

$\Sigma P_0 q_0 = 1079$

$P = 130$

fisher = ?

Sol fisher.

$$2 = \frac{1082}{1079} \times 100$$

$$2 = 100.27$$

$$f = \sqrt{100.27 \times 130}$$

$$f \Rightarrow 114.17$$

Q. A business executive was earning 10000 in Base period what should be his salary in current year. If C.y Price index is 280.

Sol $100 - 10000$ y1

$1 - \frac{10000}{100}$

$280 - \frac{10000}{100} \times 280 \Rightarrow 28000$ y2

Dearness allowance (DA) $= Y_2 - Y_1$

$DA = 28000 - 10000$

$DA = 18000$

Q. Base year 2003 = 3000 earn

DA in 2010 is C.Y Price Index is 250.

100 —— 3000 Y_1

1 —— $\frac{3000}{100}$

$250 \longrightarrow \frac{3000}{100} \times 250 \Rightarrow 7500\ Y_2$

$DA = 7500 - 3000$

$DA = 4500$

Q. Business executive was earning 19000 in B.Y what should be this salary is C.Y is Index is EIW = 3544
EW = 25.

Sol $\frac{EIW}{EW} = \frac{3544}{25} = 141.76$ C.Y

100 —— 19000 Y_1

1 — $\frac{19000}{100}$

$141.76 \longrightarrow \frac{19000}{100} \times 141.76$

$\Rightarrow 26934.4.\ Y_2$

Q. Consumer Price Index goes 100 to 200
Salary become 300 to 500
Worker have gain or loss?

Sol 100 — 200

1 — $\frac{300}{100}$

$300 \longrightarrow \frac{300}{100} \times 200 \Rightarrow 600$

but Salary become 500 so loss of ₹ 100.

Q. Deflated value $\Rightarrow \frac{\text{current year}}{\text{current Price Index}}$

$\Rightarrow$ By using deflated Index Real wages can be calculated

$$\text{Real wages} = \frac{\text{current wages}}{\text{Current Price Index}} \times 100$$

Q. C.P.I goes 100 to 200
wages becomes 300 to 500
find real wages.

Sol $R.W = \frac{500}{200} \times 100 = 250$

Q. 1977 P.I is 96
1983 P.I is 313
1983 wages in 160
find real wages

Sol $R.W = \frac{160}{313} \times 100$

$R.W = 51.12$

Q. Price is ↑ by 10%.
wages is ↑ by 20%.
find % ↑ in real wages

Sol P.I 100 +10 = 110
W = 100 +20 = 120

$\frac{120}{110} \times 100 = 109.09$

109.09 − 100 $\Rightarrow$ 9.09 less than 10%.

Purchasing Power of money is Inversly Proportional to Index numbes

$$PPM \Rightarrow \frac{1}{\text{Index Number}} \times 100$$