

# Chapter 5

## INDEX NUMBERS

### 5.20. Calculation of the price relatives.

Year	Retail Prices (Rs.)	Price relatives	
		(i) 1957 as base	(ii) 1960 as base
1957	14.95	100	95.5
1958	14.94	99.9	95.5
1959	15.10	101.0	96.5
1960	15.65	104.7	100
1961	16.28	108.9	104.0
1962	16.53	110.6	105.6

### 5.21. Calculation of Index Numbers.

Year	Production	Price relatives	
		(i) 1954 as base	(ii) Average of 1958, 59 and 60 as base
1954	282	100	51.90
1955	389	137.94	71.60
1956	438	155.32	80.61
1957	470	166.67	86.50
1958	511	181.21	94.05
1959	555	196.81	102.15
1960	564	200.00	103.80
1961	630	223.40	115.95
1962	662	234.75	121.84
1963	681	241.49	125.34

## 5.22. Computation of the simple aggregative Index Numbers.

Commodity	Average prices in Rs. per unit					
	1912	1913	1914	1915	1916	1917
Gold	25.3	30.8	33.4	35.5	35.3	36.0
Wheat	17.3	14.5	4.9	5.7	17.1	11.6
Cotton	7.8	5.4	6.7	5.6	7.2	10.2
Total	50.4	50.7	45.0	46.8	59.6	57.8

The simple aggregative indices are calculated by the formula

$$P_{0n} = \frac{\sum p_n}{\sum p_0} \times 100,$$

where the symbols have their usual meaning. Thus the simple aggregative price index for

$$1913 = \frac{50.7}{50.4} \times 100 = 100.6,$$

$$1914 = \frac{45.0}{50.4} \times 100 = 89.3,$$

$$1915 = \frac{46.8}{50.4} \times 100 = 92.9,$$

$$1916 = \frac{59.6}{50.4} \times 100 = 118.3,$$

$$1917 = \frac{57.8}{50.4} \times 100 = 114.7.$$

Calculation of the simple Average of Relatives price indices for years 1913 to 1917:

Years	Price relatives			Sum of price rela- tives	Index No. as average of relatives
	Gold	Wheat	Cotton		
1912	100	100	100	300	100
1913	122	84	69	275	91.6
1914	132	28	86	246	82.1
1915	140	33	72	245	81.7
1916	140	100	92	332	110.7
1917	142	67	131	340	113.4

## 5.23. Calculation of the price Index Numbers for April 1971 and May 1971 with May 1970 as base, using

### (i) Simple aggregative method

$$P_{0n} = \frac{\sum p_n}{\sum p_0} \times 100$$

The simple aggregative price index for April 1971 is

$$P_{01} = \frac{18.37 + 14.58 + 13.94 + 13.75}{17.50 + 14.58 + 14.67 + 17.50} \times 100 = 94.38, \text{ and}$$

the simple aggregative price index for May 1971 is

$$P_{02} = \frac{17.58 + 16.50 + 15.25 + 13.42}{17.50 + 14.58 + 14.67 + 17.50} \times 100 = 97.67.$$

### (ii) Simple average (mean) of price relatives:

Year	Price relatives				Sum of price relatives	Index No. as average of relatives
	Wheat	Barley	Jawar	Bajra		
May 1970	100	100	100	100	400	100
April 1971	105.0	100	95.0	78.6	378.6	94.65
May 1971	100.5	113.2	104.0	76.7	394.4	98.60

### (iii) Geometric mean of price relatives:

Year	Price relatives				$\Sigma \log x$	$1/n$	Indices (G.M.)
	Wheat	Barley	Jawar	Bajra			
May 1970	100	100	100	100	8.0000	2.0000	100
log	2.0000	2.0000	2.0000	2.0000			
April 1971	105.0	100	95.0	78.6	7.8943	1.9738	94.14
log	2.0212	2.000	1.9777	1.8954			
May 1971	100.5	113.2	104.0	76.7	7.9578	1.9894	97.59
log	2.0021	2.0539	2.0170	1.8848			

## 5.24. Construction of chain index numbers for average prices.

Year	Link Relatives						Total	Average	Chain Indices
	Rice	Wheat	Linseed	Gur	Cotton	Tobacco			
1928	100	100	100	100	100	100	600	100	100
1929	105.5	73.3	114.3	115.9	87.4	98.8	595.2	99.2	99.2
1930	75.3	65.5	81.2	84.9	58.1	84.8	449.8	75.0	74.4
1931	70.7	75.0	64.6	67.6	76.7	80.0	434.7	72.4	53.9

Hence the chain indices are 100, 99.2, 74.4 and 53.9.

## 5.25. Construction of chain indices for prices relatives.

Year	Link Relatives				Total of L.R.	Average	Chain Indices
	Sugar	Gur	Tea	Coffee			
1941	98	75	82	99	354	88.5	88.5
1942	102	109	90	101	402	100.5	88.9
1943	114	101	105	104	424	106.0	94.2
1944	96	101	114	91	402	100.5	94.7

Hence the chain indices are 88.5, 88.9, 94.2 and 94.7.

## 5.26. Construction of chian indices from price relatives.

Years	Link relatives of commodities			Total of relatives	(a) Average	(b) Chain Indices
	A	B	C			
1934	100	100	100	300	100	100
1935	105.0	97.0	121.0	323.0	107.7	107.7
1936	104.8	96.9	103.3	305.0	101.7	109.5
1937	104.5	106.4	104.0	314.9	105.0	115.0
1938	100.9	99.0	98.5	298.4	99.5	114.4
1939	103.5	106.1	101.6	311.2	103.7	118.6

## 5.27. (i) Calculation of Index Numbers, using the simple mean of price relatives.

Years	Price relatives of commodities				Total of relatives	Index no. as mean
	A	B	C	D		
1935	100	100	100	100	400	100
1936	125	120	87	75	407	101.8
1937	112	110	92	125	439	109.8
1938	125	120	108	150	503	125.8
1939	131	127	122	140	520	130.0

(ii) Calculation of Index Numbers, using the chain base method.

Year	Link relatives of commodities				Total of relatives	Average	Chain Indices
	A	B	C	D			
1935	100	100	100	100	400	100	100
1936	125	120	87	75	407	101.8	101.8
1937	90	92	106	167	455	113.8	$\frac{101.8 \times 113.8}{100} = 115.8$
1938	112	109	117	120	458	114.5	$\frac{115.8 \times 114.5}{100} = 132.6$
1939	105	106	113	93	417	104.2	$\frac{132.6 \times 104.2}{100} = 138.2$

(iii) The fixed base and the chain indices are generally not in close agreement. The reason being that the farther it is from the base year, the less reliable is the chain index likely to be.

### 5.28. Computation of weighted aggregative price index for 1969.

Groups	Base year		Current year		$P_0 q_0$	$P_1 q_0$
	$p_0$	$q_0$	$p_1$	$q_1$		
A	85	50	116	45	4250	5800
B	34	120	42	185	4080	5040
C	10	35	15	68	350	525
D	48	210	50	250	10080	10500
Total	---	---	--	--	18760	21865

Hence 
$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{21865}{18760} \times 100 = 116.6$$

The weighted aggregative price index for 1969 on the basis of 1965 is 116.6. This means that the prices have increased by 16.6%.

**5.29. (a) Computation of the weighted price indices with base period quantities as weights.**

Commodity	Base year		Current year		$P_0 q_0$	$P_1 q_0$	Price relatives $P_1/P_0$	$P_0 q_0 \times (P_1/P_0)$
	$P_0$	$q_0$	$P_1$	$q_1$				
Rice	3.50	71	3.15	80	248.50	223.65	0.900	223.65
Barley	2.00	107	1.80	138	214.00	192.60	0.900	192.60
Maize	2.60	62	1.75	57	161.20	108.50	0.673	108.49
Total	---	---	--	--	623.70	524.75	--	524.74

$$\text{Weighted-aggregative price index, } P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 \\ = \frac{524.75}{623.70} \times 100 = 84.14$$

Weighted Average of Relatives Price Index is

$$P_{01} = \frac{\sum \left( \frac{p_1}{p_0} \right) p_0 q_0}{\sum p_0 q_0} \times 100 = \frac{524.74}{623.70} \times 100 = 84.13$$

**(b) Computation of weighted price indices with 1951 quantities as weights.**

Commodity	Base year		Current year		$P_0 q_1$	$P_1 q_1$	Price relatives $P_1/P_0$	$P_0 q_1 \times (P_1/P_0)$
	$P_0$	$q_0$	$P_1$	$q_1$				
Rice	3.50	71	3.15	80	280.0	252.00	0.900	252.00
Barley	2.00	107	1.80	138	276.0	248.00	0.900	248.40
Maize	2.60	62	1.75	57	148.2	99.75	0.673	99.74
Total	---	---	--	--	704.2	600.15	--	600.14

∴ Weighted aggregative price Index is

$$P_{01} = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100 = \frac{600.15}{704.20} \times 100 = 85.22; \text{ and}$$

Weighted Average of Relatives Price Index is

$$P_{01} = \frac{\sum \left( \frac{p_1}{p_0} \right) p_0 q_1}{\sum p_0 q_1} \times 100 = \frac{600.14}{704.20} \times 100 = 85.22.$$

### 5.30 Computation of weighted aggregative price index for 1963

Commodities	1953 Base year		1963 Current year		$p_0 q_0$	$p_1 q_0$	$p_1 q_1$	$p_0 q_1$
	$p_0$	$q_0$	$p_1$	$q_1$				
A	12	501	10	600	6012	5010	6000	7200
B	38	100	50	194	3800	5000	9700	7372
C	40	56	40	76	2240	2240	3040	3040
Total	---	---	--	--	12052	12250	18740	17612

(i) By Laspeyres' method:

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{12250}{12052} \times 100 = 101.6$$

(ii) By Paasche's method:

$$P_{01} = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100 = \frac{18740}{17612} \times 100 = 106.4$$

### 5.31. Computation of weighted price index for 1969.

Group	Base year		Current year		$p_1 q_1$	$p_0 q_1$	$p_1/p_0$	Price Relatives	Weighted price relative
	$p_0$	$q_0$	$p_1$	$q_1$					
A	85	50	116	45	5220	3825	1.3647	5219.98	
B	34	120	42	185	7770	6290	1.2353	7770.04	
C	10	35	15	68	1020	680	1.5000	1020.00	
D	48	210	50	250	12500	12000	1.0417	12500.40	
Total	---	---	--	--	26510	22795	--	26510.42	

(i) Weighted Aggregative Price Index by Paasche's method:

$$P_{01} = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100 = \frac{26510}{22795} \times 100 = 116.30$$

(ii) Weighted Average of Relativs Price Index by Paasche's method:

$$P_{01} = \frac{\sum \left( \frac{p_1}{p_0} \right) p_0 q_1}{\sum p_0 q_1} \times 100 = \frac{26510.42}{22795} \times 100 = 116.30$$

**5.32. Construction of weighted Index numbers of prices for 1950 and 1951:**

Commodity	1946 (base year)		1950		1951		Products		
	$p_0$	$q_0$	$p_1$	$q_1$	$p_2$	$q_2$	$p_0q_0$	$p_1q_0$	$p_2q_0$
A	70.50	270	80.65	276	85.00	290	19035.00	21775.50	22950.00
B	146.95	24	155.00	18	154.75	44	3526.80	3720.00	3714.00
C	25.50	130	32.50	121	30.50	137	3315.00	4225.00	3965.00
D	64.75	185	75.00	267	60.95	355	11978.75	13875.00	11275.75
Total	--	--	--	--	--	--	37855.55	43595.50	41904.75

**Products Continued**

	$p_0q_1$	$p_1q_1$	$p_0q_2$	$p_2q_2$
	19458.00	22259.4	20445.00	24650.00
	2645.10	2790.0	6465.80	6809.00
	3085.50	3932.5	34931.50	4178.50
	17288.25	20025.0	22986.25	21637.25
$\Sigma$	42476.65	49006.9	53390.55	57274.75

**(i) Base year weighted indices:**

$$\text{Index for 1950 } (P_{1950}) = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{43595.50}{37855.55} \times 100 = 115.16$$

$$\text{Index for 1951 } (P_{1951}) = \frac{\sum p_2 q_0}{\sum p_0 q_0} \times 100 = \frac{41904.75}{37855.55} \times 100 = 110.70$$

**(ii) Current year weighted indices:**

$$\text{Index for 1950 } (P_{1950}) = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100 = \frac{49006.90}{42476.85} \times 100 = 115.37$$

$$\text{Index for 1951 } (P_{1951}) = \frac{\sum p_2 q_2}{\sum p_0 q_2} \times 100 = \frac{57274.75}{53390.55} \times 100 = 107.28$$

### 5.33. Computation of weighted index numbers.

Commodity	Base year		Current year		$p_0 q_0$	$p_1 q_0$	$p_0 q_1$	$p_1 q_1$
	$p_0$	$q_0$	$p_1$	$q_1$				
A	7	70	5	49	490	350	343	245
B	5	27	7	28	135	189	140	196
C	10	35	9	29	350	315	290	261
D	9	50	4	42	450	200	378	168
E	3	16	10	25	48	160	75	250
Total	---	---	--	--	1473	1214	1226	1120

Fisher's index

$$\begin{aligned}
 &= \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100 \\
 &= \sqrt{\frac{1214}{1473} \times \frac{1120}{1226}} \times 100 = 86.8; \text{ and}
 \end{aligned}$$

$$\text{Marshall-Edgeworth index} = \frac{\sum p_1 (q_0 + q_1)}{\sum p_0 (q_0 + q_1)} \times 100$$

$$\begin{aligned}
 &= \frac{\sum p_1 q_0 + \sum p_1 q_1}{\sum p_0 q_0 + \sum q_0 q_1} \times 100 \\
 &= \frac{2334}{2699} \times 100 = 86.5.
 \end{aligned}$$

### 5.34. Construction of Fisher's Ideal Index Number.

Commodity	Base year		Current year		$p_0 q_0$	$p_1 q_0$	$p_0 q_1$	$p_1 q_1$
	$p_0$	$q_0$	$p_1$	$q_1$				
Rice	9.3	100	4.5	90	930.0	450.0	837.0	405.0
Wheat	6.4	11	3.7	19	70.4	40.7	121.6	70.3
Jawar	5.1	5	2.7	3	25.5	13.5	15.3	8.1
Total	(ii) Taking 1964 as base:				1025.9	504.2	973.9	483.4
	$p_1$	$q_1$	$p_0$	$q_0$	$p_1 q_1$	$p_0 q_1$	$p_1 q_0$	$p_0 q_0$

$$\begin{aligned}
 \text{(i) Fisher's index for 1964} &= \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100 \\
 &= \sqrt{\frac{504.2}{1025.5} \times \frac{483.5}{973.9}} \times 100 = 49.4
 \end{aligned}$$

$$\begin{aligned}
 \text{(ii) Fisher's index for 1957} &= \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100 \\
 &= \sqrt{\frac{973.9}{483.4} \times \frac{1025.9}{504.2}} \times 100 = 202.5
 \end{aligned}$$

### 5.35. Construction of weighted index numbers.

Commodity	Base Year 1949		Current Years 1950      1951				$p_0 q_0$	$p_1 q_0$	$p_2 q_0$
	$p_0$	$q_0$	$p_1$	$q_1$	$p_2$	$q_2$			
Wheat	9.35	3,974	8.12	3,862	8.78	3,930	37,156.90	32,268.88	34,891.72
Rice	11.25	973	11.73	852	12.08	722	10,946.25	11,413.29	11,753.84
Gram	7.00	755	7.68	601	8.23	744	5,285.00	5,798.40	6,213.65
Total	---	---	---	---	---	---	53,388.15	49,480.57	52,859.21

Using Laspeyres' formula, we get

$$\text{Index for 1950} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{49,480.57}{53,388.15} \times 100 = 92.68$$

$$\text{Index for 1951} = \frac{\sum p_2 q_0}{\sum p_0 q_0} \times 100 = \frac{52,859.21}{53,388.15} \times 100 = 99.00$$

### 5.36. Calculation of the weighted index numbers.

Dairy Products	Base Year 1949		Current Years			
			1950		1951	
	$p_0$	$q_0$	$p_1$	$q_1$	$p_2$	$q_2$
Milk	3.95	9,675	3.89	9,717	4.13	10,436
Butter	61.50	118	62.20	116	59.70	116
Cheese	34.80	78	35.40	78	38.90	83

The necessary products for the calculation of Laspeyres', Paasche's, Fisher's and Marshall-Edgeworth's indices are given below:

	$p_0 q_0$	$p_1 q_0$	$p_1 q_1$	$p_0 q_1$	$p_2 q_0$	$p_0 q_2$	$p_2 q_2$
M	38,216.25	37,635.75	37,799.13	38,382.15	39,957.75	41,222.20	43,100.68
B	7,257.00	7,339.60	7,215.20	7,134.00	7,044.60	7,134.00	6,925.20
C	2,714.40	2,761.20	2,761.20	2,714.40	3,034.20	2,888.40	3,228.70
$\Sigma$	48,187.65	47,736.55	47,775.53	48,230.55	50,036.55	51,244.60	53,254.58

- (i) Laspeyres' index for 1950 =  $\frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$   
 $= \frac{47,736.55}{48,187.65} \times 100 = 99.06$ ; and
- Index for 1951 =  $\frac{\sum p_2 q_0}{\sum p_0 q_0} \times 100$   
 $= \frac{50,036.55}{48,187.65} \times 100 = 103.84$
- (ii) Paasche's index for 1950 =  $\frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100$   
 $= \frac{47,775.53}{48,230.55} \times 100 = 99.06$ ; and
- Index for 1951 =  $\frac{\sum p_2 q_2}{\sum p_0 q_2} \times 100$   
 $= \frac{53,254.58}{51,244.60} \times 100 = 103.92$
- (iii) Fisher's Ideal index for 1950 =  $\sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100$   
 $= \sqrt{\frac{47,736.55}{48,187.65} \times \frac{47,775.53}{48,230.55}} \times 100$   
 $= \sqrt{0.9906 \times 0.9906} \times 100 = 99.06$ ;
- Index for 1951 =  $\sqrt{\frac{\sum p_2 q_0}{\sum p_0 q_0} \times \frac{\sum p_2 q_2}{\sum p_0 q_2}} \times 100$   
 $= \sqrt{\frac{50,036.55}{48,187.65} \times \frac{53,254.58}{51,244.60}} \times 100$   
 $= \sqrt{1.0384 \times 1.0392} \times 100 = 103.88$ ;
- (iv) Marshall-Edgeworth index for 1950 =  $\frac{\sum p_1 (q_0 + q_1)}{\sum p_0 (q_0 + q_1)} \times 100$

$$= \frac{\sum p_1 q_0 + \sum p_1 q_1}{\sum p_0 q_0 + \sum p_0 q_1} \times 100 \\ = \frac{95,512.08}{96,418.20} \times 100 = 99.06; \text{ and}$$

Index for 1951

$$= \frac{\sum p_2 (q_0 + q_2)}{\sum p_0 (q_0 + q_2)} \times 100 \\ = \frac{\sum p_2 q_0 + \sum p_2 q_2}{\sum p_0 q_0 + \sum p_0 q_2} \times 100 \\ = \frac{103,291.13}{99,432.25} \times 100 = 103.88.$$

(v) The necessary products for the calculation of Walsh indices are obtained as below:

Dairy Products	$\sqrt{q_0 q_1}$	$\sqrt{q_0 q_2}$	$p_0 \sqrt{q_0 q_1}$	$p_1 \sqrt{q_0 q_1}$	$p_0 \sqrt{q_0 q_2}$	$p_2 \sqrt{q_0 q_2}$
Milk	9,696	10,048	38,299.20	37,717.44	39,689.60	41,498.24
Butter	117	117	7,195.50	7,277.40	7,195.50	6,984.90
Cheese	78	80	2,714.40	2,761.20	2,784.00	3,112.00
Total	--	--	48,209.10	47,756.04	49,669.10	51,595.14

Thus Walsh index for 1950

$$= \frac{\sum p_1 \sqrt{q_0 q_1}}{\sum p_0 \sqrt{q_0 q_1}} \times 100 \\ = \frac{47,756.04}{48,209.10} \times 100 = 99.06; \text{ and}$$

Index for 1951

$$= \frac{\sum p_2 \sqrt{q_0 q_2}}{\sum p_0 \sqrt{q_0 q_2}} \times 100 \\ = \frac{51,595.14}{49,669.10} \times 100 = 103.88.$$

(vi) The necessary calculations for Palgrave indices are given below:

Dairy Products	$\frac{p_1}{p_0}$	$\frac{p_2}{p_0}$	$p_1 q_1 \left( \frac{p_1}{p_0} \right)$	$p_2 q_2 \left( \frac{p_2}{p_0} \right)$
Milk	0.9848	1.0456	37,224.58	45,066.07
Butter	1.0114	0.9707	7,292.45	6,722.29
Cheese	1.0172	1.1178	2,808.69	3,609.04
Total	---	---	47,325.72	55,397.40

$$\text{Hence Palgrave index for 1950} = \frac{\sum p_1 q_1 \left( \frac{p_1}{p_0} \right)}{\sum p_1 q_1} \times 100$$

$$= \frac{47,325.72}{47,775.53} \times 100 = 99.06; \text{and}$$

$$\text{Index for 1951} = \frac{\sum p_2 q_2 \left( \frac{p_2}{p_0} \right)}{\sum p_2 q_2} \times 100$$

$$= \frac{55,397.40}{53,254.58} \times 100 = 104.02.$$

**5.37. (a) Rewriting the values in columns 2 and 3 in symbols, we get**

Year (1)	Declared values (2)	Value on the basis of 1938 values (3)
1938	$\sum p_0 q_0$	$\sum p_0 q_0$
1939	$\sum p_1 q_1$	$\sum p_0 q_1$
1940	$\sum p_2 q_2$	$\sum p_0 q_2$
1941	$\sum p_3 q_3$	$\sum p_0 q_3$

- (i) Index numbers of volumes are thus obtained by dividing the values in column 3 by  $\sum p_0 q_0$ , i.e. by Laspeyres's method.

$$\text{Thus the volume index for 1938} = \frac{\sum p_0 q_0}{\sum p_0 q_0} \times 100$$

$$= \frac{858}{858} \times 100 = 100;$$

$$\text{Volume index for 1939} = \frac{\sum p_0 q_1}{\sum p_0 q_0} \times 100$$

$$= \frac{832}{858} \times 100 = 97;$$

$$\text{Volume index for 1940} = \frac{\sum p_0 q_2}{\sum p_0 q_0} \times 100$$

$$= \frac{807}{858} \times 100 = 94; \text{ and}$$

$$\text{Volume index for 1941} = \frac{\sum p_0 q_3}{\sum p_0 q_0} \times 100$$

$$= \frac{704}{858} \times 100 = 82$$

- (ii) Index numbers of average values (prices) are obtained by dividing the entry in column 2 for any year by corresponding entry in column 3, i.e. by Paasche's formula. Thus

$$\text{the average value index for 1938} = \frac{\sum p_0 q_0}{\sum p_0 q_0} \times 100$$

$$= \frac{858}{858} \times 100 = 100;$$

$$\text{the average value index for 1939} = \frac{\sum p_0 q_1}{\sum p_0 q_1} \times 100$$

$$= \frac{840}{832} \times 100 = 101;$$

$$\text{the average value index for 1940} = \frac{\sum p_0 q_2}{\sum p_0 q_2} \times 100$$

$$= \frac{1126}{807} \times 100 = 140; \text{ and}$$

$$\text{the average value index for 1941} = \frac{\sum p_0 q_3}{\sum p_0 q_3} \times 100$$

$$= \frac{1132}{704} \times 100 = 161.$$

**(b) Computation of weighted price indices:**

Cereals	1960	1961	1962	Weight <i>w</i>	Price relatives		$(P_1/P_0)w$	$(P_2/P_0)w$
	$P_0$	$P_1$	$P_2$		$(P_1/P_0)$	$(P_2/P_0)$		
Wheat	110.70	122.85	129.00	12	1.1098	1.1653	31.3176	13.9836
Barley	99.50	124.55	120.50	8	1.2518	1.2111	10.0144	9.6888
Maize	60.25	74.90	76.25	5	1.2432	1.2656	6.2160	6.3280
Total	---	---	---	25	---	--	29.5480	30.0004

$$\text{Price index for 1961} = \frac{\sum \left( \frac{P_1}{P_0} \right) w}{\sum w} \times 100 = \frac{29.5480}{25} \times 100 = 118.19; \text{ and}$$

$$\text{Price index for 1962} = \frac{\sum \left( \frac{P_2}{P_0} \right) w}{\sum w} \times 100 = \frac{30.0004}{25} \times 100 = 120.00.$$

**5.38. Computation of Fisher's price index number for 1976:**

Commodity	Quantity (units)		Value (Rs.)	
	1961 ( $q_0$ )	1976 ( $q_1$ )	1961 ( $p_0 q_0$ )	1976 ( $p_1 q_1$ )
A	100	150	600	1200
B	80	100	400	700
C	60	72	180	432
D	30	33	450	363
Total	--	--	1630	2695
			$\sum p_0 q_0$	$\sum p_1 q_1$

To find other necessary products, we first compute the unit prices in both 1961 and 1976 by dividing the value figures by the corresponding quantity figures in both the years. Thus

Unit prices		$p_1 q_0$	$p_0 q_1$
$p_0$	$p_1$		
6	8	800	900
5	7	560	500
3	6	360	216
15	11	330	495
--	--	2050	2111
		$\sum p_1 q_0$	$\sum p_0 q_1$

Hence

$$\begin{aligned}
 \text{Fisher's price index for 1976} &= \sqrt{\frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum p_1 q_1}{\sum p_0 q_1}} \times 100 \\
 &= \sqrt{\frac{2050}{1630} \times \frac{2695}{2111}} \times 100 \\
 &= \sqrt{1.2577 \times 1.2767} \times 100 = 126.72
 \end{aligned}$$

### 5.39. Computation of quantity and price index numbers.

Commodity	Quantity (units)		Value (₹)	
	1938 ( $q_0$ )	1948 ( $q_1$ )	1938	1948
1	100	150	500	900
2	80	100	320	500
3	60	72	150	360
4	30	33	360	297
Total	---	---	1330 = $\sum p_0 q_0$	2057 = $\sum p_1 q_1$

To find other necessary products, we first calculate the average or unit prices in both 1938 and 1948 by dividing the value figures by corresponding quantity figure in both the years. Thus

Commodity	Unit prices		$p_0 q_1$	$p_1 q_0$
	1938 ( $p_0$ )	1948 ( $p_1$ )		
1	5	6	750	600
2	4	5	400	400
3	2.5	5	180	300
4	12	9	396	270
Total	---	---	1726 = $\sum p_0 q_1$	1570 = $\sum p_1 q_0$

From these products, the following quantity and indices (i.e. Laspeyres' type) can be obtained as follows:

The quantity index for 1948 with 1938 as base is

$$Q_{01} = \frac{\sum p_0 q_1}{\sum p_0 q_0} \times 100 = \frac{1726}{1330} \times 100 = 129.8.$$

The quantity index for 1938 with 1948 as base is

$$Q_{10} = \frac{\sum p_1 q_0}{\sum p_1 q_1} \times 100 = \frac{1570}{2057} \times 100 = 76.3$$

The price index for 1948 with 1938 as base is

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{1570}{1330} \times 100 = 118.0, \text{ and}$$

the price index for 1938 with 1948 as base is

$$P_{10} = \frac{\sum p_0 q_1}{\sum p_1 q_1} \times 100 = \frac{1726}{2057} \times 100 = 83.9.$$

#### 5.40. The necessary products are given below:

Com.	1955		1965		$P_1 q_0$	$P_0 q_0$	$\frac{P_1}{P_0}$	$\left(\frac{P_1}{P_0}\right) P_0 q_0$
	$p_0$	$q_0$	$p_1$	$q_1$				
A	10	501	12	600	6012	5010	1.20	6012
B	40	100	38	194	3800	4000	0.95	3800
C	50	76	40	56	3040	3800	0.80	3040
$\Sigma$	--	--	--	--	12852	12810	--	12852

Now the Weighted Aggregate price index for 1965, using base period quantities as weight, i.e. by Laspyres' formula is

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{12852}{12810} \times 100 = 100.33;$$

and the Weighted Average of relatives price index for 1965 by using Laspyres' method is

$$P_{01} = \frac{\sum (P_1/q_0) P_0 q_0}{\sum p_0 q_0} \times 100 = \frac{12852}{12810} \times 100 = 100.33.$$

#### 5.41. Calculation of quantity index numbers.

Articles	Export of Cotton Yarns and Manufactures				(i) $\frac{q_1 \times W}{q_0}$	(ii) $\frac{q_1 \times W}{q_0}$
	Quantity		Values (in 000 £)			
	1938 ( $q_0$ )	1943 ( $q_1$ )	1938	1943		
Cotton yarn (million lb)	{ A B	10.0	5.4	397	817	214.38
		2.9	2.8	278	315	268.41
Cotton manu- factures (th- ousand of yds)	{ A B C D	35.3	69.3	841	2,854	1651.03
		21.6	83.2	776	3,319	2989.04
		81.9	102.9	1,452	5,805	1821.31
		68.8	90.2	1,028	6,381	1347.46
Total		---	---	4,772	19,491	8291.63
						13642.05

(i) Index for 1943 on 1938 as base = 
$$\frac{\sum \left( \frac{q_1}{q_0} \right) W}{\sum W} \times 100$$

$$= \frac{8291.63}{4772} \times 100 = 173.8$$

(ii) Index for 1938 on 1943 as base = 
$$\frac{13642.05}{19491} \times 100 = 70.0$$

#### 5.42. Calculation of the cost of living index number.

Expenses on	Weight (W)	Price relative for 1928	I = price relative for 1929	$I \times W$
Food	35	100	97	3395
Rent	15	100	100	1500
Clothing	20	100	87	1740
Fuel	10	100	92	920
Misc.	20	100	113	2260
Total	100	--	--	9815

Hence cost of living index number for 1929 = 
$$\frac{\sum I \times W}{\sum W}$$

$$= \frac{9815}{100} = 98.15$$

As the cost of living index number for 1929 with 1928=100, is less than 100, we therefore conclude that prices in 1929 as compared with the prices in 1928 have fallen down.

### 5.43. (i) Construction of the consumer price index number, using the Aggregate Expenditure Method.

Commodity	Quantity consumed in 1939 ( $q_0$ )	Unit of price	Price in 1939 ( $p_0$ )	Price in 1940 ( $p_1$ )	$p_0 q_0$	$p_1 q_0$
Rice	6 mds.	Rs. p.m.d.	5.75	6.00	34.50	36.00
Wheat	6 mds.	Rs. p.m.d.	5.00	8.00	30.00	48.00
Gram	1 md.	Rs. p.m.d.	6.00	9.00	6.00	9.00
Sugar	1 md.	Rs. p. md.	20.00	15.00	20.00	15.00
Arhar	6 mds.	Rs. p. md.	8.00	10.00	48.00	60.00
Ghee	4 seers	Rs. p.seer	2.00	1.50	8.00	6.00
Total	---	---	---	--	146.50	174.00

$$\therefore \text{Consumer price index for 1940} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 \\ = \frac{174.00}{146.50} \times 100 = 118.8.$$

### (ii) Construction of the consumer price index number using the Household Budget Method.

Commodity	Quantity consumed in 1939 ( $q_0$ )	Unit of price	Price in 1939 ( $p_0$ )	Price in 1940 ( $p_1$ )	Price relative $I = p_1/p_0 \times 100$	Weight $W$ ( $= p_0 q_0$ )	$W \times I$
Rice	6 mds.	Rs. p.m.d.	5.75	6.00	104.3	34.50	3598.36
Wheat	6 mds.	Rs. p.m.d.	5.00	8.00	160.0	30.00	4800.00
Gram	1 md.	Rs. p.m.d.	6.00	9.00	150.0	6.00	900.00
Sugar	1 md.	Rs. p. md.	20.00	15.00	75.0	20.00	1500.00
Arhar	6 mds.	Rs. p. md.	8.00	10.00	125.0	48.00	6000.00
Ghee	4 seers	Rs. p.seer	2.00	1.50	75.0	8.00	600.00
Total	---	---	--	--	--	146.50	17398.36

$$\text{Hence the consumer price index number for 1940} = \frac{\sum W \times I}{\sum W} \\ = \frac{17398.36}{146.50} = 118.8$$

**5.44. (i) Computation of consumer price index using the base year quantities as weights.**

Article	Quantity	Price (Rs.) in		$p_0 q_0$	$p_1 q_0$
	1960 ( $q_0$ )	1960 ( $p_0$ )	1968 ( $p_1$ )		
Food	5 mds	18.00	26.50	90.00	132.50
Cloth	30 yards	2.60	2.80	78.00	84.00
Electricity	75 units	0.25	0.30	18.75	22.50
Rent	3 rooms	30.00	27.50	90.00	82.50
Miscellaneous	34 units	0.50	0.60	17.00	20.40
Total	--	--	--	293.75	341.90

∴ Consumer price index for 1968 is

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{341.90}{293.75} \times 100 = 116.39$$

**(ii) Consumer price index number using the values in the base year as weights.**

Article	Quantity 1960 ( $q_0$ )	Price in 1960 ( $p_0$ )	Price in 1968 ( $p_1$ )	Price relative $I = p_1/p_0 \times 100$	Weight $W$ ( $= p_0 q_0$ )	$W \times I$
Food	5 mds	18.00	26.50	147.22	90.00	13249.80
Cloth	30 yards	2.60	2.80	107.69	78.00	8399.82
Electricity	75 units	0.25	0.30	120.00	18.75	2250.00
Rent	3 rooms	30.00	27.50	91.67	90.00	8250.30
Miscellaneous	34 units	0.50	0.60	120.00	17.00	2040.00
Total	---	---	--	--	293.75	34189.92

Hence the consumer price index number for 1960 is

$$P_{01} = \frac{\sum W I}{\sum W} = \frac{34189.92}{293.75} = 116.39$$

### 5.45. Computation of retail price index number.

Item	Unit	Purchases (units)	Prices in July 1980	Prices on 1 Sept. 1983	$p_0 q_0$	$p_1 q_0$
Flour	kilogram	18	1.90	2.30	34.20	41.40
Meat	kilogram	2	22.00	28.00	44.00	56.00
Bread	200 gram	2	1.00	1.50	2.00	3.00
Tea	450 gram	4	8.25	10.35	33.00	41.40
Sugar	kilogram	3	7.00	7.75	21.00	23.25
Milk	Litre	2.5	3.50	4.00	8.75	10.00
Butter	450 gram	2	12.30	15.00	24.60	30.00
Eggs	Dozen	1.5	6.50	10.50	9.75	15.75
Potatoes	kilogram	10	2.60	3.20	26.00	32.00
Total	---	---	---	---	203.30	252.80

Hence the desired price index for 1983 is

$$P_{01} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{252.80}{203.30} \times 100 = 124.35.$$

