5 Index Numbers

5.1 Introduction

The buying power of a rupee varies from time to time as the amount of a commodity. One could buy by 10 rupees in 1960 now costs about 60 rupees in 1995, so to make meaningful comparisons overtime it is necessary to take into account the variability in the buying power of a rupee. For example to compare the cost of 2-year college education today with its cost in 1960, it is necessary to consider the buying power of a rupee today as compared with the buying power of a rupee in 1960. Similarly one may be interested to know the average hourly wages of a labourer in 1995 as compared with their wages in 1960. The numbers known as Index numbers are computed for this purpose and measure the relative change in a variable overtime. These are usually constructed for the variables such as prices, quantities, wages, investment and cost of living to help governments, economists and business people.

An index number is a ratio or an average of ratios usually expressed as a percentage. To construct index numbers two or more time periods are considered. The values at one of the time periods are taken as a base. This ratio of the values at the other time periods to the base period when expressed as a percentage show percentage change in the value from the value of the base period. The index number is usually denoted by I_n and is calculated by the relation:

$$I_n = \frac{\text{price in current year } n}{\text{price in base year}} \times 100 \qquad \text{.... (5.1)}$$

We will use the following notations in this chapter.

p_{0i} = price of the ith commodity in the base year.

q_{0i} = quantity of the ith commodity in the base year.

p_{0n} = price of the ith commodity in the current year.

q_{0n} = quantity of the ith commodity in the current year.

p_{0n} = price Index number for current year . P_{01} means index number for the year next to base year and so on.

Q_{0n} = Quantity Index number for current year. Q_{01} means index number for the year next to base year and so on.

I_n is also used to denote Index number for current year in the literature.

The index number for the base year is always taken as 100.

Example 5.1: The data given below is available about the price of wheat for the years 1989 to 1994. The interest is to compare the price of wheat in these years taking 1989 as the base year.

Year	1989	1990	1991	1992	1993	1994
Price	85	96	112	124	130	160

Solution:

The price index for each year is calculated by the ratio.

$$\therefore I_n = \frac{\text{price in current year}}{\text{price in 1989}} \times 100$$

The index number for 1989 is the ratio of price in 1989 to the price in 1989 expressed as a percentage i.e.,

(85/85)(100) = 100

The index number for 1990 is

(96/85)(100) = 112.94 and so on. The price indices are

Year	Price	Price index (1989 base)
1989	85.00	100
1990	96.00	112.94
1991	112.00	131.76
1992	124.00	145.88
1993	130.00	152.94
1994	160.00	188.24

The price index column indicates percentages of 1989 price for each year. For example, the price in 1992 is 145.88% of the price in 1989. So, the price of wheat is 45.88 % higher in 1992 as compared with wheat price in 1989.

5.1.1 Types of index numbers

Index numbers are generally classified into the following two types.

i. Simple index numbers.

ii. Composite or aggregate index numbers.

Simple index number

An index number is called a simple index number when it measure a relative change in a single variable with respect to a base year. For example index numbers for wages of labourers, index number of wheat prices and index number for the volume of a commodity (produced, purchased, sold, consumed etc.) overtime. In example 5.1 above, simple index numbers have been calculated.

If we are calculating price index (P_{on}) then the formula is

$$P_{on} = \frac{\text{price in year } n}{\text{price in base year}} \times 100 \qquad (5.2)$$

Similarly, wage index and other indices are calculated.

Example 5.2: Compare the daily wages of unskilled labourers in Lahore over the time period 1988-93 where the following data is available from the Pakistan Economic survey 1993 taking 1988 as base year. Wages are in rupees.

Year	1988	1989	1990	1991	1992	1993
Wages	46	51	58	71	71	86

Solution: The daily wage index I_n for each year is the ratio

$$W_{on} = \frac{\text{daily wages in year } n}{\text{daily wages in year 1988}} \times 100$$

Using this formula and taking 1988 wages as the base, the wage index numbers are calculated for each year and are given below in the last column.

Year	Wages (Rupees)	Wages index (1988 base)
1988	46	100.00
1989	51	110.87
1990	58	126.08
1991	71	154.35
1992	71	154.35
1993	86	186.96

The wage index of 126.08 for 1990 indicates that wages have been increased by 26.08 percent as compared to base year 1988. Similarly, the wages in 1993 have been increased 86.96 percent.

Composite or aggregate index numbers

An index number is called a composite (aggregate) index number when it measures a relative change in two or more variables with respect to a base year. For example index numbers for comparing two sets of prices from a wide variety of commodities, index numbers for comparing two sets of the quantities of the commodities from a wide variety of commodities. These are calculated in following two ways:

i. Unweighted index numbers
ii. Weighted index numbers

The unweighted and weighted indices may measure changes in price, quantity or value of a commodity. Accordingly these may be

a. Price index numbers
b. Quantity index numbers
c. Value index numbers

(a) and (b) are discussed in article 5.4 and 5.5.

The value index number denoted by V_{on} is $\frac{\Sigma p_n q_n}{\Sigma p_o q_o} \times 100$ (5.3)

where

$\Sigma p_n q_n =$ total value of all commodities in a given year.

$\Sigma p_o q_o$ = total value of all commodities in the base year.

The simple and composite indices are discussed in detail under headings 5.4 and 5.5.

5.1.2 Limitations of index numbers

Some limitations of index numbers are given below:

1. It is not possible to take into account all changes in product.
2. All index numbers are not suitable for all purposes.
3. There may be errors in the choice of base periods.
4. These are simply rough indications of the relative changes.
5. Different methods of construction of index numbers give different results.

5.1.3 Use of Index numbers

i) The price index numbers are used to measure the average price changes in a commodity or a group of commodities with the passage of time relative to the base period. This helps in comparing prices of one commodity with another.

ii) The price index numbers are used to measure the buying power of the money.

iii) The consumer price indices (CPI) are used as a factor to cancel out the effect of inflation or deflation by the governments as these measure the changes in the prices of consumer goods.

iv) The wholesale price index numbers (WPI) help in the adjustment of contract prices and payments by industrial organization as these measure changes in producer's selling prices.

v) The quantity index numbers are used to measure changes in the quantities produced, a consumed, purchased, sold, exported or imported.

vi) The index numbers are helpful for the economists and the businessmen to describe the existing conditions and help plan near future.

vii) The index numbers of import and export prices help to measure charges in terms of trade of country.

5.2 Construction of price index numbers

The construction of different index numbers involves the following main steps.

a. Purpose and scope

The first step is to define the purpose of index numbers. It should be clearly mentioned why, where and what changes are to be measured.

b. Selecting components

i. Commodities. ii. Price of commodities.

As an index number is constructed to represent a particular purpose. So, it is important to select the commodities to be included keeping in view the cost of collecting data. The items should be precisely defined in terms of quality specifications and relevant data should be readily available overtime as some items become obsolete with the introduction of new products. For practical purposes, the number of items selected should not be less than twenty. The prices of these items should be collected from different places keeping in view the quality of the items. The sampling should be carried out with care as the posted or listed prices are not the retail prices sometimes.

c. Choosing the base year

The purpose of constructing index numbers is to make comparisons. So, the base year should be chosen with care to be a year of normal prices and should not be a year too far from the current year. It is also possible to use an average of prices for several years to act as a base year e.g. it may be an average of 3 years. Usually base year is taken fixed because of comparison purposes but it may be taken as variable in case we calculate what we call "link relatives" discussed under 5.4 (iii)

d. Choosing the weights

The weights chosen should indicate the relative importance of various commodities to be included in the construction of an index. As all the commodities selected are not equally important so they should be given different weights. For example wheat should be given more weight as compared with tea.

The weights chosen for the price index may be the quantities of the base year or current year. It depends upon the situation what weight to be used. The quantities may be quantities produced or quantities marketed because in agricultural economics, a high proportion of the food produced is often consumed by the families themselves and not sold in the markets.

The weights may be formulated as follows.

Let W_{oi} denotes the weight for the ith commodity in the base year.

V_{oi} is the value of the marketed or produced commodity in base year then

Value of the commodity = price × quantity

$$V_{oi} = P_{oi} q_{oi}$$

The weight

$$W_{oi} = \frac{V_{oi}}{\Sigma V_{oi}} \tag{5.4}$$

Here, ΣV_{oi} is the total value of the k items in the base year

e. Choosing the average

An index number can be constructed as average of ratios according to the definition of index number. For example, consider k commodities then the arithmetic mean of k ratios each computed for single commodity is

$$P_{on} = \frac{\sum_{i=1}^{k} \frac{P_{ni}}{P_{oi}}}{k} \tag{5.5}$$

Other averages such as geometric mean, harmonic mean or median can also be used instead of arithmetic man. Although geometric mean is more appropriate for averaging ratios but in practice arithmetic mean is used for convenience.

5.3 Unweighted index numbers

The idea is to give equal weights to each item in the index. The unweighted index numbers are computed in the following two ways:

i. Simple aggregate Index

It is the ratio of the sum of prices (quantities) of commodities for a given year to the sum of prices (quantities) of the same commodities in the base year, expressed as a percentage.

The price index denoted by P_{on} in calculated by the formula

$$P_{on} = \frac{\sum_{i=1}^{k} P_{ni}}{\sum_{i=1}^{k} P_{oi}} \times 100 \quad = \frac{\sum P_n}{\sum P_o} \times 100 \qquad (5.6)$$

where k is the number of commodities P_{oi} and P_{oi} are the prices of the commodities in the current and the base years respectively, n denotes the current years, 0 denotes the base year and i stands for the number of commodities.

These indices suffer from drawback that changes in the measuring units may affect the value of the index which ultimately lessen their usefulness for making meaningful comparisons. Secondly these indices use equal weight for all commodities whereas all commodities are not equally important.

ii. Average Relative Index

It is the average of simple index numbers calculated individually for each commodity. For k commodities it is calculated by the relation.

$$P_{on} = \frac{1}{k} \sum_{i=1}^{k} \frac{P_{ni}}{P_{oi}} \qquad (5.7)$$

The simple index numbers P_{ni} / P_{oi} are also called price relatives. Thus average index is the average of price relatives. Usually, the average used is arithmetic mean but other averages such as geometric mean or median may be used.

These indices suffer from the drawback that these don't use weights for the different commodities according to their importance but changes in the measuring units don't affect the index value.

Example 5.3: Calculate the unweighted price index for 1994 when the procurement/ support prices of agricultural commodities in rupees per 40 Kg in 1980 and 1994 are given as follows:

Commodity	Prices	
	1980	1994
Wheat	58	160
Rice	118	360
Potato	27	19
Onion	80	84

Solution:

i. **Simple aggregate index**

The simple aggregate price index for 1994 is

$$P_{on} = \frac{160+360+19+84}{58+118+27+80} \times 100 = \frac{623}{283} \times 100 = 22014 = \frac{\sum_{i=1}^{k} P_{ni}}{\sum_{i=1}^{k} P_{oi}} \times 100$$

This indicates that the prices of the above 4 commodities in 1994 are 120.14% higher than they were in 1980.

ii. **Average relative index**

The simple price index number for wheat is given by

$$P_{on} = \frac{160}{58} = 2.7586 \text{ or } 275.86\%$$

The simple price index for rice is given by

$$P_{on} = \frac{360}{118} = 3.0508 \text{ or } 305.08\%$$

Similarly, the index numbers for potato and onion are

$$\frac{19}{27} = 0.7037 \text{ or } 70.37\% \text{ and } \frac{84}{80} = 1.05 \text{ or } 105\% \text{ respectively.}$$

So, the average relative index for commodities is given by

using arithmetic mean as average

$$P_{on} = \frac{2.7586 + 3.0508 + 0.7037 + 1.05}{4} = 1.8908 \; or \; 189.08\%$$

This index indicates that the prices are 89.08% higher in 1994 as compared with 1980.

using median as average

One can use the median as average, then the median value of these 4 values is obtained by arranging them in ascending order as follows:

0.7037, 1.05, 2.7586, 3.0508

As 4 is an even number so the median is the average of middle two val ues i.e.,

(1.05 + 2.7586)/2 = 1.9043, so our index number is

1.9043(100)% = 190.43%

using geometric mean as average

Y	$\log Y$
1.05	0.0212
2.7586	0.4407
3.0508	0.4844
0.7037	0.1526
Total:	0.7937

$$\text{G.M.} = \text{Antilog } (\Sigma \log Y / n)$$
$$= \text{Antilog } (0.7937/4)$$
$$= \text{Antilog } (0.1984) = 1.5791$$

So, the index is

(1.5791) (100) = 157.91

In this example, wheat and onion had equal weights but clearly wheat is produced more as compared with onion, so it is usually recommended to use weights in the index proportional to the value of the production of each item.

Example 5.4: Calculate index numbers of price, using 1962 as base

i) Mean ii) Median are used.

Years	**Commodities**			
	Firewood	**Softcake**	Kerosene oil	Match
1962	3.25	2.50	0.20	0.06
1963	3.44	2.80	0.22	0.06
1964	3.50	2.00	0.25	0.06
1965	3.75	2.50	2.50	0.06

Solution:

Years	**Price relatives**				Total	**Index numbers**	
	Fire-wood	Soft-cake	Kerosene oil	Match		Mean	Median
1962	100	100	100	100	400	100	100
1963	106	112	110	100	428	107	108
1964	108	80	125	100	413	103	104
1965	115	100	125	100	440	110	108

Method for finding the average relative Index number.

With the introduction of new commodities and quality goods in the market, the tastes and habits of the people change overtime. This brings change in the relative importance of the commodities. In such situations, it becomes necessary to change the base year and a quantity called **Link relative** is calculated instead of **price relative** for each year. The link relative is a quantity computed by taking the price of the previous year as a base. These are also expressed as percentages like price relative.

$$\text{Link relatives} = \frac{\text{Price of an item for current year}}{\text{Price of an item for previous year}} \times 100$$

$$= \frac{P_n}{P_{n-1}} \times 100$$

Link relatives are not directly comparable because they have no fixed base. To make them comparable, they are converted to what we call **Chain indices**. The chain index for the first year is taken as 100 and then the chain index for succeeding year is obtained by multiplying its link relative with the chain index of the proceeding year and dividing the results by 100. One can note that these chain indices are just the price relatives computed by taking the first year as a base.

Advantages of chain base methods

This method is rarely used because the price relatives give the same results. However, it has certain advantages.

i) Link relatives are useful to make year to year comparisons.

ii) New items can be substituted for old items provided the number of items remains the same.

iii) The weighing system can be changed according to the change in the relative importance of different items.

iv) Changes in the Geographical coverage can be accommodated.

Example 5.5: Compute link relatives and chain index for the data of the example 5.2.

Year	Wages	Link relative	Index numbers
1988	46	100	100
1989	51	$\frac{51}{46}\times100=110.87$	$\frac{110.87\times100}{100}=110.87$
1990	58	$\frac{58}{51}\times100=113.73$	$\frac{113.73\times110.87}{100}=126.09$
1991	71	$\frac{71}{58}\times100=122.41$	$\frac{122.41\times126.09}{100}=154.35$
1992	71	$\frac{71}{71}\times100=100$	$\frac{100\times154.35}{100}=154.35$
1993	86	$\frac{86}{71}\times100=121.13$	$\frac{121.13\times154.35}{100}=186.96$

Example 5.6: Find chain index numbers for the price data given below. The price of the commodities are in Rs. per 40 Kg.

Years	Commodities			
	Wheat	Rice	Potato	Onion
1980	58	118	27	80
1981	60	120	30	90
1982	75	130	30	95
1983	90	150	40	100

Solution: First we compute link relative, by the relation

$$\text{Link relative} = \frac{P_n}{P_{n-1}} \times 100$$

The link relative for wheat for the year 1980 is taken as 100, for 1981 it is 60/58 $\times 100$ = 103.45; for 1982 it is 75/60 $\times$ 100 = 125.00 and so on for all the other commodities and are given below:

Year	Link relatives					
	Wheat	Rice	Potato	Onion	Total	Mean
1980	100	100	100	100	400	100
1981	103.4	101.7	112.5	112.5	428.7	107.2
1982	125.0	108.3	105.6	105.6	438.9	109.7
1983	120.0	115.4	105.3	105.3	474.0	118.5

The chain index for 1980 is 100; The chain index for 1981 is obtained by multiplying 100 with the link relative of 1981 and dividing it by 100; i.e., (107.19)(100)/100=107.19; the chain index for 1982 is (109.72)(107.19)/ 100=117.61 and so on. These are given in the adjoining table:

Year	Chain Indices
1980	100
1981	$\frac{107.19 \times 100.00}{100} = 107.19$
1982	$\frac{109.72 \times 107.19}{100} = 117.61$
1983	$\frac{118.49 \times 117.91}{100} = 139.36$

5.4 Weighted index number

In the weighted index numbers the different commodities in the combination receive their weights proportional to their importance. These are calculated by the following two types:

5.4.1. Weighted aggregate index

It is the ratio of the sum of weighted commodity prices (quantities) to the sum of weighted commodity prices (quantities) in the base year, expressed as a percentage, the weights being the corresponding quantities (prices).

The price index denoted by P_{on} (weighted) is calculated by the following formula.

$$P_{on} = \frac{\sum_{i=1}^{k} P_{ni} q_{oi}}{\sum_{i=1}^{k} P_{oi} q_{oi}} \times 100 \qquad (5.8)$$

where, p_{ni}, p_{oi} are the prices of the commodities in the current and base year and q_{ni}, q_{oi} are the corresponding quantities respectively.

Weighted index numbers are of various kinds. The most common are discussed below:

a. Laspeyre's Index Number

It was named after the name of an economist Etienne Laspeyres who introduced it. It is denoted by P_{on} and is calculated by the following formula.

Index number for prices

$$P_{on} = \frac{\sum_{i=0}^{k} P_{ni} q_{oi}}{\sum_{i=0}^{k} P_{oi} q_{oi}} \times 100 \qquad (5.9)$$

Here the weights are base year quantities and the idea of using base year quantities as weights for current year prices is that the base year quantities don't change overtime. This is true for every day consumer commodities but for others the increase in price is followed by the decrease in the quantity consumed so more weights are given to the commodities whose prices have increased.

Index number for quantities

$$Q_{on} = \frac{\sum_{i=0}^{k} q_{ni}\, p_{oi}}{\sum_{i=0}^{k} q_{oi}\, p_{oi}} (100) \tag{5.10}$$

Here the weights are base year prices.

b. Paasche's Index Number

It is a weighted index and unlike Laspeyre's index, it uses current year quantities as weights rather than base year quantities for the price index. It is denoted by P_{on} and is calculated by the formula

$$P_{on} = \frac{\sum_{i=0}^{k} p_{ni}\, q_{ni}}{\sum_{i=0}^{k} p_{oi}\, q_{ni}} (100) \tag{5.11}$$

Unlike Laspeyres index this index gives less weight to the commodities whose prices have increased. Similarly, the quantity index number is

$$Q_{on} = \frac{\sum_{i=1}^{k} q_{ni}\, p_{ni}}{\sum_{i=1}^{k} q_{oi}\, p_{ni}} (100) \tag{5.12}$$

c. Fisher's ideal Index Number

This index number uses the fact that Laspeyres index gives more weight to commodities whose prices have increased and Paasche's index gives less weight to commodities whose prices have increased so, there should be an index number that should be in between these two index numbers. This aim is achieved by taking the geometric mean of these index numbers. So, the Fisher's index number P_{on} is given by

$$P_{on} = \sqrt{\text{Laspeyre} \times \text{Paasche}} \tag{5.13}$$

$$= \sqrt{\left(\frac{\Sigma p_{ni}\, q_{oi}}{\Sigma p_{oi}\, q_{oi}}\right)\left(\frac{\Sigma p_{ni}\, q_{ni}}{\Sigma p_{oi}\, q_{ni}}\right)} \times 100 \tag{5.14}$$

Example 5.7: Complete index numbers from the following data using 1964 as base.

i) Laspeyre's Index. ii) Paasche's Index iii) Fisher's Index

for the following data using 1964 as base.

Items	1964		1967	
	Price	Quantity	Price	Quantity
A	10	12	12	15
B	9	15	5	20
C	5	24	9	20
D	10	5	14	5

Solution:

Items	1964		1967		$p_o q_o$	$p_n q_o$	$p_n q_n$	$p_o q_n$
	p_o	q_o	p_n	q_n				
A	10	12	12	15	120	144	180	150
B	9	15	5	20	105	75	100	140
C	5	24	9	20	120	216	180	100
D	10	5	14	5	50	70	70	80
Total:	-	-	-	-	425	505	530	470

i) Laspeyre's Index $= \frac{\sum P_n q_o}{\sum P_o q_o} \times 100 \frac{505}{425} \times 100 = 118.8$

ii) Paasche's Index $= \frac{\sum P_n q_n}{\sum P_o q_n} \times 100$

$$= \frac{530}{470} \times 100 = 112.8$$

iii) Fisher's Index $= \sqrt{\frac{\Sigma p_n q_o}{\Sigma p_o q_o} \times \frac{\Sigma p_n q_n}{\Sigma p_o q_n}} \times 100$

$$= \sqrt{\frac{505}{425} \times \frac{530}{470}} \times 100$$

$$= 115.8$$

5.5 Consumer Price index (CPI) and Wholesale Price Index (WPI)

Federal Bureau of Statistics (FBS) calculates the following price indices in the country to measure price changes overtime.

i) Consumer Price Index (CPI) ii) Sensitive Price Index (SPI)

iii) Wholesale Price Indices (WPI)

We shall discuss meaning and construction with reference to Pakistan.

5.5.1 Consumer Price Index (CPI)

CPI is constructed to measure the aggregate change in the cost of a fixed basket of goods and services purchased at current prices with its cost at a given period called the base, which is always taken as hundred. It is also called cost of living index.

The CPI was computed for the first time in early 1950's with base 1948-49 for industrial workers in Lahore, Karachi and Sialkot only as a measure of inflation. These days, it is being calculated for four different income groups and occupational groups in 25 big cities of the country and covers 464 items of consumption in the basket of goods and services which represent their taste, habits and customs.

To construct the CPI, the prices of the items to be included are sampled from different locations. The weights to different commodities are given keeping in view their importance to make the indices reliable. The weight assigned to each commodity is the average percentage expenditure on it to the total expenditure of a family. The present weights used are based on the results of a Family Budget Survey conducted for this purpose. Due to change in income, taste and other seasonal and geographical factors, the weights are different for different income groups, occupational categories, cities and various commodity groups.

5.5.2 Construction of CPI

The construction of consumers price index number involves the following steps:

1. Deciding the category of the people
2. Family Budget inquiry
3. Selection of items
4. Price quotations
5. Choice of weights

1. Deciding category of the people.

The first and the most important step in the construction of consumer price index numbers is the decision regarding the category of the people for whom the index numbers are going to be constructed. It should be decided before hand and whether they are for clerks, industrial, coolies.

2. Family Budget Inquiry

After deciding the category of the people an adequate number of families should be selected during a normal period. Family budget inquiry is conducted on the basis of random sampling. This inquiry would give information regarding,

i) the qualities and quantities of the items consumed by them. Index different heads such as food articles, clothing house rent, fuel lighting, education gifts, newspaper, transport etc.

ii) the retail prices of the items.

iii) amount spent by various items.

3. Selection of Items

With the help of family budget inquiry, it becomes easier to select the items which should be included in the construction of consumer's price index numbers. Only these items should be included which are largely used by that class of people and which are not subject to wide variation in quantity, supply and prices.

4. Price Quotations

The price quotations should be retail prices and not the whole rate prices. The prices should be obtained from the shops, publications of the govt. and official reporters of deciding locality.

5. Choices of Weights

All the items that enter into family budget are not of equal importance and thus weights must be assigned to the items. There are two types of weights:

ii) **Quantity Basis:** It means the quantity of the different items consumed in the base mean.

iii) **Value Basis:** It means total values of the items consumed by each group. It is calculated by multiplication of the quantities consumed and the prices, there are two methods.

a) **Aggregative Expenditure Method**

According to this method, the quantities consumed in the base year used as weights. It is the base year weighted index given by Laspeyre's

$$P_{on} = \frac{\Sigma P_n q_o}{\Sigma P_o q_o} \times 100$$

b) **Family Budget Method**

This method is the weighted average of price relatives. In this method, the family budget of a large number of families are carefully studied and the aggregate expenditure of the average family on various items is estimated. The amount of money spent by the families concerned are calculated from a family budget inquiry. The formula is

$$P_{on} = \frac{\Sigma IW}{\Sigma W} \times 100$$

Where, $I = \frac{P_n}{P_o} \times 100$

$$W = p_o q_o$$

Example 5.8: An inquiry into the budgets of the middle class families in a city of England gave the following information:

Expenses on	Food 35%	Rent 15%	Clothing 20%	Fuel 10%	Misc. 20%
Price (1928)	150	30	75	25	10
Price (1929)	145	30	65	23	15

What changes in cast of living the figures of 1929 show as compared to 1928?

Solution:

Expansion	W	Price (1928) (p_o)	Price (1929) (p_n)	$\frac{P_n}{P_o}\times 100$	IW
Food	35	150	145	97	3395
Rent	15	30	30	100	1500
Clothing	20	75	65	87	1740
Fuel	10	25	23	92	920
Misc.	20	40	45	113	2260
Total	100	-	-	-	9815

cost of living for 1929

$$P_{on} = \frac{\Sigma IW}{\Sigma W} = \frac{9815}{100} = 98.15$$

Interpretation of CPI computed and circulated by FBS

The following tables are taken from the Pakistan Economic Survey (1993-1994) where, CPI has been calculated by the Federal Bureau of Statistics (FBS) for items and for different income groups.

Consumer Price Index (on annual basis)			
Index	**Weight**	**% change**	**% point Contribution (1993-94/1992-93)**
General	100.00	10.61	10.61
Food, Beverages	49.90	10.40	5.19
House rent	17.76	9.83	1.75
Fuel & lighting	5.62	14.74	0.83
Household furniture equipment	2.34	5.21	0.12
Miscellaneous	2.44	22.11	0.54

The table indicates that highest increase recorded during the period is 22.11% in the miscellaneous group followed by the fuel and lighting group which recorded an increase of 14.74%. The lowest increase was recorded in the household, furniture and equipment group.

Since weights vary across the commodity groups, the highest contribution to overall CPI increase has been made by food, tobacco, beverages and group which is calculated by computing the ratio 100/49.90 = 2.004 and then dividing the change 10.40 by 2.004 i.e., 10.40/2.004 = 5.19 and similarly, for the house rent group i.e., 100/17.76 = 5.6306, then 9.83/5.63 = 1.75 and so on.

The following table gives the consumer price index for different income groups in Pakistan.

	Income group	**% change 1994/1993**	**Ratio of individual group index to overall CPI**
I.	Upto Rs.1000	8.27	97.18
II.	Rs.1001-2500	8.56	100.59
III.	Rs.2501-4500	8.91	104.70
IV.	Above Rs.4500	8.67	101.88
V.	All groups (combined)	8.51	100.00

The table indicates that there is an increasing trend in the indices of first three income groups starting from 8.27 to 8.91, then the index for 4th income group is 8.67 whereas the combined index is 8.51. The last column is the ratio of individual group to overall for the first group it is 8.27/8.51(100)=97.18; for the second group it is 8.56/8.51(100) = 100.59, and so on.

As the CPI is used to cancel out the effect of inflation so these indices suggest that the measures should be taken to protect the group I and II as compared with the other groups.

CPI and rate of inflation

The common way used to measure inflation in Pakistan is through CPI. While calculating annual rate of inflation one should compare the current year CPI with that of last year. The average annual rate of inflation over a longer period of time can be calculated by taking the average of those years. The inflation rate during the years mentioned below is computed using the CPI with base 1980-1981. The rate of inflation for 1989-1990 is $[(177.33-167.23)/167.23] \times 100 = 6.04$ and similarly others.

Period	Index	Rate of Inflation
1988-89	167.23	---
1989-90	177.33	6.04
1990-91	199.78	12.66
1991-92	218.99	9.62
1992-93	239.26	9.26
1993-94	266.00	11.18
Total:		48.76

The annual average rate of inflation for 5 years is 48.76/5 = 9.75%

Measurement of purchasing power of money

The inverse of CPI can be used to measure the purchasing power of money. Since the base of CPI is 100 and the Pakistani rupee is also convertible into 100 paisas, the purchasing power of rupee is [I/CPI] × 100. Through this approach the purchasing power of Pakistani rupee in January 1995 as compared to 1980-1981 has come down to paisas 33 only.

5.5.2 Sensitive Price Indicator (SPI)

SPI is calculated in the same way with the same formula as the CPI but the difference is that it includes only 46 essential commodities instead of 464 in the CPI.

5.5.3 Wholesale price index (WPI)

This index indicates change in producer's selling prices and is not an indicator of wholesale prices as the name indicates.

These are computed from the information collected by sampling the producer's selling prices. Weights are derived on the basis of the value of the marketable surplus of commodities available for sale. These are computed with the same formulas as for the CPI. The following table gives the wholesale price indices of selected items taken from Pakistan Economic Survey (1993-94).

Consumer Price Index (on annual basis)			
Index	**Weight**	**% change**	**% point Contribution (1993-94/1992-93)**
General	100.00	12.71	12.71
Food	50.63	12.42	6.29
Raw material	8.97	18.69	1.68
Fuel, lighting and lubricants	11.79	22.65	2.67
Manufacturers	24.06	6.84	1.65
Building material	4.55	11.33	0.52

The table indicates that the wholesale price index increased by 12.71 percent. The highest increase of 22.65% is recorded in the 'Lubricants' group and on the other hand, the lowest increase of 6.84% is recorded in the 'Manufacturers' group. The percentage point contribution in the last column is calculated in the

same way as for the consumer price index in the previous table. It should be noted that in these indices it is valid to compare adjacent years, such as the value of 106.30 in 1992 and the value of 110.40 in 1993. The year to year change is 110.40-106.30 = 4.10 points or

$$\frac{4.10(100)}{106.30} = 3.86\%$$

Exercise 5

Ans on Page 253

5.1 What is an index number? Give the uses of an index number.

5.2 Define an index number. Discuss the main points involved in the construction of index numbers of prices.

5.3 Define an index number and describe the different types of index number.

5.4 Discuss the important problems involved in the construction of index number of prices.

5.5 Compare the following concepts:

i. Simple and composite index.

ii. Fixed and chain base method.

5.6 What is the weighted index number?

5.7 Find the index number of price from the following data taking average price of all years as the base.

Years	1970	1971	1972	1973	1974	1975	1976	1977
Prices	15	19	21	30	37	38	40	48

5.8 Given the prices of a commodity per maund for the period 1945 to 1960 as;

Year	Prices	Year	Prices	Year	Prices
1945	12.7	1950	24.85	1955	15.65
1946	18.97	1951	20.90	1956	16.15
1947	19.70	1952	19.80	1957	20.20
1948	13.50	1953	23.65	1958	25.25
1949	15.65	1954	24.55	1959	32.40

Construct index numbers correct to 2 decimal place:

i. 1945 as base.

ii. Average price of all the year as base prices.

5.9 Find index number using

i. 1977 as base

ii. average of the price as base:

Years	Prices	Years	Prices	Years	Prices
1977	22.5	1980	30	1983	37.5
1978	25	1981	35	1984	47.5
1979	27.5	1982	32.5	1985	45

5.10 For the following data, find index numbers taking

i. 1930 as base ii. Average of 1st 3 years as base

iii. the year 1935 as base

Years	Prices	Years	Prices	Years	Prices
1930	4	1933	7	1936	9
1931	5	1934	8	1937	10
1932	6	1935	10	1938	11

5.11 The following figures show the wholesale prices of refined petroleum per gallon in UK for the year specified. On the basis of 1923=100, construct a series of price relatives.

Years	Prices	Years	Prices
1923	13	1928	11 ¼
1924	13 ½	1929	10 ½
1925	13	1930	12 ½
1926	11 ½	1931	10 ¼
1927	12 ⅔	1932	10 ½

5.12 Construct index numbers of prices for the following data taking 1960 as base:

Years	Prices	Years	Prices
1960	50	1965	72
1961	52	1966	73
1962	55	1967	75
1963	57	1968	71
1964	62	1969	70

5.13 The prices in Rs. Per maund of coal sold during the year 1953-58 as given below: Compute index number of price for the year 1953 as base.

Years	Prices	Years	Prices	Years	Prices
1953	14.95	1955	15.10	1957	16.28
1954	14.95	1956	15.65	1958	16.28

5.14 From the data given below, compute, the index numbers of prices, taking 1962 as base.

Commodities (Prices in Rs.)				
Year	**Firewood**	**Soft cake**	**Kerosene oil**	**Matches**
1962	3.25	2.50	0.20	0.06
1963	3.44	2.80	0.22	0.06
1964	3.50	2.00	0.25	0.06
1965	3.75	2.50	0.25	0.06

5.15 Compute index numbers of prices from the following data taking 1981 as base and using median as average.

Year	Prices		
	A	*B*	*C*
1981	18	85	52
1982	22	76	60
1983	28	80	66
1984	31	95	80

5.16 Find chain index numbers (using geometric mean to average the relatives) for the following data of prices, taking 1970 as the base year.

Commodities	Years				
	1970	**1971**	**1972**	**1973**	**1974**
A	40	43	45	42	50
B	160	162	165	161	168
C	20	29	52	23	27
D	240	245	247	250	255

5.17 The following table gives the average whole sale prices in rupees per unit of gold, wheat, cotton during the year 1912–1917. Construct index number with 1912 as base using

i) A.M. ii) G.M.

Commodities	Average price in Rs. Per unit					
	1912	**1913**	**1914**	**1915**	**1916**	**1917**
Gold	25.3	30.8	33.4	35.5	35.4	36.0
Wheat	17.3	14.5	4.9	5.7	17.7	11.6
Cotton	7.8	5.4	6.7	5.6	7.2	10.2

5.18 Construct chain indices for the following years, taking 1940 as base.

Item	Years				
	1940	**1941**	**1942**	**1943**	**1944**
Wheat	2.80	3.40	3.60	4.00	4.20
Rice	2.95	3.60	2.90	2.75	2.75
Maize	3.10	3.50	3.40	4.50	3.70

5.19 Construct index numbers for 1963 assuming 1953 as base period by

i) Laspeyre's formula ii) Paasche's formula.

Commodities	1953		1963	
	Price	Quantity	Price	Quantity
A	2	50	10	40
B	3	10	8	5
C	4	5	4	5

5.20 Compute the weighted index numbers for 1964 from the following data with 1960 as base.

Commodities	Price		Quantity	
	1960	1964	1960	1964
Milk	3.95	4.25	97.75	104.36
Cheese	34.80	38.90	78	83
Butter	61.56	59.70	118	116

5.21 Compute Fisher's index number for the following data.

Commodities	Base Year		Current Year	
	Price	Quantity	Price	Quantity
A	7	70	5	49
B	5	27	7	28
C	10	35	9	29
D	9	50	4	42
E	3	16	10	25

5.22 Construct the following with the help of data given below.

Fisher's ideal index taking 1970 as base.

Commodities	Total Production (tons)		Harvest Price (Rs)	
	1970	1971	1970	1971
Rice	71	26	3.80	3.50
Barley	107	83	2.90	1.90
Maize	72	48	2.90	1.80

5.23 Calculate Fisher's Ideal index from the following data with 1965 as base year.

Commodities	1965		1970	
	Price	Quantity	Price	Quantity
A	4.6	102	9.50	96
B	3.7	15	7.36	28
C	10.2	17	8.42	21
D	8.9	19	9.87	13

5.24 Define weighted and unweighted index numbers and explain why weighted index numbers are preferred over unweighted index numbers.

5.25 Calculate Laspeyre's, Paasche's and Fisher's ideal index for the following data with 1992 as base.

Item	Average price (Rs)		Quantity (Units)	
	1992	1993	1992	1993
Wheat flour	4.38	4.57	20Kg	16Kg
Rice	14.15	15.58	10Kg	12Kg
Moong pulse	18.67	17.28	1Kg	1Kg
Gram pulse	10.41	16.36	1Kg	1Kg

5.26 The following figures give the average annual prices in U.K. for beef and mutton.

Years	Price		Year	Price		Year	Price	
	Beef	Mutton		Beef	Mutton		Beef	Mutton
1935	54	75	1938	62	62	1941	72	85
1936	54	73	1939	61	68	1942	76	90
1937	61	73	1940	72	85	1943	79	90

Construct index number of meat prices giving weights 2 and 1 for beef and mutton respectively. Take the year 1935 as the base year.

5.27 The following table shows the average price in rupees for wheat, rice and barley.

Year	Price		
	Wheat	Rice	Barley
1980	175.5	480.4	82.4
1981	180.3	509.7	90.6

Taking 1980 as base year, construct price index number by weighted average of relative method for the year 1981 using the weight 20 for wheat, 12 for rice and 4 for barley.

5.28 An inquiry into the budgets of the middle class families in a city of England gave the following information. What change in cost of living the figures of 1929 show as compared in 1928.

Expenses on	Food 35%	Rent 15%	Clothing 20%	Fuel 10%	Misc. 20%
Price (1928)	150	30	75	25	40
Price (1929)	145	30	65	23	45

5.29 Fill in the blanks:

i) The changes in whole sale or retail price are studied in ________.

ii) The volume or quantity of goods are compared by ________.

iii) In ________ both quantities and prices are used.

iv) Index number are used for ________ business activity and in discovering ________ fluctuation and business ________.

v) The purpose of index number may be ________ or ________.

vi) The two method of selection base periods are ________ and ________.

vii) The base period in fixed base should be ________.

viii) ________ process is must in ________ method for comparison purpose.

ix) Geometric mean is a suitable average in ________ method.

x) Un-weighted indices are classified into simple ________ indices and simple ________.

5.30 Against each statement, write T for true and F for false statement.

i) Six steps are involved in the construction of index numbers of prices.

ii) In price relative, the given year price is divided by the base year price.

iii) Laspeyre's Index number is also named as current year weighted index number.

iv) Fisher's Index number is the Geometric Mean of the Laspeyre's and Paasche's Index number.

v) Aggregate expenditure method and Family Budget method are the types of the consumer price index number.

vi) The Index numbers are calculated in percentages.

vii) Index numbers are statistical barometers.

viii) In chain base method the base year is fixed.

ix) The most suitable average for Index numbers is Harmonic Mean.

x) The smaller the size of the sample, the greater would be the accuracy.