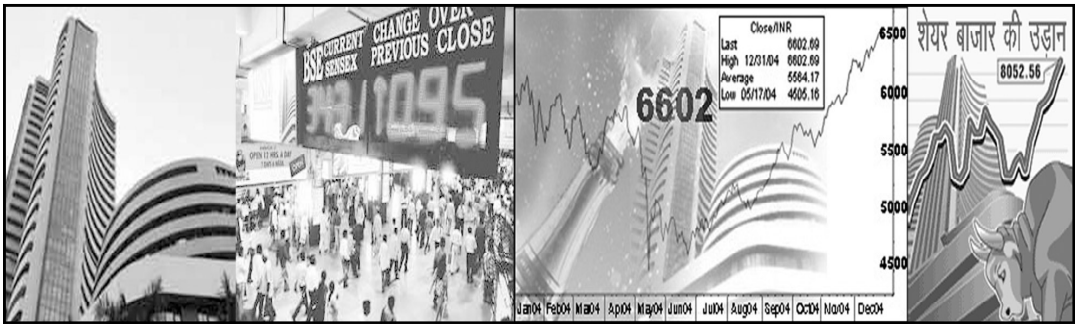
CHAPTER

8

Index Numbers



Studying this chapter should enable you to:

- *understand the meaning of the term index number;*
- *become familiar with the use of some widely used index numbers;*
- *calculate an index number;*
- *appreciate its limitations.*

1. INTRODUCTION

You have learnt in the previous chapters how summary measures can be obtained from a mass of data. Now you will learn how to obtain summary measures of change in a group of related variables.

Rabi goes to the market after a long gap. He finds that the prices of most commodities have changed. Some items have become costlier, while others have become cheaper. On his return from the market, he tells his father about the change in price of the each and every item, he bought. It is bewildering to both. The industrial sector consists of many subsectors. Each of them is changing. The output of some subsectors are rising, while it is falling in some subsectors. The changes are not uniform. Description of the individual rates of change will be difficult to understand. Can a single figure summarise these changes? Look at the following cases:

Case 1

An industrial worker was earning a salary of Rs 1,000 in 1982. Today, he

earns Rs 12,000. Can his standard of living be said to have risen 12 times during this period? By how much should his salary be raised so that he is as well off as before?

Case 2

You must be reading about the sensex in the newspapers. The sensex crossing 8000 points is, indeed, greeted with euphoria. When, sensex dipped 600 points recently, it eroded investors' wealth by Rs 1,53,690 crores. What exactly is sensex?

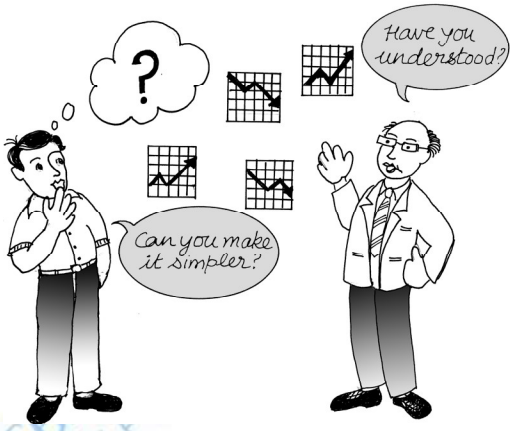
Case 3

The government says inflation rate will not accelerate due to the rise in the price of petroleum products. How does one measure inflation?

These are a sample of questions you confront in your daily life. A study of the index number helps in analysing these questions.

2. WHAT IS AN INDEX NUMBER

An index number is a statistical device for measuring changes in the magnitude of a group of related variables. It represents the general trend of diverging ratios, from which it is calculated. It is a measure of the average change in a group of related variables over two different situations. The comparison may be between like categories such as persons, schools, hospitals etc. An index number also measures changes in the value of the variables such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc.



Conventionally, index numbers are expressed in terms of percentage. Of the two periods, the period with which the comparison is to be made, is known as the base period. The value in the base period is given the index number 100. If you want to know how much the price has changed in 2005 from the level in 1990, then 1990 becomes the base. The index number of any period is in proportion with it. Thus an index number of 250 indicates that the value is two and half times that of the base period.

Price index numbers measure and permit comparison of the prices of certain goods. Quantity index numbers measure the changes in the physical volume of production, construction or employment. Though price index numbers are more widely used, a production index is also an important indicator of the level of the output in the economy.

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3. CONSTRUCTION OF AN INDEX NUMBER

In the following sections, the principles of constructing an index number will be illustrated through price index numbers.

Let us look at the following example:

Example 1

Calculation of simple aggregative price index

TABLE 8.1

Commodity	*Base period price (Rs)*	*Current period price (Rs)*	*Percentage change*
A	2	4	100
B	5	6	20
C	4	5	25
D	2	3	50

As you observe in this example, the percentage changes are different for every commodity. If the percentage changes were the same for all four items, a single measure would have been sufficient to describe the change. However, the percentage changes differ and reporting the percentage change for every item will be confusing. It happens when the number of commodities is large, which is common in any real market situation. *A price index represents these changes by a single numerical measure.*

There are two methods of constructing an index number. It can be computed by the *aggregative method* and by the *method of averaging relatives.*

The Aggregative Method

The formula for a *simple aggregative price index* is

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

Where P_1 and P_0 indicate the price of the commodity in the current period and base period respectively. Using the data from example 1, the *simple aggregative price index* is

$$P_{01} = \frac{4+6+5+3}{2+5+4+2} \times 100 = 138.5$$

Here, price is said to have risen by 38.5 percent.

Do you know that such an index is of limited use? The reason is that the units of measurement of prices of various commodities are not the same. It is unweighted, because the relative importance of the items has not been properly reflected. The items are treated as having equal importance or weight. But what happens in reality? In reality the items purchased differ in order of importance. Food items occupy a large proportion of our expenditure. In that case an equal rise in the price of an item with large weight and that of an item with low weight will have different implications for the overall change in the price index.

The formula for a *weighted aggregative price index* is

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

An index number becomes a weighted index when the relative

importance of items is taken care of. Here weights are quantity weights. To construct a weighted aggregative index, a well specified basket of commodities is taken and its worth each year is calculated. It thus measures the changing value of a fixed aggregate of goods. Since the total value changes with a fixed basket, the change is due to price change. Various methods of calculating a weighted aggregative index use different baskets with respect to time.



Example 2

Calculation of *weighted aggregative price index*

TABLE 8.2

Commodity	*Base period*		*Current period*	
	Price P_0	*Quantity* q_0	*Price* p_1	*Quality* q_1
A	2	10	4	5
B	5	12	6	10
C	4	20	5	15
D	2	15	3	10

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

$$= \frac{4\times10 + 6\times12 + 5\times20 + 3\times15}{2\times10 + 5\times12 + 4\times20 + 2\times15} \times 100$$

$$= \frac{257}{190} \times 100 = 135.3$$

This method uses the base period quantities as weights. A weighted aggregative price index using base period quantities as weights, is also known as *Laspeyre's price index*. It provides an explanation to the question that if the expenditure on base period basket of commodities was Rs 100, how much should be the expenditure in the current period on the same basket of commodities? As you can see here, the value of base period quantities has risen by 35.3 per cent due to price rise. Using base period quantities as weights, the price is said to have risen by 35.3 percent.

Since the current period quantities differ from the base period quantities, the index number using current period weights gives a different value of the index number.

$$P_{01} = \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1} \times 100$$

$$= \frac{4\times5 + 6\times10 + 5\times15 + 3\times10}{2\times5 + 5\times10 + 4\times15 + 2\times10} \times 100$$

$$= \frac{185}{140} \times 100 = 132.1$$

It uses the current period quantities as weights. A weighted aggregative price index using current period quantities as weights is known as *Paasche's price index.* It helps in answering the question that, if the

current period basket of commodities was consumed in the base period and if we were spending Rs 100 on it, how much should be the expenditure in current period on the same basket of commodities. Paasche's price index of 132.1 is interpreted as a price rise of 32.1 percent. Using current period weights, the price is said to have risen by 32.1 per cent.

Method of Averaging relatives

When there is only one commodity, the price index is the ratio of the price of the commodity in the current period to that in the base period, usually expressed in percentage terms. The method of averaging relatives takes the average of these relatives when there are many commodities. The price index number using *price relatives* is defined as

$$P_{01} = \frac{1}{n}\Sigma\frac{p_1}{p_0}\times 100$$

where P_1 and P_o indicate the price of the *i*th commodity in the current period and base period respectively. The ratio $(P_1/P_0) \times 100$ is also referred to as price relative of the commodity. *n* stands for the number of commodities. In the current example

$$P_{01} = \frac{1}{4}\left(\frac{4}{2}+\frac{6}{5}+\frac{5}{4}+\frac{3}{2}\right)\times 100 = 149$$

Thus the prices of the commodities have risen by 49 per cent.

The *weighted index of price relatives* is the weighted arithmetic mean of price relatives defined as

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

where W = Weight.

In a *weighted price relative index* weights may be determined by the proportion or percentage of expenditure on them in total expenditure during the base period. It can also refer to current period depending on the formula used. These are, essentially, the value shares of different commodities in the total expenditure. In general the base period weight is preferred to the current period weight. It is because calculating the weight every year is inconvenient. It also refers to the changing values of different baskets. They are strictly not comparable. Example 3 shows the type of information one needs for calculating *weighted price index.*

Example 3

Calculation of *weighted price relatives index*

TABLE 8.3

Commodity	*Base year price (in Rs.)*	*Current year price (in Rs)*	*Price relative*	*Weight in %*
A	2	4	200	40
B	5	6	120	30
C	4	5	125	20
D	2	3	150	10

The weighted price index is

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

$$= \frac{40 \times 200 + 30 \times 120 + 20 \times 125 + 10 \times 150}{100}$$

= 156

The *weighted price index* is 156. The price index has risen by 56 percent. The values of the *unweighted price index* and the *weighted price index* differ, as they should. The higher rise in the weighted index is due to the doubling of the most important item A in example 3.

Activity

- Interchange the current period values with the base period values, in the data given in example 2. Calculate the price index using Laspeyre's, and Paasche's formula. What difference do you observe from the earlier illustration?

4. SOME IMPORTANT INDEX NUMBERS

Consumer price index

Consumer price index (CPI), also known as *the cost of living index,* measures the average change in retail prices. The *CPI* for industrial workers is increasingly considered the appropriate indicator of general inflation, which shows the most accurate impact of price rise on the cost of living of common people. Consider the statement that the *CPI*

Consumer Price Index

In India three CPI's are constructed. They are CPI for industrial workers (2001 as base), CPI for new series (rural, urban — all India was introduced w.e.f. June 2011 and CPI for agricultural labourers (base 1986–87). They are routinely calculated every month to analyse the impact of changes in the retail price on the cost of living of these three broad categories of consumers. The CPI for industrial workers and agricultural labourers are published by Labour Bureau, Shimla. The Central Statistical Organisation publishes the CPI number of urban non manual employees. This is necessary because their typical consumption baskets contain many dissimilar items.

The weight scheme in CPI for industrial workers (2001=100) by major commodity groups is given in the following table. In this scheme food has the largest weight. Food being the most important category, any rise in the food price will have a significant impact on CPI. This also explains the government's frequent statement that oil price hike will not be inflationary.

Major Group	*Weight in %*
Food and beverages	45.86
Pan, supari, tobacco, etc.	2.38
Fuel & light	6.84
Housing	10.07
Clothing & footwear	6.53
Misc. group	20.82
General	*100.00*

Source: *Economic Survey, 2014-15 Government of India.*

for industrial workers(2001=100) is 277 in December 2014. What does this statement mean? It means that if the industrial worker was spending Rs 100 in 2001 for a typical basket of commodities, he needs Rs 277 in December 2014 to be able to buy an identical basket of commodities. It is not necessary that he/she buys the basket. What is important is whether he has the capability to buy it.

Example 4

Construction of *consumer price index* number.

TABLE 8.4

Item	*Weight in % W*	*Base period price (Rs)*	*Current period price (Rs)*	*$R=P_1/P_0$ 100 (in%)*	*WR*
Food	35	150	145	96.67	3883.45
Fuel	10	25	23	92.00	920.00
Cloth	20	75	65	86.67	1733.40
Rent	15	30	30	100.00	1500.00
Misc.	20	40	45	112.50	2250.00
					9786.85

$$CPI = \frac{\Sigma WR}{\Sigma W} = \frac{9786.85}{100} = 97.86$$

This exercise shows that the cost of living has declined by 2.14 per cent. What does an index larger than 100 indicate? It means a higher cost of living necessitating an upward adjustment in wages and salaries. The rise is equal to the amount, it exceeds 100. If the index is 150, 50 percent upward adjustment is required. The salaries of the employees have to be raised by 50 per cent.

Wholesale price index

The *wholesale price index number indicates the change in the general price level.* Unlike the CPI, it does not have any reference consumer category. It does not include items pertaining to services like barber charges, repairing etc.

What does the statement "WPI with 1993-94 as base is 189.1 in March, 2005" mean? It means that the general price level has risen by 89.1 percent during this period.

Industrial production index

The *index number of industrial production measures changes in the level of industrial production* comprising many industries. It includes the production of the public and the private sector. It is a weighted average of quantity relatives. The formula for the index is

$$IIP_{01} = \frac{\Sigma q_1 \times W}{\Sigma W} \times 100$$

In India, it is currently calculated every month with 2004-05 as the base. In table 8.6, you can see the index number of some industrial groupings along with their weights.

Wholesale Price Index

The commodity weights in the WPI are determined by the estimates of the commodity value of domestic production and the value of imports inclusive of import duty during the base year. It is available on a weekly basis. Commodities are broadly classified into three categories viz (i) primary articles, (ii) fuel, power, light and lubricants and (iii) manufactured products. The weight scheme is given below. The low weight of fuel, power, light and lubricants explains how the government can get away with such a statement that the oil price hike will not be inflationary at least in the short run.

TABLE 8.5

Category	*Weight in %*	*No. of items*
Primary articles	20.1	102
Fuel, power, light & lubricants	14.9	19
Manufactured products	65.0	555

Source: *Economic Survey 2014–2015, Govt. of India, pg. A-65*

TABLE 8.6

Broad industrial grouping and their weights

Broad groupings	*Weight in %*	*Index no. in 2013-14*
Mining and quarrying	14.2	124.7
Manufacturing	75.5	181.9
Electricity	10.3	164.7
General index		172.0

Base year 2004-05

As the table shows, the growth performances of the broad industrial categories differ. The general index represents the average performance of these categories. Why does a comparatively lower performance of mining and quarrying not pull down the general index?

Agricultural production index

Index number of agricultural production is a weighted average of quantity relatives. Its base period is triennium ending 2007-08. In 2013–14 the index number of agricultural production was 129.2. It has increased by 22.2 percent from the year 2007-08. Foodgrains have a weight of 50.07 percent in this index.

Sensex

You ofen come across a news item in a newspaper,

"Sensex breaches 8700 mark. BSE closes at 8650 points. Investor wealth rises by Rs 9,000 crore. The sensex broke the 8700 mark for the first time in its history but ended off the mark at 8650, also a new record closing level".

The rise in sensex was at the highest level till date, which reflects the good health of the economy in general. As the share prices increase, reflected by the rise in sensex, the value of wealth of the shareholders also rises.

Look at another news item,

"Sensex dips 600 in 30 days flat. Rs 1,53,690 crore investor wealth eroded. While the sensex has lost 338

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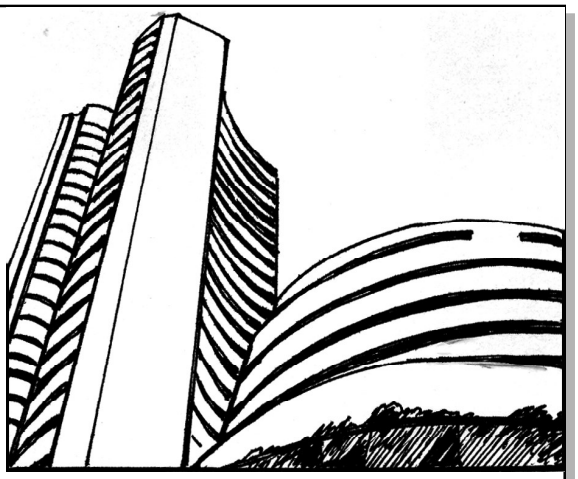
Bombay Stock Exchange

Sensex is the short form of Bombay Stock Exchange Sensitive Index with 1978–79 as base. The value of the sensex is with reference to this period. It is the benchmark index for the Indian stock market. It consists of 30 stocks which represent 13 sectors of the economy and the companies listed are leaders in their respective industries. If the sensex rises, it indicates that the market is doing well and investors expect better earnings from companies. It also indicates a growing confidence of investors in the basic health of the economy.



points in two consecutive days, it has eroded 6.8% or 598 points since October 4 when it hit an all time high at 8800 points. Investor wealth eroded by a staggering Rs 1,53,690 crore or 6.7% during the period."

It shows that all is not well with the health of the economy. The investors may find it hard to decide whether to invest or not.



Another useful index widely used to know the development of a country is Human Development Index (HDI) about which you might have studied in Class X. In recent times industrialists use an index known as producer price index (See Box). Scholars state that this index may soon replace the wholesale price index. You will study more about all these indices in higher classes.

Producer Price Index

Producer price index number measures price changes from the producers' perspective. It uses only basic prices including taxes, trade margins and transport costs. A Working Group on Revision of Wholesale Price Index (2004–05=100) is inter alia examining the feasibility of switching over from WPI to a PPI in India as in many countries.

5. ISSUES IN THE CONSTRUCTION OF AN INDEX NUMBER

You should keep certain important issues in mind, while constructing an index number.

- You need to be clear about the purpose of the index. Calculation of a volume index will be inappropriate, when one needs a value index.

• Besides this, the items are not equally important for different groups of consumers when a consumer price index is constructed. The rise in petrol price may not directly impact the living condition of the poor agricultural labourers. Thus the items to be included in any index have to be selected carefully to be as representative as possible. Only then you will get a meaningful picture of the change.

• Every index should have a base. This base should be as normal as possible. Extreme values should not be selected as base period. The period should also not belong to too far in the past. The comparison between 1993 and 2005 is much more meaningful than a comparison between 1960 and 2005. Many items in a 1960 typical consumption basket have disappeared at present. Therefore, the base year for any index number is routinely updated.

• Another issue is the choice of the formula, which depends on the nature of question to be studied. The only difference between the Laspeyres' index and Paasche's index is the weights used in these formulae.

• Besides, there are many sources of data with different degrees of reliability. Data of poor reliability will give misleading results. Hence, due care should be taken in the collection of data. If primary data are not being used, then the most reliable source of secondary data should be chosen.

Activity

• Collect data from the local vegetable market over a week for, at least 10 items. Try to construct the daily price index for the week. What problems do you encounter in applying both methods for the construction of a price index?

6. INDEX NUMBER IN ECONOMICS

Why do we need to use the index numbers? Wholesale price index number (WPI), consumer price index number (CPI) and industrial production index (IIP) are widely used in policy making.

• Consumer index number (CPI) or cost of living index numbers are helpful in wage negotiation, formulation of income policy, price policy, rent control, taxation and general economic policy formulation.

• The wholesale price index (WPI) is used to eliminate the effect of changes in prices on aggregates such as national income, capital formation etc.

• The WPI is widely used to measure the rate of inflation. Inflation is a general and continuing increase in prices. If inflation becomes sufficiently large, money may lose its traditional function as a medium of exchange and as a unit of account. Its primary impact lies in lowering the value of money. The weekly inflation rate is given by

$$\frac{X_t - X_{t-1}}{X_{t-1}} \times 100$$ where X_t and X_{t-1}

refer to the WPI for the tth and $(t-1)^{th}$ weeks.

- CPI are used in calculating the purchasing power of money and real wage:

(i) Purchasing power of money = 1/ Cost of living index

(ii) Real wage = (Money wage/Cost of living index) × 100

If the CPI (1982=100) is 526 in January 2005 the equivalent of a rupee in January, 2005 is given by

$\text{Rs}\ \frac{100}{526} = 0.19$. It means that it is worth 19 paise in 1982. If the money wage of the consumer is Rs 10,000, his real wage will be

$$\text{Rs}\ 10,000 \times \frac{100}{526} = \text{Rs}\ 1,901$$

It means Rs 1,901 in 1982 has the same purchasing power as Rs 10,000 in January, 2005. If he/she was getting Rs 3,000 in 1982, he/she is worse off due to the rise in price. To maintain the 1982 standard of living the salary should be raised to Rs 15,780 which is obtained by multiplying the base period salary by the factor 526/100.

- Index of industrial production gives us a quantitative figure about the change in production in the industrial sector.
- Agricultural production index provides us a ready reckoner of the performance of agricultural sector.
- Sensex is a useful guide for investors in the stock market. If the sensex is rising, investors are optimistic of the future performance of the economy. It is an appropriate time for investment.

Where can we get these index numbers?

Some of the widely used index numbers — WPI, CPI, Index Number of Yield of Principal Crops, Index of Industrial Production, Index of Foreign Trade — are available in *Economic Survey.*

Activity

- Check from the newspapers and construct a time series of sensex with 10 observations. What happens when the base of the consumer price index is shifted from 1982 to 2000?

7. Conclusion

Estimating index number enables you to calculate a single measure of change of a large number of items. Index numbers can be calculated for price, quantity, volume, etc.

It is also clear from the formulae that the index numbers need to be interpreted carefully. The items to be included and the choice of the base period are important. Index numbers are extremely important in policy making as is evident by their various uses.

Recap

- An index number is a statistical device for measuring relative change in a large number of items.
- There are several formulae for working out an index number and every formula needs to be interpreted carefully.
- The choice of formula largely depends on the question of interest.
- Widely used index numbers are wholesale price index, consumer price index, index of industrial production, agricultural production index and sensex.
- The index numbers are indispensable in economic policy making.

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EXERCISES

1. An index number which accounts for the relative importance of the items is known as
   (i) weighted index
   (ii) simple aggregative index
   (iii) simple average of relatives
2. In most of the weighted index numbers the weight pertains to
   (i) base year
   (ii) current year
   (iii) both base and current year
3. The impact of change in the price of a commodity with little weight in the index will be
   (i) small
   (ii) large
   (iii) uncertain
4. A consumer price index measures changes in
   (i) retail prices
   (ii) wholesale prices
   (iii) producers prices
5. The item having the highest weight in consumer price index for industrial workers is
   (i) Food
   (ii) Housing
   (iii) Clothing
6. In general, inflation is calculated by using
   (i) wholesale price index
   (ii) consumer price index
   (iii) producers' price index

7. Why do we need an index number?
8. What are the desirable properties of the base period?
9. Why is it essential to have different CPI for different categories of consumers?
10. What does a consumer price index for industrial workers measure?
11. What is the difference between a price index and a quantity index?
12. Is the change in any price reflected in a price index number?
13. Can the CPI for urban non-manual employees represent the changes in the cost of living of the President of India?
14. The monthly per capita expenditure incurred by workers for an industrial centre during 1980 and 2005 on the following items are given below. The weights of these items are 75,10, 5, 6 and 4 respectively. Prepare a weighted index number for cost of living for 2005 with 1980 as the base.

Items	*Price in 1980*	*Price in 2005*
Food	100	200
Clothing	20	25
Fuel & lighting	15	20
House rent	30	40
Misc	35	65

15. Read the following table carefully and give your comments.

INDEX OF INDUSTRIAL PRODUCTION BASE 1993–94

Industry	*Weight in %*	*1996–97*	*2003–2004*
General index	100	130.8	189.0
Mining and quarrying	10.73	118.2	146.9
Manufacturing	79.58	133.6	196.6
Electricity	10.69	122.0	172.6

16. Try to list the important items of consumption in your family.
17. If the salary of a person in the base year is Rs 4,000 per annum and the current year salary is Rs 6,000, by how much should his salary be raised to maintain the same standard of living if the CPI is 400?
18. The consumer price index for June, 2005 was 125. The food index was 120 and that of other items 135. What is the percentage of the total weight given to food?
19. An enquiry into the budgets of the middle class families in a certain city gave the following information;

Expenses on items	*Food 35%*	*Fuel 10%*	*Clothing 20%*	*Rent 15%*	*Misc. 20%*
Price (in Rs) in 2004	1500	250	750	300	400
Price (in Rs) in 1995	1400	200	500	200	250

What is the cost of living index during the year 2004 as compared with 1995?

20. Record the daily expenditure, quantities bought and prices paid per unit of the daily purchases of your family for two weeks. How has the price change affected your family?

21. Given the following data-

Year	*CPI of industrial workers (1982 =100)*	*CPI of urban non-manual employees (1984–85 = 100)*	*CPI of agricultural labourers (1986–87 = 100)*	*WPI (1993–94=100)*
1995–96	313	257	234	121.6
1996–97	342	283	256	127.2
1997–98	366	302	264	132.8
1998–99	414	337	293	140.7
1999–00	428	352	306	145.3
2000–01	444	352	306	155.7
2001–02	463	390	309	161.3
2002–03	482	405	319	166.8
2003–04	500	420	331	175.9

Source: *Economic Survey, 2004–2005, Government of India*

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(i) Comment on the relative values of the index numbers.
(ii) Are they comparable?

Activity

- Consult your class teacher to make a list of widely used index numbers. Get the most recent data indicating the source. Can you tell what the unit of an index number is?
- Make a table of consumer price index for industrial workers in the last 10 years and calculate the purchasing power of money. How is it changing?