LECTURE NOTES ON INDEX NUMBERS

INTRODUCTION:

Index numbers are statistical devices designed to measure the net change in the level of a phenomenon or a variable or a group of related variables over a period of time. In other words, index numbers are the devices for measuring differences in the magnitude of a group of related variables over two different periods. The related variables may be prices of goods or the quantity of goods produced or the quantity of goods consumed, etc. For example, when we say that the index number of wholesale price is 123 for July-2016 compared to July 2105, it means that there is a net increase of 23 % in the prices of wholesale commodities during the year. Thus, we say that Index numbers are convenient devices for measuring relative changes of differences from time to time or from place to place. Just as the arithmetic mean is used to represent a set of values, an index number is used to represent a set of values over two or more different periods or localities.

The basic device used in all methods of index number construction is to average the relative change in either quantities or prices since relatives are comparable and can be added even though the data from which they were derived cannot themselves be added. For example, if wheat production has gone up to 110% of the previous year's production and cotton production has gone up to 105%, it is possible to average the two percentages as they have gone up by 107.5%. This assumes that both have equal weight; but if wheat production is twice as important as cotton, percentage should be weighted 2 and 1. The average relatives obtained through this process are called the index numbers.

Definition: An index number is a ratio or an average of ratios expressed as a percentage, two or more time periods are involved, one of which is the base time period. The value at the base time period serves as the standard point of comparison.

An index time series is a list of index numbers for two or more periods of time, where each index number employs the same base year. Relatives are derived because absolute numbers measured in some appropriate unit, are often of little importance and meaningless in themselves. If the meaning of a relative figure remains ambiguous, it is necessary to know the absolute as well as the relative number.

Broadly speaking, there are two major types of index numbers: simple and composite. The simple index is computed for one variable whereas the composite is calculated from two or more

variables. Most index numbers are composite in nature.

PROBLEMS IN THE CONSTRUCTION OF INDEX NUMBERS:

Following are some of the important criteria/problems which have to be faced in the construction of index Numbers.

Selection of data: It is important to understand the purpose for which the index is used. If it is used for purposes of knowing the cost of living, there is no need of including the prices of capital goods which do not directly influence the living. Index numbers are often constructed from the sample. It is necessary to ensure that it is representative. Random sampling, and if need be, a stratified random sampling can ensure this. It is also necessary to ensure comparability of data. This can be ensured by consistency in the method of selection of the units for compilation of index numbers. However, difficulties arise in the selection of commodities because the relative importance of commodities keeps on changing with the advancement of the society. More so, if the period is quite long; these changes are quite significant both in the basket of production and the uses made by people.

Base Period: It should be carefully selected because it is a point of reference in comparing various data describing individual behaviour. The period should be normal i.e., one of the relative stability, not affected by extraordinary events like war, famine, etc. It should be relatively recent because we are more concerned with the changes with reference to the present and not with the distant past. There are three variants of the base fixed, chain, and the average.

Selection of Weights: It is necessary to point out that each variable involved in composite index should have a reasonable influence on the index, i.e., due consideration should be given to the relative importance of each variable which relates to the purpose for which the index is to be used. For example, in the computation of cost of living index, sugar cannot be given the same importance as the cereals.

Use of Averages: Since we have to arrive at a single index number summarizing a large amount of information, it is easy to realize that average plays an important role in computing index numbers. The geometric mean is better in averaging relatives, but for most of the indices arithmetic mean is used because of its simplicity.

Choice of Variables: Index numbers are constructed with regard to price or quantity or any other measure. We have to decide about the unit. For example, in price index numbers it is necessary to decide whether to have wholesale or the retail prices. The choice would depend on the purpose.

Further, it is necessary to decide about the period to which such prices will be related. There may be an average of price for certain time-period or the end of the period. The former is normally preferred.

Selection of Formula: The question of selection of an appropriate formula arises, since different types of indices give different values when applied to the same data. Obviously, the selection of an appropriate formula depends upon the availability of data and accuracy desired. **Notations:** It is customary to let $P_n(^1)$, $P_n(^2)$, $P_n(^3)$ denote the prices during n^{th} period for the first, second and third commodity. The corresponding price during a base period are denoted by $P_o(^1)$, $P_o(^2)$, $P_o(^3)$, etc. With these notations the price of commodity *j* during period *n* can be indicated by $P_n(^j)$.

Relatives: One of the simplest examples of an index number is a price relative, which is the ratio of the price of single commodity in a given period to its price in another period called the base period or the reference period. It can be indicated as follows:

$$\text{Price Relative} = \frac{P_n}{P_0} \text{ x100}$$

There can be other relatives such as of quantities, volume of consumption, exports, etc. The relatives in that case will be:

$$\text{Quantity relative} = \frac{Q_n}{Q_0} \text{ x100}$$

Similarly, there are value relatives:

$$\text{Value Relative} = \frac{V_n}{V_0} = \frac{P_n Q_n}{P_0 Q_0}$$

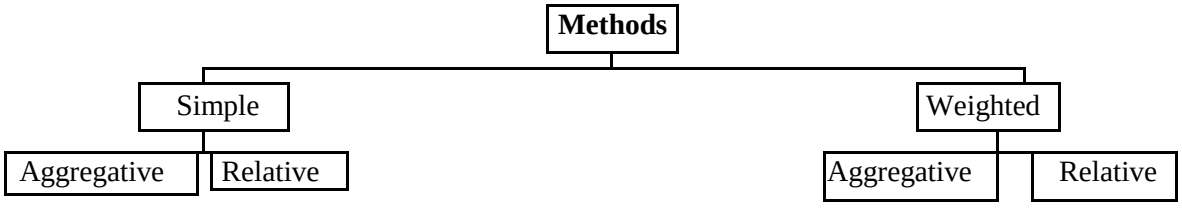
When successive price or quantities are taken, the relatives are called the link relative,

$$\frac{P_1}{P_0}, \frac{P_2}{P_1}, \ldots\ldots\ldots \frac{P_n}{P_{n-1}}$$

When the above relatives are in respect to a fixed base period these are also called the chain relatives with respect to this base or the relatives chained to the fixed base. They are in the form of :

$$\frac{P_1}{P_0}, \frac{P_2}{P_0}, \ldots\ldots\ldots \frac{P_n}{P_0}$$

The broad heads can be shown as:



SIMPLE AGGREGATIVE METHOD:

In this method of computing a price index, we express the total of commodity prices in a given year as a percentage of total commodity price in the base year. In symbols, we have

Simple aggregative Price Index: $\frac{\sum P_n}{\sum P_0}$ .100

Where ΣP_n is the sum of all commodity prices in the current year and ΣP_o is the sum of all commodity prices in the base year.

Ex:

Commodities	**1998**	**1999**	**2000**
Cheese (per 100 gms)	12.00	15.00	15.60
Egg (per piece)	3.00	3.60	3.30
Potato (per kg)	5.00	6.00	5.70
Aggregrate	20.00	24.60	24.60
Index	100	123	123

Simple aggregative Price Index for 1999 and 2000 over 1998= $\frac{\sum P_n}{\sum P_0}$ .100 $= \frac{24.60}{20}$. 100 = 123

The above method is easy to understand but it has a serious defect. It shows that the first commodity exerts greater influence than the other two because the price of the first commodity is higher than that of the other two. Further, if units are changed then the Index numbers will also change. The Index number taking the price of eggs per dozen i.e., Rs. 36, Rs. 43.20, Rs. 39.60 for the three years respectively. This is the major flaw in using absolute quantities and not the relatives. Such price quotations become the concealed weights which have no logical significance.

SIMPLE AVERAGE OF RELATIVES:

One way to rectify the drawbacks of a simple aggregative index is to construct a simple average of relatives. Under it we invert the actual price for each variable into percentage of the base period. These percentages are called relatives because they are relative to the value for the base period. The index number is the average of all such relatives. One big advantage of price relatives is that they are pure numbers. Price index number computed from relatives will remain the same regardless of the units by which the prices are quoted. This method thus meets criterion of unit test (discussed later). Also quantity index can be constructed for a group of variables that are expressed in divergent units.

Ex: In the proceeding example we will calculate relatives as follows:

Commodities	1998	1999	2000
A	100.0	125.0	130.0
B	100.0	120.0	110.0
C	100.0	120.0	114.0
Aggregate	300.0	365.0	354.0
Index	100.0	127.7	118.0

Inspite of some improvement, the above method has a flaw that it gives equal importance to each of the relatives. This amounts to giving undue weight to a commodity which is used in a small quantity because the relatives which have no regard to the absolute quantity will give weight more than what is due from the quantity used. This defect can be remedied by the introduction of an appropriate weighing system.

WEIGHTED METHOD:

To meet the weakness of the simple or un-weighted methods, we weigh the price of each commodity by a suitable factor often taken as the quantity or the volume of the commodity sold during the base year or some typical year. These indices can be classified into broad groups:

(i) Weighted Aggregative Index.

(ii) Weighted Average of Relatives.

(i) Weighted Aggregative Index: Under this method we weigh the price of each commodity by a suitable factor often taken as the quantity or value weight sold during the base year or the given year or an average of some years. The choice of one or the other will depend on the importance we want to give to a period besides the quantity used. The indices are usually calculated in percentages. The following are the important weighted index numbers under weighted aggregative method: The various alternatives formulae in use are:

(a) Laspeyres' Index number

(b) Paasche's Index number

(c) Fisher's index number

(d) Dorbish-Bowley's index number

(e) Marshall-Edgeworth's index number

(f) Kelly's index number