INDEX NUMBERS

Definitions

An index number is a percentage ratio of prices, quantities or values comparing two time periods or two points in time. The time period that serves as a basis for the comparison is called the base period and the period that is compared to the base period is called the given or current period.

A price index measures the change in the money value of an item (or group of items) over time whereas a quantity index measures the non-monetary value of an item (or a group of items) over time.

An index number that represents a percentage comparison of the number of cars sold in a given month as compared with that of a base month is a quantity index. A price index represents a comparison of prices between two time periods and, finally, a value index is one that represents a comparison of the total value of production or sales in two time periods without regard to whether the observed difference is a result of differences in quantity, price or both.

Index numbers are also differentiated according to the number of commodities or products included in the comparison. A simple index, also known as a relative, is a comparison involving only one item but an index whose calculation is based on several items is known as an aggregate or composite index. A very famous example of a composite index is the Retail Prices Index (RPI), which measures the changes in costs in the items of expenditure of the average household.

Index points

The term ‘points’ refers to the difference between the index values in two time periods. If the indices for 1999 and 2000 for a certain item are 137 and 151 respectively, it would mean that there has been an increase of \( \frac{(151 - 137)}{137} \times 100 = 10.2\% \).

The base period

The base period, which is the starting point for all comparison, always has an index of 100.

Notation

All indices pertaining to the base period have an ‘o’ (old) as subscript and all those involving the given period have an ‘n’ (new) as subscript.

FORMULAE

Simple price index \quad I_p = \frac{P_n}{P_o} \times 100

Simple quantity index \quad I_q = \frac{q_n}{q_o} \times 100
**Time series of relatives**

Given the values of some commodity over time (time series), there are two ways of computing index relatives:

1. **The fixed base method**

   A base year is selected and all subsequent changes are measured against this base. We use such an approach only if the basic nature of the commodity is unchanged over time.

2. **The chain base method**

   In this case, changes are calculated with respect to the value of the commodity in the period immediately before. This approach is used for any set of commodity values but is necessarily used if the basic nature of the commodity is changing over time.

**Rebasing**

It is often necessary to update the base period of an index because it is too far in the past. This is done by assigning a value of 100 to the new base. All necessary adjustments should be made accordingly thereafter. If a base period is kept for too long, the subsequent indices do tend to have huge values.

The following table shows that the base year 1990 is outdated since the index for 2001 has almost reached 400. If we choose 1997 as the new base, then we should multiply all the indices by $\frac{100}{240.4}$:

<table>
<thead>
<tr>
<th>Year</th>
<th>Index</th>
<th>Rebased index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>100.0</td>
<td>41.6</td>
</tr>
<tr>
<td>1991</td>
<td>112.3</td>
<td>46.7</td>
</tr>
<tr>
<td>1992</td>
<td>124.5</td>
<td>51.8</td>
</tr>
<tr>
<td>1993</td>
<td>137.8</td>
<td>57.3</td>
</tr>
<tr>
<td>1994</td>
<td>145.2</td>
<td>60.4</td>
</tr>
<tr>
<td>1995</td>
<td>178.0</td>
<td>74.0</td>
</tr>
<tr>
<td>1996</td>
<td>200.3</td>
<td>83.3</td>
</tr>
<tr>
<td>1997</td>
<td>240.4</td>
<td>100.0</td>
</tr>
<tr>
<td>1998</td>
<td>281.9</td>
<td>117.3</td>
</tr>
<tr>
<td>1999</td>
<td>322.2</td>
<td>134.0</td>
</tr>
<tr>
<td>2000</td>
<td>357.1</td>
<td>148.5</td>
</tr>
<tr>
<td>2001</td>
<td>389.5</td>
<td>162.0</td>
</tr>
</tbody>
</table>

Rebasing is also used in order to enable comparison between sets of indices. If they have different base periods, one of them will have to be rebased so as to facilitate the comparison between their rates of increase or decrease.

**Time series deflation**

The real value of a commodity can be measured in terms of an indicator such as the rate of inflation (normally represented by the Retail Prices Index). For example, if the price of a commodity were $10 in 1998 and $11 in 1999, we would deduce that there has been an increase of 10% but if we are told that, during that period, the prices in general increased by 12%, then we would argue that the real cost of the commodity has decreased.
Example (deflation)

<table>
<thead>
<tr>
<th>Year</th>
<th>Wages($)</th>
<th>RPI</th>
<th>Real wages($)</th>
<th>Real wages index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>12 000</td>
<td>250</td>
<td>12 000</td>
<td>100.0</td>
</tr>
<tr>
<td>1991</td>
<td>12 500</td>
<td>260</td>
<td>12 019</td>
<td>100.2</td>
</tr>
<tr>
<td>1992</td>
<td>13 000</td>
<td>275</td>
<td>11 818</td>
<td>98.5</td>
</tr>
<tr>
<td>1993</td>
<td>13 500</td>
<td>295</td>
<td>11 441</td>
<td>95.3</td>
</tr>
<tr>
<td>1994</td>
<td>14 000</td>
<td>315</td>
<td>11 111</td>
<td>92.6</td>
</tr>
</tbody>
</table>

Real wage = Wage \times \frac{\text{base indicator}}{\text{current indicator}}

We observe that though the wages have been increasing regularly by $500 every year, the real wages have been decreasing during 1992-94 with respect to the RPI. This shows that the increase has not been able to match the rise in standard of living during those years.

Composite (aggregate) index numbers

The RPI, which considers components such as food, alcoholic drink, tobacco and housing, is an example of a composite index.

**FORMULA**

Simple aggregate price index

\[ I_p (\text{simple aggregate}) = \frac{\sum p_n}{\sum p_o} \times 100 \]

**Drawbacks**

- It ignores the quantities of each item consumed
- It ignores the units to which the price refers

Average relatives indices

To overcome the problem of different units, we consider the changes in prices as ratios rather than absolutes so that all price movements are treated as equally important.

**FORMULA**

Average price relatives index = \( \frac{1}{k} \sum \left( \frac{p_n}{p_o} \times 100 \right) \) where \( k \) is the number of goods.
Weighted means of relatives indices

In the above discussion, the relative importance of each item has not been taken into consideration. Bread is probably more important than soft drinks. To compensate for this, we attach a weight to each item so as to reflect its importance. Weightings are assigned to each item as a result of market research to decide about their relative importance. For a simple cost of living index, it would be necessary to find out how much the average person or household spends each week on each item to determine their respective weightings.

The method of weightings involves

1. Calculating index relatives for each of the components
2. Using the weights given to obtain a weighted average of the relatives

**FORMULA**

Weighted means of relatives index

\[
\text{Weighted means of relatives index} = \frac{\sum wI}{\sum w} \text{ where } w \text{ is the weighting factor and } I \text{ is the index relative.}
\]

Laspeyre and Paasche indices

The Laspeyre indices use weights from the base period and are therefore sometimes called base-weighted indices whereas the Paasche indices use current time period weights.

**FORMULAE**

Laspeyre price index

\[
\text{Laspeyre price index} = \frac{\sum p_n q_o}{\sum p_o q_o} \times 100
\]

Laspeyre quantity index

\[
\text{Laspeyre quantity index} = \frac{\sum q_n p_o}{\sum q_o p_o} \times 100
\]

Paasche price index

\[
\text{Paasche price index} = \frac{\sum p_n q_n}{\sum p_o q_n} \times 100
\]

Paasche quantity index

\[
\text{Paasche quantity index} = \frac{\sum q_n p_n}{\sum q_o p_n} \times 100
\]
Comparison between Laspeyre and Paasche indices

LASPEYRE INDICES

1. It requires quantities to be ascertained for base year only.
2. The denominator is fixed so that the index may be calculated as soon as the current prices or quantities are known.
3. Laspeyre index numbers can be directly compared for several time periods because the denominator is fixed.
4. The weights of a Laspeyre become out of date.
5. It assumes that, whatever the price changes, the quantities purchased will remain the same. It therefore assumes that, as goods become more expensive, the same quantities will be purchased. Inflation could therefore be overstated.

PAASCHE INDICES

1. It requires quantities to be ascertained every time period and this may prove to be very costly.
2. The denominator has to be recalculated every time period. The index cannot be calculated until the end of the period when the current prices and quantities are known.
3. Comparisons can only be drawn directly between the current year and the base year because the denominator has to be recalculated every year.
4. Paasche indices are updated every year.
5. The effect of current weighting means that greater importance is placed on goods that are relative cheaper now than what they were in the base year. Inflation could therefore be understated.

Construction of an index

After the purpose of the index has been specified, we must make sure that the items selected from the universe of commodities must be fully representative. These items must be very well defined and their values must be easily verifiable.

The choice of items for the Retail Prices Index (RPI), for example, is not very easy, especially that we cannot choose all domestic items. Thus, a selective basket of goods must be found, including spending on mortgages and rents, public transport, food and drink, electricity, gas, telephone, clothing, leisure activities and so on.

Data must therefore be collected to determine the values of the items and the weights to be assigned to them. For a price index, an actual average of the actual prices must be calculated since prices keep fluctuating from place to place and from time to time. It is common practice to use quantities as weights when calculating a price index and use prices as weights when calculating a quantity index. Other difficulties may arise when calculating a cost of living index – for example, it might not be that easy to define a typical family.

The choice of a base year is made quite easily while taking care that the year is representative and that it was not a period in which prices and quantities had extreme values. A base year should be regularly updated in order to reflect patterns of consumption very clearly. In so doing, we prevent actual index numbers from becoming too large, especially when a base year is outdated.
Limitations of index numbers

1. Weightings may become outdated.
2. A change in the items may occur.
3. The data used to calculate index numbers might be incomplete, outdated or inaccurate.
4. No base year is perfectly representative of some particular period of time.
5. The basket of goods is often selective.
6. A national index may not be relevant at the rural or urban levels.
7. An index may exclude important items.

Misinterpretations of index numbers

1. Rise in prices should be interpreted with respect to the immediately previous time period.
2. A fall in rate of inflation does not imply a fall in prices.