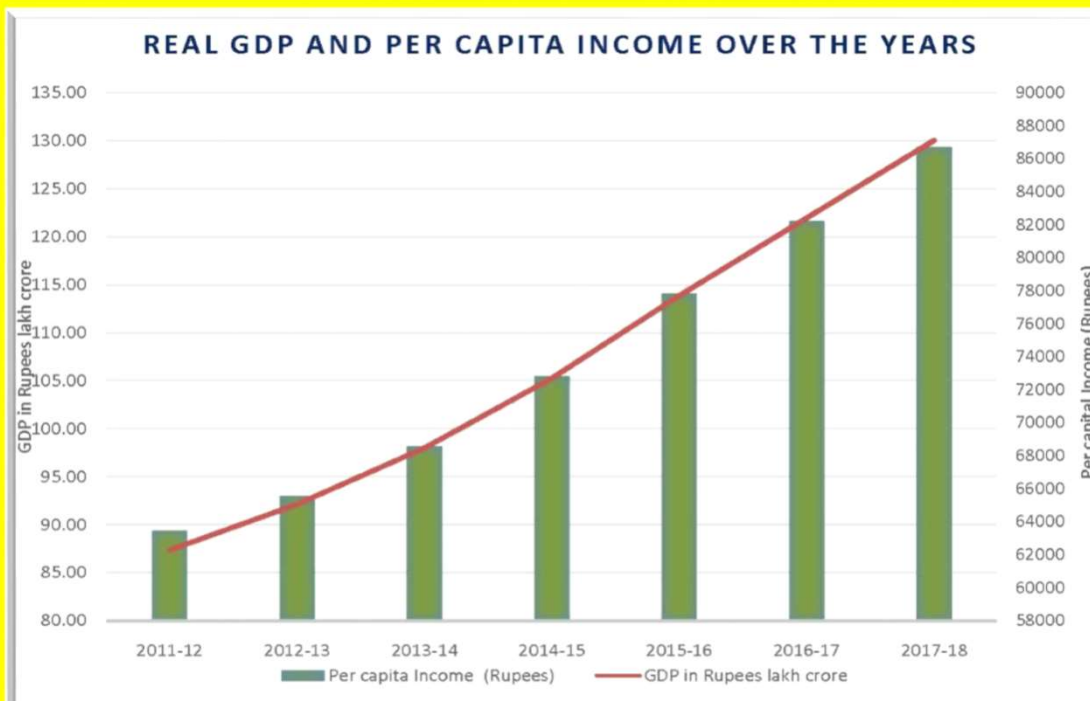


Index Numbers



Source: National Accounts Statistics 2017; Press Note on First Revised Estimate on National Income FY 2016-17 dated 31.01.2018 and Second Advance Estimate of National Income 2017-18 dated 28.02.2018.



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Index Numbers

- What is Index Number ?
- Definitions used for all Index Numbers
- Why Convert Data to indices ?
- Types of Index Number
- Some Important Price indices

A white plastic tray containing several tubes of toothpaste and a bar of soap. The tubes are of various colors (purple, blue, pink, green) and have labels like 'dry era', 'LOW odor', and 'chisel'. The bar of soap is dark brown and rectangular.

What is Index Number ?

- An **Index Number** is a statistical value that measures the relative change in price, quantity, value, or some other item of interest with respect to time or place.
- A simple index number measures the relative change in one or more than one variable.
- Bowley stated that "Index numbers are used to gauge the changes in some quantity which we cannot observe directly".



Definition

- “Index numbers are quantitative measures of growth of prices, production, inventory and other quantities of economic interest.”
- “Index number indicate the the level of certain phenomenon at a given time or place in comparison with the level of the same phenomenon at some other standard time or place



Characteristics Of Index Numbers

- Index numbers are specialised averages.
- Index numbers measure the change in the level of a phenomenon.
- Index numbers measure the effect of changes over a period of time.
- Index numbers are Economic Barometers.
- Index numbers are sign and guide posts of Business.
- Index number are the ratio of the current value to a base value.

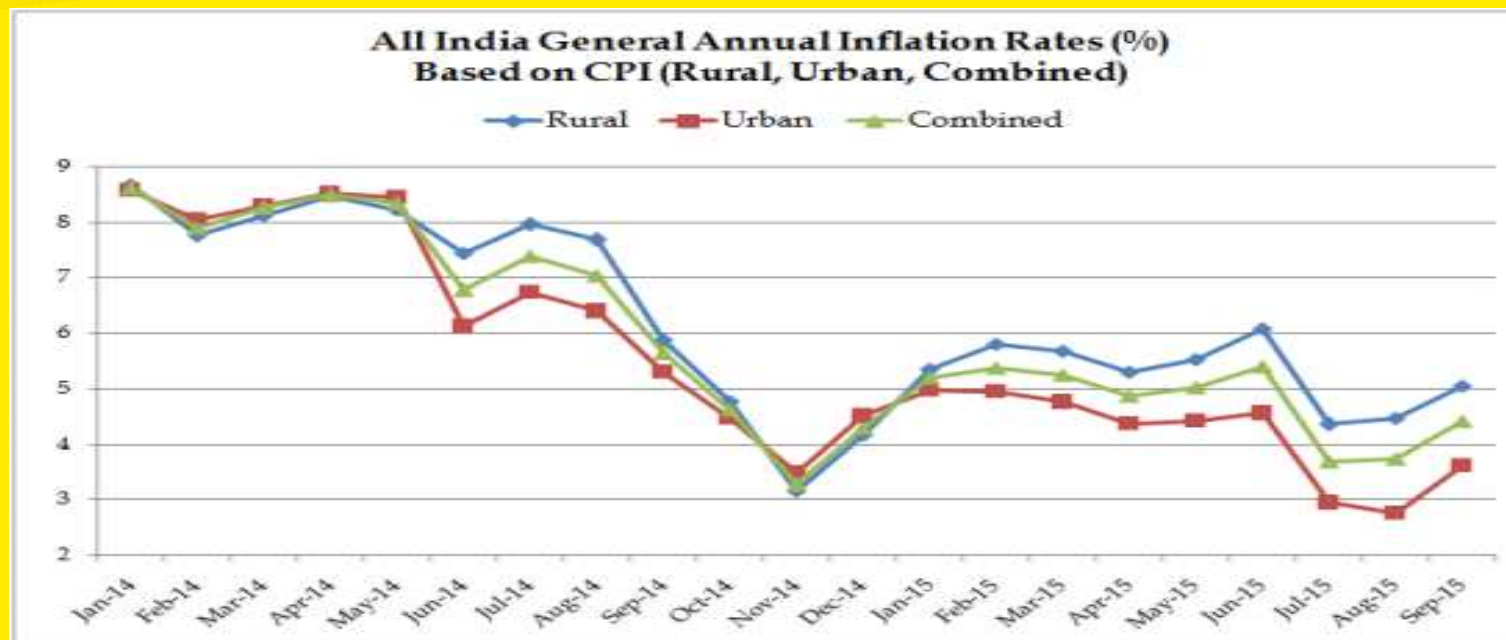


Terms used for all Index Numbers

- **Current period** :- The period for which you wish to find the Index Number.
- **Base period** :- The period with which you wish to compare prices of the current period.
- **Price** :- Price of the commodity or items you want to compare.
- **Quantity** :- Quantity of the commodity or items you want to compare.

Why Convert Data to Indices?

- An index is a convenient way to express a change in a diverse group of items.
- Converting data to indices also makes it easier to assess the trend in a series composed of exceptionally large numbers.





Why Convert Data to Indices?

- Many times we have to combine several items and develop an index to compare the cost of this aggregation of items in two different time period
 - ✓ For example, we might be interested in an index for items that relate to the expense of operating and maintaining an automobile. The items in the index might include tires, oil changes, and gasoline prices
 - ✓ Or we might be interested in a college student index. This index might include the cost of books, tuition, hostel, meals, and entertainment.
- There are several ways we can combine the items to determine the index.

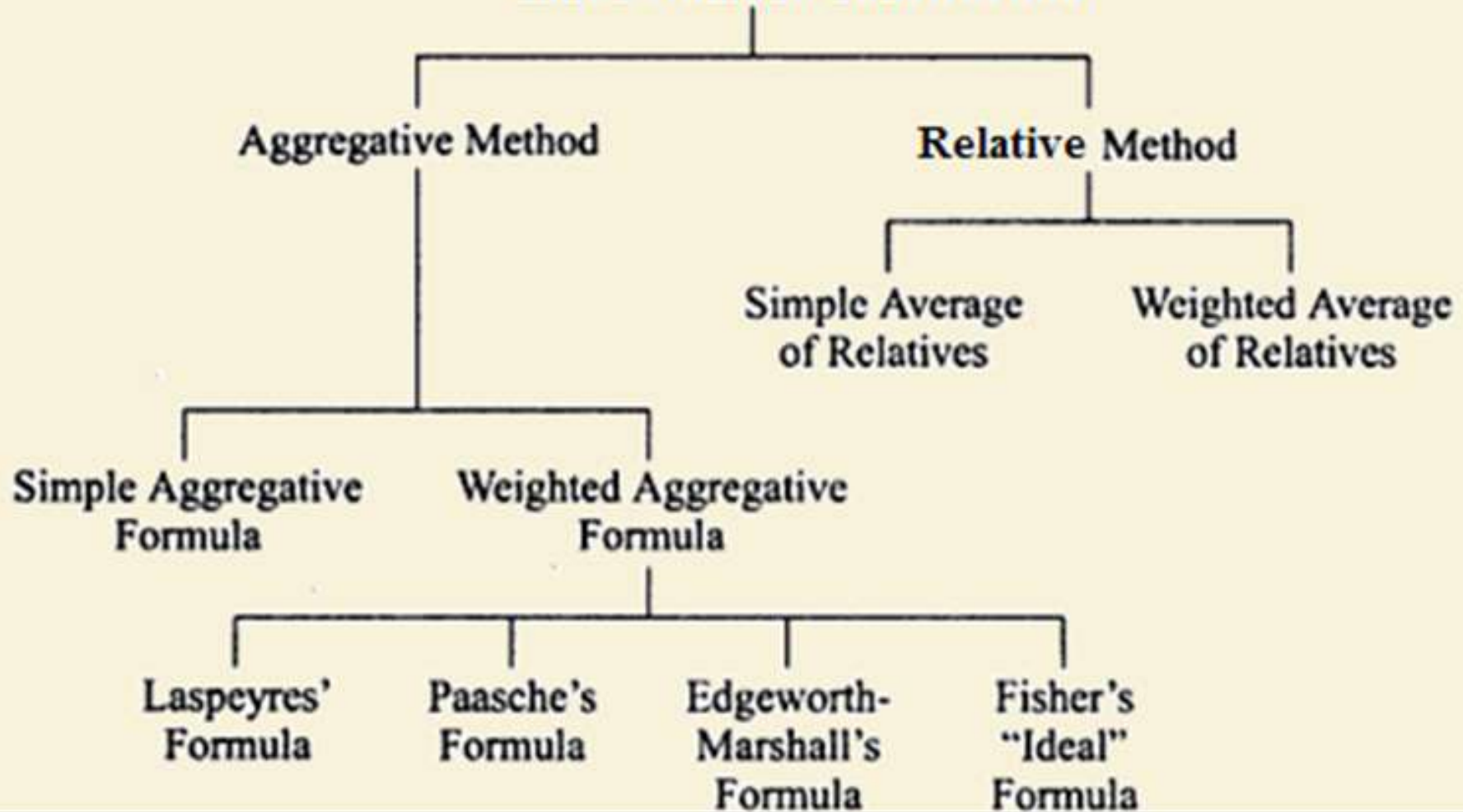
A white rectangular box is shown at an angle, containing several tubes of toothpaste and a bar of soap. The toothpaste tubes are in various colors (purple, blue, pink, green) and have labels like 'LOW odor' and 'chisel'. The bar of soap is dark brown and textured. The box is set against a bright yellow background.

Types of Index Number

- Price Index
 - Unweighted indices
 - Simple Aggregate Index
 - Simple Average of the Relative Prices
 - Weighted indices
 - Laspeyres Price Index
 - Paasche Price Index
 - Fisher's Price Index
- Quantity Index
- Value Index
- Special Purpose Index Consumer Price Index (CPI)



Index Number Construction





Price Index

- Price Relative :- The price relative of an item is defined as:

$$\text{Price Relative} = \frac{P_t}{P_o}$$

Where:

P_t = price in current period

P_o = price in base period

- Price Relative Index provides a ratio that indicates the change in price of an item from one period to another.



Simple Price Index

- Simple Price Index is a common method of expressing this change as a percentage:

$$\text{Simple Price Index} = \frac{p_t}{p_o} \times 100$$

Where:

p_t = price in current period

p_o = price in base period



Simple Price Index

- The simple price index finds the percentage change in the price of an item from one period to another.
- An index number is always referenced back to a **base year** which is always given a value of **100**.
- Subsequent figures (the next years) are then **scaled** in relation to the base year, so an index gives the *change* since the *base year*.



Suppose we have the price of an item for each year over a four year period:

Year	Price
1	2.00
2	2.20
3	2.40
4	2.90



WHAT IS THE INCREASE EACH YEAR?

Year	Price	Calculation	Index
1	2.00	$(2.00 * 100 / 2)$	100
2	2.20	$(2.20 * 100 / 2)$	110
3	2.40	$(2.40 * 100 / 2)$	120
4	2.90	$(2.90 * 100 / 2)$	145

We could choose **Year 1** as the **base year**.



Unweighted indices

Simple Aggregate Price Index :- In most cases we are interested in the prices of a “basket of goods”, and not just one item. We therefore need an **aggregate** index.

1. Add up column of prices

2. Use

$$\frac{\sum P_t}{\sum P_o} \times 100$$

Item	Price Yr0	Price Yr1	Price Yr2
A	1.00	1.10	1.15
B	2.00	2.30	2.35
C	5.00	5.60	5.70
	8.00	9.00	9.20
	100	112.5	115

$$\frac{9}{8} \times 100$$



Interpretation

- A price index of 113 would indicate an increase of 13% relative to the base year.
- A price index of 75 would indicate a decrease of 25% relative to the base year.



Simple Aggregate Index

Disadvantages:

- ✓ An item with a relatively large price can dominate the index.
- ✓ If prices are quoted for different quantities, the simple aggregate index will yield a different answer. This makes it possible to manipulate the value of the index.
- ✓ Does not take into account the quantity of each item sold.



Unweighted Indices (Average of Relative Prices)

- The ***Average of Relative Prices*** is the average of the individual simple price indices of all items.
 - ✓ It does not take into account the quantity of each item sold.
 - ✓ It is a vast improvement on the simple aggregate index.



Average of Relative Prices

$$\begin{aligned} \text{Average of Relative Prices} &= \frac{\text{sum of the simple price indexes}}{k} \\ &= \frac{\sum \left(\frac{p_t}{p_o} \times 100 \right)}{k} \end{aligned}$$

Where:

k = number of items

p_t = price in current period

p_o = price in base period



Example

Item	Price Yr0	Price Yr1	Price Yr2	PR Yr0	PR Yr1	PR Yr2
A	1.00	1.10	1.15	100	110	115
B	2.00	2.30	2.35	100	115	117.5
C	5.00	5.60	5.70	100	112	114
				300	337	346.5
				100	112.33	115.5

1. Find PR's for each item.
2. Add up columns.
3. Find the average



The indices we have discussed either dealt with a single item or assumed that all items are of equal importance.

This is obviously not true!

We need an index which can deal with a “basket of goods” and take account of the ***relative importance*** of the items in the basket.



Weighted Index Numbers

- Use of a weighted index allows greater importance to be attached to some items.
- Generally we use **Quantities** consumed as weights.
- Price Index uses $\text{Price} \times \text{weight}(\text{Quantity})$ i.e. total cost or expenditure of that item.
- Most commonly used:
 - ✓ Base-Weighted Index – Use **base year** quantities (Laspeyres).
 - ✓ Current-Weighted Index – Use **current year** quantities (Paasche).



Base-Weighted Price Index (Laspeyres's Index)

- Known as the *Average of Weighted Relative Prices*.
- The weights used are the **quantities** of each item bought in the **base period**.
- This is given by:

$$\frac{\text{Current year prices x weights}}{\text{Base year prices x weights}} \times 100$$



$$\text{Laspeyres's Index} = \frac{\sum p_t q_0}{\sum p_0 q_0} \times 100$$

Where:

q_0 = quantity bought in base period

p_t = price in current period

p_0 = price in base period

Laspeyres's Index

Item	Quant Yr0	Price Yr0	Price Yr1	Price Yr2	P ₀ Q ₀	P ₁ Q ₀	P ₂ Q ₀
A	50	1.00	1.10	1.15	50	55	57.5
B	20	2.00	2.30	2.35	40	46	47
C	5	5.00	5.60	5.70	25	28	28.5
					115	129	133
					100	112.2	115.7

1. Multiply each price by the *quantity in Year 0*.

2. Add up each column.

3. Use the given formula

$$\frac{\sum (P_t Q_0)}{\sum (P_0 Q_0)} \times 100$$



Disadvantage with Laspeyres

- Laspeyres's Index assumes that the *same amount* of each item is bought every year.
- If I bought 35 kg of oranges in base year, the index assumes I bought the same amount every year, when in reality if the price went up, one might buy less.



Current-Weighted Price Index (Paasche's Index)

- Paasche Index uses consumption in the current period.
- Measures the change in the cost of purchasing items in terms of quantities relating to the current period.
- Paasche and Laspeyres will generally not yield the same result.



$$\text{Paasche's Index} = \frac{\sum p_t q_t}{\sum p_0 q_t} \times 100$$

Where:

q_t = quantity bought in current period

p_t = price in current period

p_0 = price in base period

Paasche's Index

Item	Quant Yr0	Quant Yr1	Quant Yr2	Price Yr0	Price Yr1	Price Yr2
A	50	55	60	1.00	1.10	1.15
B	20	21	23	2.00	2.30	2.35
C	5	5	4	5.00	5.60	5.70

P1Q1	P0Q1	P2Q2	P0Q2
60.5	55	69	60
48.3	42	54.05	46
28	25	22.8	20
136.8	122	145.85	126

- Use Formula $\frac{\sum (P_t Q_t)}{\sum (P_0 Q_t)} \times 100$
- Note the structure of this.
- We need to find Sum of $P_1 Q_1$ and Sum of $P_0 Q_1$

$$\frac{136.8}{122} \times 100 =$$

112.1311

$$\frac{145.85}{126} \times 100 =$$

115.754



Laspeyres versus Paasche Index

Laspeyres's Index

- ✓ The *Laspeyres Index* measures the ratio of expenditures on base year quantities in the current year to expenditures on those quantities in the base year.
- ✓ The Laspeyres's Index is usually larger than the Paasche's Index.

Paasche's Index

- ✓ The *Paasche index* measures the ratio of expenditures on current year quantities in the current year to expenditures on those quantities in the base year.
- ✓ With the Paasche index it is difficult to make year-to-year comparisons since every year a new set of weights is used.



Laspeyres versus Paasche Index

Laspeyres's Index

- ✓ Since the *Laspeyres index* uses base period weights, it may overestimate the rise in the cost of living, because people may have reduced their consumption of items that have become costly.
- ✓ Laspeyres's Index tends to overweight goods whose prices have increased.

Paasche's Index


- ✓ Since the Paasche index uses current period weights, it may underestimate the rise in the cost of living, because people may have increased their consumption of items.
- ✓ Paasche's Index, on the other hand, tends to overweight goods whose prices have gone down.



Fisher's Ideal Index

- Fisher's Ideal Index was developed in an attempt to offset these shortcomings.
- It is the geometric mean of the Laspeyres and Paasche indices.
- It is given below:

$$\text{Fisher's Index} = \sqrt{(\text{Laspeyres's Index} \times \text{Paasche's Index})}$$


$$Fisher's\ Index = \sqrt{\frac{\sum p_t q_0}{\sum p_0 q_0} \times \frac{\sum p_t q_t}{\sum p_0 q_t}} \times 100$$

Where:

q_t = quantity bought in current period

q_o = quantity bought in base period

p_t = price in current period

p_o = price in base period



Quantity indices

- An index that measures changes in quantity levels over time is called a quantity index.
- Probably the best known quantity index is the Index of Industrial Production.
- A weighted aggregate quantity index is computed in much the same way as a weighted aggregate price index.
- A weighted aggregate quantity index for period t is given by

$$\text{Quantity Index} = \frac{\sum Q_t w_t}{\sum Q_0 w_t} \times 100$$



Value Index

- A **value index** measures changes in both the price and quantities involved.
- A value index, such as the index of department store sales, needs the original base-year prices, the original base-year quantities, the present-year prices, and the present year quantities for its construction.
- Its formula is given as:

$$\text{Value Index} = \frac{\text{Total value in the current year}}{\text{Total value in the base year}} \times 100$$



$$\text{Value Index} = \frac{\sum p_t q_t}{\sum p_0 q_0} \times 100$$

Where:

q_t = quantity bought in current period

q_0 = quantity bought in base period

p_t = price in current period

p_0 = price in base period



Special Purpose Index:- Consumer Price Index (CPI)

- It is also known as '**Cost-of-Living**' *Index*.
- **It is a general indicator of the rate of price change** for consumer goods and services.
- The **CPI** measures price change over time and does not provide comparisons between relative price levels at a particular date.



Special Purpose Index:- Consumer Price Index (CPI)

- The CPI does not provide any basis for measuring relative price levels between the different cities.
- It allows consumers to determine the effect of price increases on their **Purchasing Power**.
- It is a yardstick for revising wages, pensions, alimony payments, etc. It computes **Real Income**.

An open white box containing several tubes of toothpaste and a bar of soap. The toothpaste tubes are in various colors (purple, blue, pink, green) and some have labels like 'dry era', 'LOW odor', and 'chisel'. The bar of soap is dark brown and rectangular.

Consumer Price Index (CPI) is given by:

$$\text{CPI} = \frac{\sum p_t w}{\sum p_0 w} \times 100$$

A white rectangular box is shown, partially open, containing several tubes of toothpaste and a bar of soap. The toothpaste tubes are in various colors (purple, blue, pink, green) and have labels like 'dry era', 'LOW odor', and 'chisel'. The bar of soap is dark brown and textured. The box is set against a bright yellow background.

CPI Uses - Formulas

$$\textit{Real Income} = \frac{\textit{Money Income}}{\textit{CPI}} \times 100$$

$$\textit{Purchasing Power Of Money} = \frac{1}{\textit{CPI}} \times 100$$



Price indices: Other Considerations

- Selection of Items
 - ✓ When the class of items is very large, a representative group (usually not a random sample) must be used.
 - ✓ The group of items in the aggregate index must be periodically reviewed and revised if it is not representative of the class of items in mind.
- Selection of a Base Period
 - ✓ As a rule, the base period should not be too far from the current period.
 - ✓ The base period for most indices is adjusted periodically to a more recent period of time.



Price indices: Other Considerations

- **Quality Changes**

- ✓ A basic assumption of price indices is that the prices are identified for the same items each period.
- ✓ Is a product that has undergone a major quality change the same product it was?
- ✓ A substantial quality improvement also may cause an increase in the price of a product.



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