

# Statistics and Probability

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# INDEX NUMBERS



## **INTRODUCTION**

- An index number measures the relative change in price, quantity, value, or some other item of interest from one time period to another.
  
- A simple index number measures the relative change in one or more than one variable.

## **WHAT IS AN INDEX NUMBER**



- An index number measures how much a variable changes over time.
- We calculate the index number by finding the ratio of the current value to a base value.

Index No. =  $P_1/P_0 * 100$  OR  $Q_1/Q_0 * 100$



# Index numbers- Examples

The variable may be

- price of a particular commodity or a group of commodities
- volume of trade, imports and exports, agricultural or industrial production, etc.
- Human and livestock population
- national income of a country or
- cost of living of persons belonging to particular income group/profession, etc.

## **DEFINITION**

- “Index numbers are quantitative measures of growth of prices, production, inventory and other quantities of economic interest.”

-Ronold

## **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.

# Types of Index Numbers

## (i) Price Index Number:

It compares levels of prices from one period to another.

## (ii) Quantity Index Number:

A quantity index measures how much quantity of a variable changes over time.

## (iii) Value Index Number:

The value index measures changes in total monetary worth. It measures changes in rupee value of a variable. In effect, the value index combines price and quantity changes to present a more informative index.

# Simple Price Index Numbers

The price of rice in Karachi per kg is Rs. 150 in the year 2013 and the price of rice per kg was 120 in the year 2012.

Find index number for the year 2013 and comment.

Solution:

Price in 2012 = Rs. 120

Price in 2013 = Rs. 150

$$\text{Price Index} = \frac{\text{Price in 2013}}{\text{Price in 2012}} \times 100$$

$$= \frac{150}{120} \times 100$$

$$\text{Price Index} = 125\%$$

The index number 125% means that the price of the rice per Kg increased by 25% in 2013 as compared to 2012.

# Simple Price Index Number

Where

- : Price of the product in the base year
- : Price of the product in the current year

# Simple Price Index Numbers

The following data shows the prices of an item for 8 years.

Year	1990	1991	1992	1993	1994	1995	1996	1997
Price (Rs.)	45	50	60	65	70	72	68	83

Calculate the Index number of all the years taking 1990 as the base year.

# Simple Price Index Numbers

Year	Price	Price Relative = $\frac{P_n}{P_o} \times 100$
1990	45	$\frac{45}{45} \times 100 = 100$
1991	50	$\frac{50}{45} \times 100 = 111.11$
1992	60	$\frac{60}{45} \times 100 = 133.33$
1993	65	$\frac{65}{45} \times 100 = 144.44$
1994	70	$\frac{70}{45} \times 100 = 155.55$
1995	72	$\frac{72}{45} \times 100 = 160$
1996	68	$\frac{68}{45} \times 100 = 151.11$
1997	83	$\frac{83}{45} \times 100 = 184.44$

# Chain Base Index Number (Link Relatives)

Where

- : Price of the product in the current year
- : Price of the product in the previous year

# Chain base index numbers (Link Relatives)

Year	Price	Link Relatives
2000	50	
2001	55	
2002	62	
2003	70	
2004	80	
2005	92	
2006	100	
2007	110	

# Chain Indices

Year	Link Relatives	Chain Indices
2000	100%	100%
2001	110%	110%
2002	112.72	
2003	112.90	
2004	114.29	
2005	115	
2006	108.70	
2007	110	

# Composite Index Numbers

Commodities	Price				
	2004	2005	2006	2007	2008
Kappas	620	618	719	909	874
Wheat	204	219	245	288	305
Rice	616	671	704	767	910

# Composite Index Numbers by Average Method

The following table gives the average whole-sale prices.

Commodities	Price				
	2004	2005	2006	2007	2008
Kappas	620	618	719	909	874
Wheat	204	219	245	288	305
Rice	616	671	704	767	910

Calculate the average of relative index taking 2004 as base by:

- (a) Mean & (b) Median

Commodities	Price Relatives				
	2004	2005	2006	2007	2008
Kappas	$\frac{620}{620} \times 100 = 100$	$\frac{618}{620} \times 100 = 99.68$	$\frac{719}{620} \times 100 = 115.97$	$\frac{909}{620} \times 100 = 146.61$	$\frac{874}{620} \times 100 = 140.97$
Wheat	$\frac{204}{204} \times 100 = 100$	$\frac{219}{204} \times 100 = 107.35$	$\frac{245}{204} \times 100 = 120.09$	$\frac{288}{204} \times 100 = 141.18$	$\frac{305}{204} \times 100 = 149.51$
Rice	$\frac{616}{616} \times 100 = 100$	$\frac{671}{616} \times 100 = 108.93$	$\frac{704}{616} \times 100 = 114.29$	$\frac{767}{616} \times 100 = 124.51$	$\frac{910}{616} \times 100 = 147.73$
Sum	300	315.96	356.35	412.3	438.21
Mean	100	105.32	116.78	137.43	146.07
Median	100	107.35	115.97	141.18	147.73

# Chain Indices by Average Method

The following table gives the average whole-sale prices.

Commodities	Price				
	2004	2005	2006	2007	2008
Kappas	620	618	719	909	874
Wheat	204	219	245	288	305
Rice	616	671	704	767	910

Construct the chain indices.

# Chain Indices by Average Method

Commodities	Link Relatives				
	2004	2005	2006	2007	2008
Kappa	$\frac{620}{620} \times 100 = 100$	$\frac{618}{620} \times 100 = 99.68$	$\frac{719}{618} \times 100 = 116.34$	$\frac{909}{719} \times 100 = 126.43$	$\frac{874}{909} \times 100 = 96.15$
Wheat	$\frac{204}{204} \times 100 = 100$	$\frac{219}{204} \times 100 = 107.35$	$\frac{245}{219} \times 100 = 111.87$	$\frac{288}{245} \times 100 = 117.55$	$\frac{305}{288} \times 100 = 105.90$
Rice	$\frac{616}{616} \times 100 = 100$	$\frac{671}{616} \times 100 = 108.93$	$\frac{704}{671} \times 100 = 104.92$	$\frac{767}{704} \times 100 = 108.95$	$\frac{910}{767} \times 100 = 118.64$
Sum	300	315.96	333.13	352.93	320.69
Mean	100	105.32	111.04	117.64	106.89
Chain Indices	100	105.32	$\frac{105.32 \times 111.04}{100} = 116.95$	$\frac{116.95 \times 117.64}{100} = 137.58$	$\frac{137.58 \times 106.89}{100} = 147.06$

# Simple Aggregative Method

Calculate index number for the following data. Taking 2005 as base year by using simple aggregative method.

Commodities	Prices			
	2005	2006	2007	2008
Sugar	15	16.5	17	18
Wheat	25.4	21.4	25.5	30.4
Rice	15.5	16.2	19	19.5
Gram	13.5	14.3	13.7	14.0

# Weighted Aggregative Method

QUESTION  
MR A is incharge of keeping in stock certain items that his company needs in repairing its machines ,he arranged the data in the following table. Calculate weighted aggregative price index.

Items	Price 2003	Price 2004	Price 2005	Average no.used
A	1.25	1.50	2.00	900
B	6.50	7.00	6.25	50
C	5.25	5.90	6.40	175
D	0.50	0.80	1.00	200

# Weighted Aggregative Method

	PW		
	2003	2004	2005
A	1125	1350	1800
B	325	350	312.5
C	918.75	1032.5	1120
D	100	160	200
<b>Sum</b>	<b>2468.75</b>	<b>2892.5</b>	<b>3432.5</b>

# Weighted Aggregative Method

Commodities	Price 2007	Quantity 2007	Price 2008	Quantity 2008
A	8	45	12	50
B	4	100	4	110
C	6	50	8	55
D	12	30	14	35

# Weighted Aggregative Method

- Laspeyre's Index Number

(Base Year Quantity weighted Method)

- Paasche's Index Number

(Current Year Quantity weighted Method)

Fisher's Index Number

Taking 2007 as base year construct index numbers by Laspeyre's , Paasche's and Fisher's methods.

Commodities	Price 2007	Quantity 2007	Price 2008	Quantity 2008
A	8	45	12	50
B	4	100	4	110
C	6	50	8	55
D	12	30	14	35

# Practice Problems

27. From the following data find Index using 2010 as a base year by:  
(I) Laspeyre Index                         (II) Paasche's Index  
(III) Fisher Ideal Index

Commodities	Price		Quantity	
	2010	2011	2010	2011
A	64	75	270	290
B	58	68	185	200
C	18	21	130	137
D	50	60	134	145

28. Construct Price Index numbers for the year 2010 by using Laspeyre  
Paasche's and Fisher's Ideal Index number formula.

Commodities	2009		2010	
	Price	Quantity	Price	Quantity
Cotton	95	60	120	60
Rice	80	100	90	120
Wheat	40	50	60	60

29. Find Laspeyre's Price Index numbers for the year 2008 and 2009.

Commodities	2007		2008		2009	
	Price	Quantity	Price	Quantity	Price	Quantity
A	3	51	12	42	18	43
B	4	11	10	7	11	12
C	5	6	6	7	13	10

30. Find Laspeyre's, Paasche's Price Index numbers taking 2006 as base year.

Commodities	Price			Quantity		
	2006	2007	2008	2006	2007	2008
A	7	8	10	30	32	33
B	10	12	14	40	42	45
C	15	17	18	50	55	57

## **Index Numbers**

### **Special Purpose Index**

- There are many indexes that are prepared for special purposes, such as the Corruption Perception Index, Ease of Doing Business index, Consumer Price index (CPI), Producer Price Index (PPI).
- The calculation of the consumer price index and the inflation rate for Table 14.4 is shown below.

## CPI of 2008 and 2009 by taking 1999 as base year

*Table 14.4: Calculation of Consumer Price Index*

Price	1999	1999	1999	2008	2008	2009	2009
	Quantity	Price	Expenditure	Price	Expenditures (on base-year quantities)	Price	Expenditures (on base-year quantities)
Diabetes examination	2	\$60.00	\$120.00	\$80.00	\$160.00	\$90.00	\$180.00
Rice	40	15.00	600.00	25.00	1000.00	28.00	1120.00
Chicken	30	35.00	1050.00	45.00	1350.00	52.00	1560.00
Total			\$1770.00		\$2510.00		\$2860.00

## Index Numbers

$$\text{Consumer Price Index} = \left( \frac{\text{Expenditure in Current Year}}{\text{Expenditure in Base Year}} \right) \times 100$$

$$\text{Consumer Price Index (2008)} = \left( \frac{\$2510}{\$1770} \right) \times 100 = 141.81$$

$$\text{Consumer Price Index} = \left( \frac{\$2860}{\$1770} \right) \times 100 = 161.58$$

$$\text{Inflation Rate} = \left( \frac{\text{Current Year CPI} - \text{Last Year CPI}}{\text{Last Year CPI}} \right) \times 100$$

$$\text{Inflation Rate} = \left( \frac{161.58 - 141.81}{141.81} \right) \times 100 = 13.94\%$$

# Thank You

