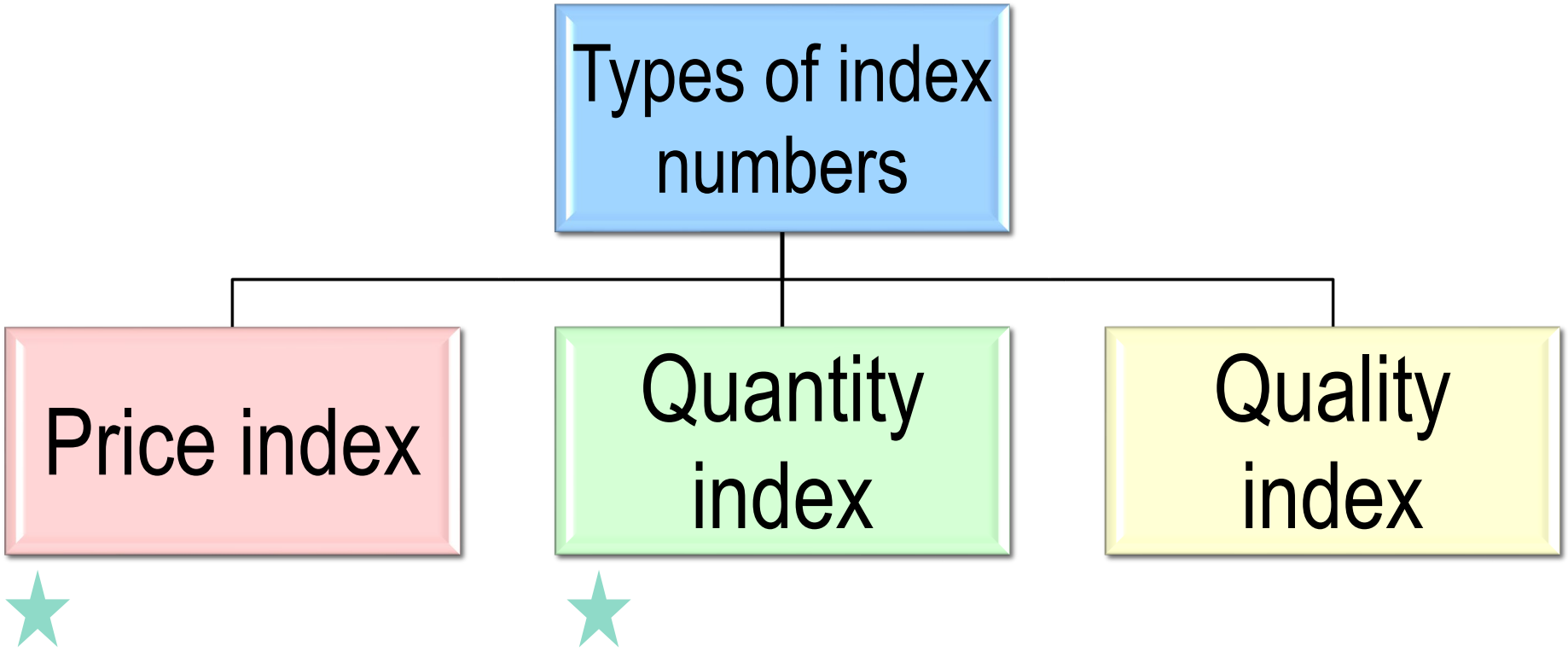
Topic 4
Chapter 8

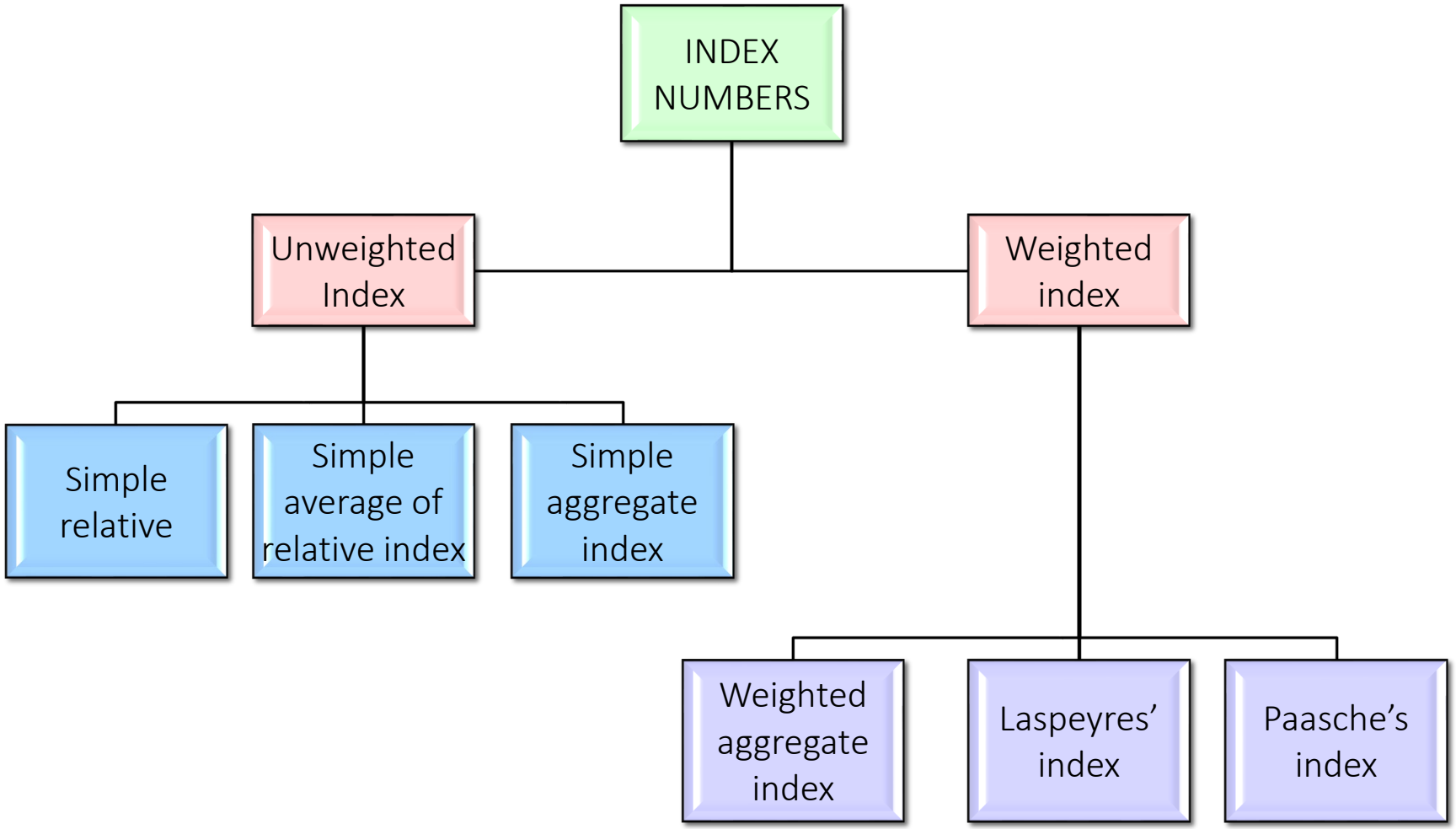
Index Numbers


Types of index numbers
Price index
Quantity index
Quality index

Definition

Price index is the percentage change in price of an item or a group of items in a given period with respect to the price of the same item or items in the base year.

Quantity index is the percentage change in quantities in a given period with respect to the quantities of the same item or items in the base year.


INDEX NUMBERS
Unweighted Index
Weighted index
Simple relative
Simple average of relative index
Simple aggregate index
Weighted aggregate index
Laspeyres' index
Paasche's index

Guidelines

1. Simple Relative Price Index
   Simple Relative Quantity Index

2. Simple Average Price Index
   Simple Average Quantity Index

3. Simple Aggregate Price Index
   Simple Aggregate Quantity Index

4. Weighted Aggregate Price Index
   Weighted Aggregate Quantity Index

5. Laspeyres' Price Index
   Laspeyres' Quantity Index

6. Paasche's Price Index
   Paasche's Quantity Index

Simple Relative Index

A simple relative price index, $I = \frac{p_t}{p_o} \times 100$

A simple relative quantity index, $I = \frac{q_t}{q_o} \times 100$

Example 1 Simple price relative index

Prices of petrol in 2018 and 2019 were RM2.30 and RM2.45 per liter respectively. Taking 2018 as the base year, find the price relative index for 2019.

$$p_0 = 2.30$$
$$p_t = 2.45$$

$$I = \frac{p_t}{p_0} = \frac{2.45}{2.30} \times 100 = 106.52$$

Interpretation:

In 2019, the price of petrol has increased by 6.52% as compared to 2018.

Example 2

Calculate the quantity relative (quantity index) of sales for 2019 taking 2018 as the base year

Year	2018	2019
Number of water filters	800	1600

$$q_0 = 800$$
$$q_t = 1600$$

$$I = \frac{q_t}{q_0} \times 100 = \frac{1600}{800} \times 100 = 200$$

Interpretation:

In 2019, the quantity of number of water filter sold has increased by 100% as compared to 2018.

Simple average of relative index

Simple average of relative index compares the overall changes for **a group of commodities or items** under consideration.

The average of relative prices index is

$$I = \frac{1}{n}\sum \frac{p_t}{p_o} \times 100$$

The average of relative quantities index is

$$I = \frac{1}{n}\sum \frac{q_t}{q_o} \times 100$$

Example 3

Table below shows a country's average prices of petrol, diesel and cooking gas for 2017, 2018 and 2019. Compute average of relative prices index for 2019 with

(a) 2017 as base

Item	2017	2018	2019
Petrol	1.90	2.30	2.50
Diesel	1.60	2.20	2.40
Cooking gas	1.00	1.20	1.30

Solution (a)

Price relative of petrol

$$I = \frac{p_t}{p_0} = \frac{p_{2019}}{p_{2017}} = \frac{2.50}{1.90} \times 100 = 131.58$$

Price relative of diesel

$$I = \frac{p_t}{p_0} = \frac{p_{2019}}{p_{2017}} = \frac{2.40}{1.60} \times 100 = 150.00$$

Price relative of cooking gas

$$I = \frac{p_t}{p_0} = \frac{p_{2019}}{p_{2017}} = \frac{1.30}{1.00} \times 100 = 130.00$$

Average of relative prices index

$$I = \frac{1}{3}(131.58 + 150 + 130)$$

$$I = 137.19$$

The average price in 2019 have increased by 37.19% as compared to 2017

Example 4

Calculate the average of relative quantities index of three types of foods A, B and C for 2018 taking 2016 as the base year.

Type of food	Quantity sold (kg)	
	2016	2018
A	600	650
B	1800	2200
C	1200	1400

Solution:

Type of food	2016	2018	Relative quantity index
A	600	650	$\frac{650}{600}\times 100 = 108.33$
B	1800	2200	$\frac{2200}{1800}\times 100 = 122.22$
C	1200	1400	$\frac{1400}{1200}\times 100 = 116.67$

Average of relative quantities index,

$$I = \frac{1}{n}\sum \frac{q_t}{q_o}\times 100$$

$$= \frac{1}{3}(108.33 + 122.22 + 116.67) = 115.74$$

The average quantities in 2018 have increased by 15.74% as compared to 2016.

Simple aggregate index

Simple aggregate index is the ratio of total price/quantity of a group of items calculated in the current year to the total price/quantity calculated in the base year.

Disadvantage:

Does not take into account the relative importance of the various commodities.

Simple aggregate price index $$I = \frac{\sum p_t}{\sum p_o} \times 100$$

Simple aggregate quantity index $$I = \frac{\sum q_t}{\sum q_o} \times 100$$

Example 5

Calculate the simple aggregate price index for 2018 and 2019 taking 2017 as the base year.

Item	2017	2018	2019
Petrol	1.20	1.35	1.50
Diesel	0.60	0.70	1.00
Cooking gas	1.00	1.20	1.60

Solution

Simple aggregate price index for 2018 with base 2017

$$I = \frac{1.35 + 0.70 + 1.20}{1.20 + 0.60 + 1.00} \times 100$$

$$I = 116.07$$

The total price in 2018 have increased by 16.07% as compared to 2017

Simple aggregate price index for 2019 with base 2017

$$I = \frac{1.50 + 1.00 + 1.60}{1.20 + 0.60 + 1.00} \times 100$$

$$I = 146.42$$

The total price in 2019 have increased by 46.42% as compared to 2017

Example 6

Calculate the simple aggregate quantity index for 2018 for three types of washing machines X, Y and Z with 2016 as the base year.

Type of washing machine	Sales quantity	
	2016	2018
X	300	600
Y	500	800
Z	900	1500

Solution

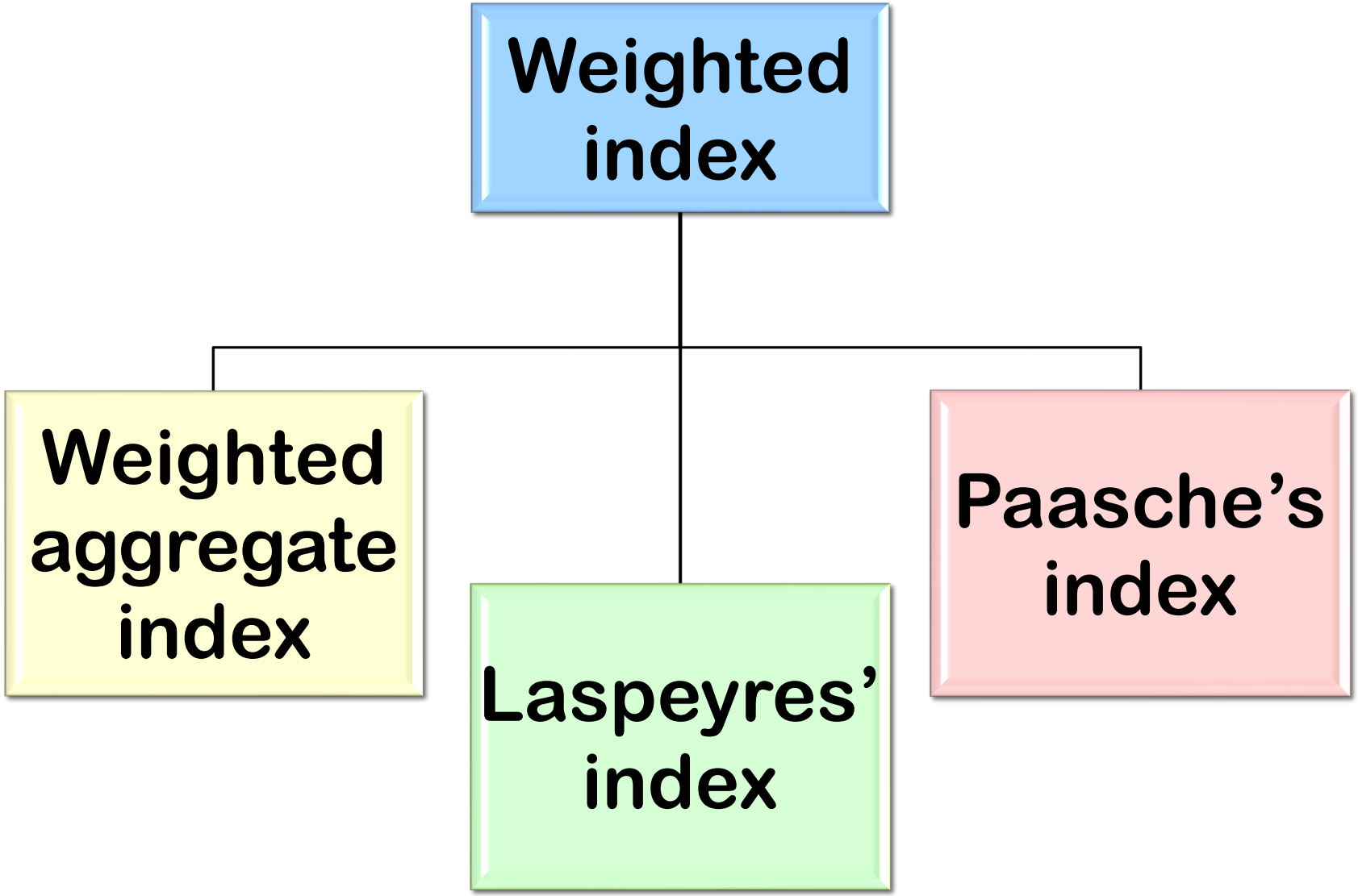
The simple aggregate quantity index for 2018 is

$$I = \frac{\sum q_t}{\sum q_o} \times 100$$

$$I = \frac{600 + 800 + 1500}{300 + 500 + 900} \times 100$$

$$I = 170.59$$

The total sales quantity for the three types of washing machine has increased by 70.59% from 2016 to 2018.


Weighted index
Weighted aggregate index
Laspeyres' index
Paasche's index

Weighted aggregate index

Weighted price index

$$\frac{\sum p_t w}{\sum p_o w} \times 100$$

Weighted quantity index

$$\frac{\sum q_t w}{\sum q_o w} \times 100$$

Example 7

For the data given below, calculate the weighted aggregate price index for 2006 using 2004 as the base year.

Type of food	Weight	Price (2017)	Price (2019)
A	3	1.50	2.00
B	5	2.80	3.20
C	8	5.00	6.00

Solution

Weighted aggregate price index for 2019

$$I = \frac{\sum wp_n}{\sum wp_o} \times 100$$

$$I = \frac{3(2.00) + 5(3.20) + 8(6.00)}{3(1.50) + 5(2.80) + 8(5.00)} \times 100$$

$$I = 119.66$$

The price index obtained indicate that there exist an increased of 19.66% in 2019 compared to the price in 2017

Example 8

For the data given below, calculate the weighted aggregate quantity index for 2019 using 2017 as the base year.

Type of commodity	Weight	Quantity 2017	Quantity 2019
A	3	15	25
B	4	20	30
C	5	50	40

Solution

Weighted aggregate quantity index for 2019

$$I = \frac{\sum wq_n}{\sum wq_o} \times 100$$

$$I = \frac{3(25) + 4(30) + 5(40)}{3(15) + 4(20) + 5(50)} \times 100$$

$$I = 105.33$$

The quantity index indicates that there is an increased of 5.33% in 2019 compared to the quantities in 2017

Laspeyres' Index & Paasche's Index

(1) Laspeyres' price index

$$\frac{\sum p_t q_o}{\sum p_o q_o} \times 100$$

(2) Paasche's price index

$$\frac{\sum p_t q_t}{\sum p_o q_t} \times 100$$

Example 9

Anthony Industry produces electrical components that require four main raw materials. The following table shows the price and quantity required for each material.

Raw material	Price per kg (RM)		Quantity (kg)	
	2017	2019	2017	2019
A	4.00	5.00	4000	3500
B	6.00	7.00	2750	3000
C	5.00	4.00	2000	3000
D	8.00	9.00	1000	2000

Using 2017 as the base year, calculate

a. Laspeyres' price index for year 2019

b. Paasche's price index for 2019

Solution

a) Laspeyres' price index for year 2019

5 x 4000

4 x 4000

Raw material	p_o	p_t	q_o	q_t	p_tq_o	p_oq_o
A	4.00	5.00	4000	3500	20000	16000
B	6.00	7.00	2750	3000	19250	16500
C	5.00	4.00	2000	3000	8000	10000
D	8.00	9.00	1000	2000	9000	8000
					56250	50500

Therefore,

$$= \frac{\sum p_t q_o}{\sum p_o q_o} \times 100$$

$$= \frac{56250}{50500} \times 100$$

$$= 111.39$$

The Laspeyer's price index obtained indicate that there is an increased of 11.39% in 2019 raw materials price as compared to the price in 2017.

Solution

b) Paasche's price index for 2019

5 x 3500

4 x 3500

Raw material	p_o	p_t	q_o	q_t	p_tq_t	p_oq_t
A	4.00	5.00	4000	3500	17500	14000
B	6.00	7.00	2750	3000	21000	18000
C	5.00	4.00	2000	3000	12000	15000
D	8.00	9.00	1000	2000	18000	16000
					68500	63000

Therefore,

$$= \frac{\sum p_t q_t}{\sum p_o q_t} \times 100$$

$$= \frac{68500}{63000} \times 100$$

$$= 108.73$$

The Paasche's price index indicate that there is an increased of 8.73% in 2019 price of raw materials as compared to 2017.

(3) Laspeyres' quantity index

$$\frac{\sum q_t p_o}{\sum q_o p_o} \times 100$$

(4) Paasche's quantity index

$$\frac{\sum q_t p_t}{\sum q_o p_t} \times 100$$

Example 10

Raw material	Price per kg (RM)		Quantity (kg)	
	2017	2019	2017	2019
A	4.00	5.00	4000	3500
B	6.00	7.00	2750	3000
C	5.00	4.00	2000	3000
D	8.00	9.00	1000	2000

Refer to the data above and use 2017 as the base year, calculate

a. Laspeyres' quantity index for 2019

b. Paasche's quantity index for 2019

Laspeyres' quantity index

$$= \frac{\sum q_t p_o}{\sum q_o p_o} \times 100$$

$$= \frac{3500(4) + 3000(6) + 3000(5) + 2000(8)}{4000(4) + 2750(6) + 2000(5) + 1000(8)} \times 100$$

$$= \frac{63000}{50500} \times 100 = 124.75\%$$

The quantity index increased by 24.75% in 2019 compared to 2017

Paasche's quantity index

$$= \frac{\sum q_t p_t}{\sum q_o p_t} \times 100$$

$$= \frac{3500(5) + 3000(7) + 3000(4) + 2000(9)}{4000(5) + 2750(7) + 2000(4) + 1000(9)} \times 100$$

$$= \frac{68500}{56250} \times 100 = 121.78\%$$

The quantity index increased by 21.78% in 2019 compared to 2017