

Statistik Bisnis

Week 3.1 - Index Number

Agenda

- 15 minutes Attendance check
- 75 minutes Discussion and Exercise

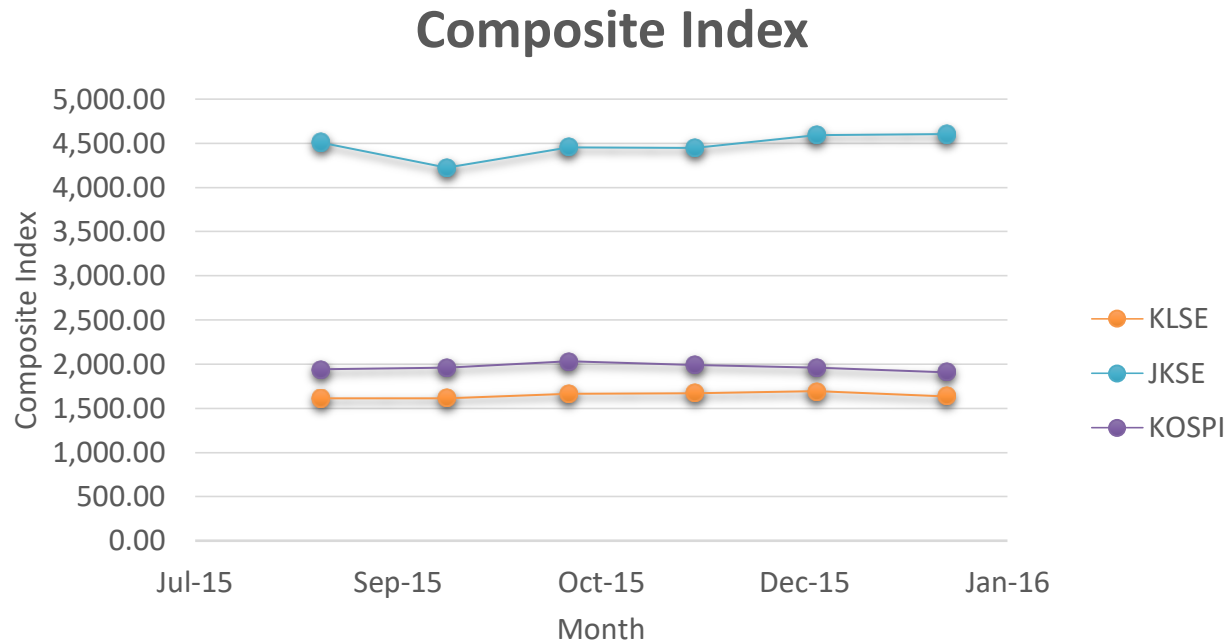
Objectives

At the end of this session the students will be able to

- Explain what an index number is
- Compile a simple index number
- Identify different types of index numbers
- Explain how index numbers can be used in practice

Introduction

The best-known index is the **consumer price index**, which gives a sort of "average" value for inflation based on price changes for a group of selected products. The **JKSE and NASDAQ indexes** for the Jakarta Stock Exchanges, respectively, are also index numbers.



Index Number



Simple Index



Unweighted Aggregate Index



Weighted Aggregate Index

SIMPLE INDEX NUMBER

Simple Index Number

INDEX NUMBER A number that expresses the relative change in **price, quantity, or value** compared to a base period.

Let's see this problem:

Menurut statistik Kanada, pada tahun 1995 rata-rata pendapatan pekerja usia 15 tahun keatas di Newfoundland dan Labrador adalah \$20.828 per tahun. Pada tahun 2001, rata-ratanya menjadi \$24.165 per tahun. Berapakah indeks pendapatan tahunan dari pekerja diatas 15 tahun di Newfoundland dan Labrador pada tahun 2001 dengan menggunakan tahun 1995 sebagai tahun dasar?

Simple Index Number

INDEX NUMBER A number that expresses the relative change in **price, quantity, or value** compared to a base period.

Solution:

$$I = \frac{\textit{Average yearly income of wage earners over 15 in 2001}}{\textit{Average yearly income of wage earners over 15 in 1995}} (100)$$

$$I = \frac{24,165}{20,828} (100) = 116.0$$

Simple Index Number

Now, Let's consider this problem:

Statistik Kanada mengeluarkan data jumlah lahan pertanian di Kanada menurun dari 276.548 pada tahun 1996, menjadi 246.923 pada tahun 2001. Berapakah indeks dari jumlah lahan pertanian pada tahun 2001 dengan menggunakan tahun 1996 sebagai tahun dasar?

Solution:

$$I = \frac{\textit{Number of farm in 2001}}{\textit{Number of farm in 1996}} (100)$$

$$I = \frac{276.548}{246.923} (100) = 89,3$$

Simple Index Number

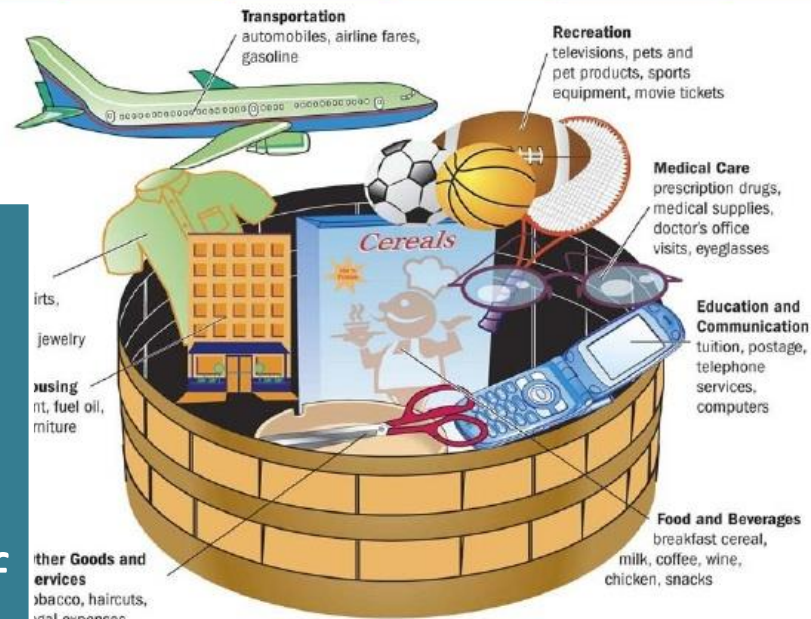
Note from the previous discussion that:

1. Index numbers are actually percentages because they are based on the number 100. However, the percent symbol is usually omitted.
2. Each index number has a base period. The current base period for the Consumer Price Index is 2012 = 100, changed from 2007 = 100 in January 2014.
3. Most business and economic indexes are computed to the nearest whole number, such as 214 or 96, or to the nearest tenth of a percent, such as 83.4 or 118.7.

Why convert data to indexes?

CPI Market Basket

An index is a convenient way to express a change in a diverse group of items.



Why convert data to indexes?

Converting data to indexes also makes it easier to assess the trend in a series composed of exceptionally large numbers.

Year	Indonesia's Official Reserve Assets Position
2013	99,387,000,000.00
2014	111,862,000,000.00
Difference	12,475,000,000.00

$$\frac{\textit{Official Reserve Asset Position in 2014}}{\textit{Official Reserve Asset Position in 2013}}$$

$$= \frac{111,862,000,000}{99,387,000,000} \times 100 = 113$$

Construction of Index Numbers

- Simple Price Index

$$PI = \frac{P_t}{P_0} \times 100$$

Where:

PI : Price Index

P_t : Price in the given period or selected period

P_0 : Price in the base period

Construction of Index Numbers

Let's take a look on the table below:

Prices and Price Index of a Benson Automatic Stapler

Year	Price of Stapler (\$)	Price Index (1990=100)
1985	18	
1990	20	100
1991	22	
1992	23	
2001	38	

The base period used here is year 1990

Construction of Index Numbers

Let's take a look on the table below:

Prices and Price Index of a Benson Automatic Stapler

Year	Price of Stapler (\$)	Price Index (1990=100)
1985	18	90
1990	20	100
1991		110
1992		115
2001		190

$$PI_{1985} = \frac{18}{20} \times 100$$

The base period used here is year 1990

Construction of Index Numbers

Simple Quantity Index

$$QI = \frac{Q_t}{Q_0} \times 100$$

Where:

QI : Quantity Index

Q_t : Quantity in the given period or selected period

Q_0 : Quantity in the base period

Simple Value Index

$$VI = \frac{(P_t \times Q_t)}{(P_0 \times Q_0)} \times 100$$

VI : Value Index

P_t : Price in the given period or selected period

P_0 : Price in the base period

Exercise

Tabel berikut memuat nilai tukar rupiah ke dolar Amerika setiap akhir tahun. Konversikan data tersebut menjadi angka indeks dengan menggunakan tahun 2011 sebagai tahun dasar.

Year	IDR per USD	Index (2011=100)
2011	9,098	
2012	9,788	
2013	12,180	
2014	12,545	
2015	13,830	

Exercise

Tabel berikut memuat nilai tukar rupiah ke dolar Amerika setiap akhir tahun. Konversikan data tersebut menjadi angka indeks dengan menggunakan tahun 2011 sebagai tahun dasar.

Year	IDR per USD	Index (2011=100)
2011	9,098	100
2012	9,788	108
2013	12,180	134
2014	12,545	138
2015	13,830	152

UNWEIGHTED AGGREGATE INDEXES

Unweighted Indexes



Simple Average of
the Price Indexes



Simple Aggregate
Index

Simple Average of the Price Indexes

Tabel berikut memuat harga beberapa jenis makanan pada tahun 1995 dan 2005. Bagaimana cara menentukan indeks untuk kelompok jenis makanan ini untuk tahun 2005, dengan menggunakan tahun 1995 sebagai tahun dasar.

Computation of Index for Food Price 2005, 1995=100

Item	1995 Price (\$)	2005 Price (\$)	Simple Index
Bread white (loaf)	0.77	1.98	
Eggs (dozen)	1.85	1.84	
Milk (litre) white	0.88	1.98	
Apples, red delicious (500 g)	1.46	1.75	
Orange juice (355 ml concentrate)	1.58	1.70	
Coffee, 100% ground roast (400 g)	4.40	3.99	
Total	10.94	13.24	

Simple Average of the Price Indexes

Tabel berikut memuat harga beberapa jenis makanan pada tahun 1995 dan 2005. Bagaimana cara menentukan indeks untuk kelompok jenis makanan ini untuk tahun 2005, dengan menggunakan tahun 1995 sebagai tahun dasar.

Computation of Index for Food Price 2005, 1995=100

Item	1995 Price (\$)	2005 Price (\$)	Simple Index
Bread white (loaf)	0.77	1.98	257.1
Eggs (dozen)	1.85	1.84	99.5
Milk (litre) white	0.88	1.98	225.0
Apples, red delicious (500 g)	1.46	1.75	119.9
Orange juice (355 ml concentrate)	1.58	1.70	107.6
Coffee, 100% ground roast (400 g)	4.40	3.99	90.7
Total	10.94	13.24	899.8

Simple Average of the Price Indexes

SIMPLE AVERAGE OF THE PRICE INDEXES

$$PI = \frac{\sum PI_i}{n}$$

$$PI = \frac{899.8}{6} = 150$$

- This indicates that the mean of the group of indexes increased 50 percent from 1995 to 2005.

Simple Aggregate Index

Let's use the data from before:

Item	1995 Price (\$)	2005 Price (\$)
Bread white (loaf)	0.77	1.98
Eggs (dozen)	1.85	1.84
Milk (litre) white	0.88	1.98
Apples, red delicious (500 g)	1.46	1.75
Orange juice (355 ml concentrate)	1.58	1.70
Coffee, 100% ground roast (400 g)	4.40	3.99
Total	10.94	13.24

Simple Aggregate Price Index

$$API = \frac{\sum P_t}{\sum P_0} \times 100$$

$$PI = \frac{13.24}{10.94} \times 100 = 121$$

Simple Aggregate Index

Simple Aggregate Quantity Index

$$AQI = \frac{\sum Q_t}{\sum Q_0} \times 100$$

Where:

AQI : Aggregate Quantity Index

Q_t : Quantity in the given period or selected period

Q_0 : Quantity in the base period

Simple Aggregate Value Index

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

AVI : Aggregate Value Index

P_t : Price in the given period or selected period

P_0 : Price in the base period

Simple Aggregate Index

- Because the value of a simple aggregate index can be influenced by the units of measurement, it is not used frequently.
- In our example the value of the index would differ significantly if we were to report the price of apples in tonnes rather than kilograms.
- Also, note the effect of coffee on the total index.
- For both the current year and the base year, the value of coffee is about 40 percent of the total index, so a change in the price of coffee will drive the index much more than any other item.
- So we need a way to appropriately “weight” the items according to their relative importance.

WEIGHTED INDEXES

Weighted Indexes

- Laspeyres' Index
- Paasche's Index
- Fisher's Index
- Dorbish and Bowley's Index
- Marshall-Edgeworth's index
- Walsh's index

Laspeyres' Index

Etienne Laspeyres developed a method in the latter part of the 18th century to determine a weighted index using **base-period weights**.

Laspeyres' Price Index

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

Where:

P_t : Price in the given period or selected period

P_0 : Price in the base period

Q_0 : Quantity in the base period

Laspeyres' Index

Tabel berikut memuat data harga dari enam jenis makanan dan jumlah unit yang dikonsumsi oleh satu keluarga pada tahun 1995 dan 2005

Item	1995		2005	
	Price (\$)	Quantity	Price (\$)	Quantity
Bread white (loaf)	0.77	50	1.98	55
Eggs (dozen)	1.85	26	2.98	20
Milk (litre) white	0.88	102	1.98	130
Apples, red delicious (500 g)	1.46	30	1.75	40
Orange juice, (355 ml concentrate)	1.58	40	1.7	41
Coffee, 100% ground roast (400 g)	4.4	12	4.75	12

Laspeyres' Index

Solution:

Item	$P_0 \times Q_0$	$P_t \times Q_0$
Bread white (loaf)	38.5	99
Eggs (dozen)	48.1	77.48
Milk (litre) white	89.76	201.96
Apples, red delicious (500 g)	43.8	52.5
Orange juice, (355 ml concentrate)	63.2	68
Coffee, 100% ground roast (400 g)	52.8	57
	336.16	555.94

$$LPI = \frac{555.94}{336.16} \times 100 = 165$$

Paasche's Index

The Paasche index is an alternative. The procedure is similar, but instead of using base period weights, we use **current period weights**.

Paasche's Price Index

$$PPI = \frac{\sum(P_t \times Q_t)}{\sum(P_0 \times Q_t)} \times 100$$

Where:

P_t : Price in the given period or selected period

P_0 : Price in the base period

Q_t : Quantity in the given period or selected period

Paasche's Index

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Item	1995		2005	
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Bread white (loaf)	0.77	50	1.98	55
Eggs (dozen)	1.85	26	2.98	20
Milk (litre) white	0.88	102	1.98	130
Apples, red delicious (500 g)	1.46	30	1.75	40
Orange juice, (355 ml concentrate)	1.58	40	1.7	41
Coffee, 100% ground roast (400 g)	4.4	12	4.75	12

Paasche's Index

Solution:

Item	$P_0 \times Q_t$	$P_t \times Q_t$
Bread white (loaf)	42.35	108.9
Eggs (dozen)	37	59.6
Milk (litre) white	114.4	257.4
Apples, red delicious (500 g)	58.4	70
Orange juice, (355 ml concentrate)	64.78	69.7
Coffee, 100% ground roast (400 g)	52.8	57
	369.73	622.6

$$PPI = \frac{622.6}{369.73} \times 100 = 168$$

Laspeyres' Index vs. Paasche's Index

Laspeyres'

- **Advantages:**
Requires quantity data from only the base period. This allows a more meaningful comparison over time. The changes in the index can be attributed to changes in the price.
- **Disadvantages:**
Does not reflect changes in buying patterns over time. Also, it may overweight goods whose prices increase.

Paasche's

- **Advantages:**
Because it uses quantities from the current period, it reflects current buying habits.
- **Disadvantages:**
It requires quantity data for each year, which may be difficult to obtain. Because different quantities are used each year, it is impossible to attribute changes in the index to changes in price alone. It tends to overweight the goods whose prices have declined. It requires the prices to be recomputed each year.

Fisher's Index

In an attempt to offset Laspeyres' index and Paasche Index shortcomings, Irving Fisher, in his book *The Making of Index Numbers*, published in 1922, proposed an index called **Fisher's ideal index**. It is the **geometric mean** of the Laspeyres and Paasche indexes.

- **Fisher's Ideal Index**

$$FII = \sqrt{LPI \times PPI}$$

Where:

LPI : Laspeyres's Price Index

PPI : Paasche's Price Index

Fisher's Index

From the problem before, we got:

- LPI = 165
- PPI = 168

Therefore,

$$FII = \sqrt{165 \times 168} = 166$$

Dorbish and Bowley's Index

Another attempt to consider taking an evenly weighted average of these fixed-basket price indices as a single estimator of price change between the two periods is developed by Drobisch (1871) and Bowley (1901).

- **Dorbish and Bowley's Index**

$$DBI = \frac{LPI + PPI}{2}$$

Where:

LPI : Laspeyres's Price Index

PPI : Paasche's Price Index

Dorbish and Bowley's Index

From the problem before, we got:

- LPI = 165
- PPI = 168

Therefore,

$$DBI = \frac{165 + 168}{2} = 166.5$$

Marshall-Edgeworth's Index

Marshall (1887) and *Edgeworth* (1925) also try to develop *price index* formula to deal with problems related to laspeyres' index and paasche's index by using **arithmetic mean of the quantities**.

- **Marshall-Edgeworth's index**

$$LPI = \frac{\sum(P_t(Q_0 + Q_t))}{\sum(P_0(Q_0 + Q_t))} \times 100$$

Where:

P_t : Price in the given period or selected period

P_0 : Price in the base period

Q_t : Quantity in the given period or selected period

Q_0 : Quantity in the base period

Marshall-Edgeworth's Index

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Orange juice, (355 ml concentrate)	1.58	40	1.7	41
Coffee, 100% ground roast (400 g)	4.4	12	4.75	12

Marshall-Edgeworth's Index

Solution:

Item	Q_0+Q_t	$P_0(Q_0+Q_t)$	$P_t(Q_0+Q_t)$
Bread white (loaf)	105	80.85	207.9
Eggs (dozen)	46	85.1	137.08
Milk (litre) white	232	204.16	459.36
Apples, red delicious (500 g)	70	102.2	122.5
Orange juice, (355 ml concentrate)	81	127.98	137.7
Coffee, 100% ground roast (400 g)	24	105.6	114
		705.89	1178.54

$$MEI = \frac{1178.54}{705.89} \times 100 = 167$$

Walsh's index

Correa Moylan Walsh (1901) also saw the price index number problem in the using fixed-basket index (laspeyres' and paasche index), and suggest using **geometric mean of both quantities**.

- **Walsh's index**

$$LPI = \frac{\sum(P_t \sqrt{Q_0 \times Q_t})}{\sum(P_0 \sqrt{Q_0 \times Q_t})} \times 100$$

Where:

P_t : Price in the given period or selected period

P_0 : Price in the base period

Q_t : Quantity in the given period or selected period

Q_0 : Quantity in the base period

Walsh's index

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Orange juice, (355 ml concentrate)	1.58	40	1.7	41
Coffee, 100% ground roast (400 g)	4.4	12	4.75	12

Walsh's index

Solution:

Item	$\sum VQ_0 \times Q_t$	$P_0(\sum VQ_0 \times Q_t)$	$P_t(\sum VQ_0 \times Q_t)$
Bread white (loaf)	52.44	40.38	103.83
Eggs (dozen)	22.80	42.19	67.95
Milk (litre) white	115.15	101.33	228.00
Apples, red delicious (500 g)	34.64	50.58	60.62
Orange juice, (355 ml concentrate)	40.50	63.99	68.84
Coffee, 100% ground roast (400 g)	12.00	52.8	57
		351.26	586.25

$$WI = \frac{586.25}{351.26} \times 100 = 167$$

Special-Purpose Indexes

- The Consumer Price Index (CPI)
- JKSE Composite Index
- NASDAQ Composite Index
- Wholesale Price Index
- Human Development Index

EXERCISE

Betts Electronics

Betts Electronics membeli tiga suku cadang untuk mesin robot yang mereka gunakan dalam proses manufakturnya. Informasi mengenai harga suku cadang tersebut dan jumlah yang telah dibeli dapat dilihat pada tabel berikut.

Part	Price (\$)		Quantity	
	1999	2005	1999	2005
RC-33	0.5	0.6	320	340
SM-14	1.2	0.9	110	130
WC50	0.85	1	230	250

Betts Electronics

- a. Hitung indeks harga sederhana untuk masing-masing suku cadang tersebut. Gunakan tahun 1999 sebagai tahun dasar.
- b. Hitung Indeks Harga Agregat sederhana untuk tahun 2005. Gunakan tahun 1999 sebagai tahun dasar.
- c. Hitung indeks harga Laspeyres untuk tahun 2005 dengan menggunakan tahun 1999 sebagai tahun dasar.
- d. Hitung indeks Paasche untuk tahun 2005 dengan menggunakan tahun 1999 sebagai tahun dasar.
- e. Tentukan indeks ideal Fisher dengan menggunakan nilai indeks Laspeyres dan Paasche yang telah anda hitung pada poin-poin sebelumnya.
- f. Tentukan indeks nilai untuk tahun 2005 dengan menggunakan tahun 1999 sebagai tahun dasar.

THANK YOU