Index Numbers

Chapter 15

GOALS

- Describe the term index.
- Understand the difference between a weighted and an unweighted index.
- Construct and interpret a Laspeyres price index.
- Construct and interpret a Paasche price index.
- Construct and interpret a value index.
- Explain how the Consumer Price Index is constructed and interpreted.

Index Numbers

- 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 just one variable.

Index Number – Example 1

According to the Bureau of Labor Statistics, in January 1995 the average hourly earnings of production workers was $11.47. In June 2005 it was $16.07.

What is the index of hourly earnings of production workers for June 2005 based on January 1995?

$$P = \frac{\text{Average hourly earnings of production workers in February 2006}}{\text{Average hourly earnings of production workers in January 1995}}(100)$$

$$= \frac{\$16.47}{\$11.47}(100) = 143.6$$

Index Number –Example 2

An index can also compare one item with another.

Example: The population of the Canadian province of British Columbia in 2004 was 4,196,400 and for Ontario it was 12,392,700. What is the population index of British Columbia compared to Ontario?

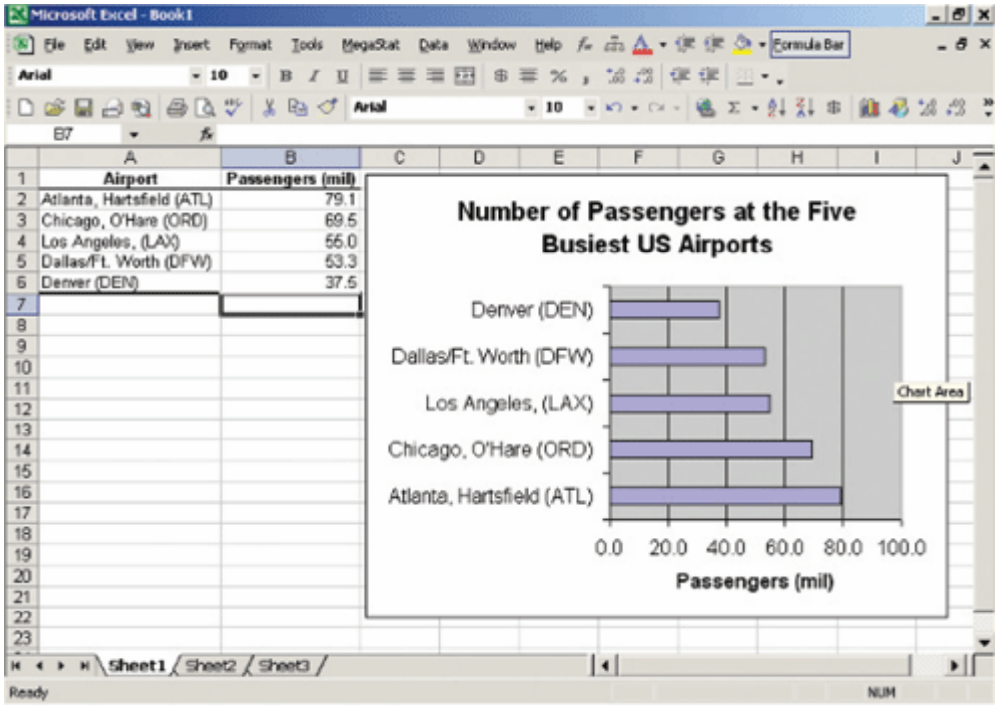
The index of population for British Columbia is 33.9, found by:

$$P = \frac{\text{Population of British Columbia}}{\text{Population of Ontario}}(100) = \frac{4{,}196{,}400}{12{,}392{,}700}(100) = 33.9$$

Index Number – Example 3

The following Excel output shows the number of passengers (in millions) for the five largest airports in the United States in 2004.

What is the index for Atlanta, Chicago, Los Angeles, and Dallas/Ft. Worth compared to Denver?



Index Number – Example 3 (cont.)

Airport	Passengers	Index	Found by
Atlanta, Hartsfield (ATL)	79.1	210.9	(79.1/37.5)*100
Chicago, O'Hare (ORD)	69.5	185.3	(69.5/37.5)*100
Los Angeles (LAX)	55.0	146.7	(55.0/37.5)*100
Dallas/Ft. Worth (DFW)	53.3	142.1	(53.3/37.5)*100
Denver (DEN)	37.5	100.0	(37.5/37.5)*100

Why Convert Data to Indexes?

- An index is a convenient way to express a change in a diverse group of items.
  - The Consumer Price Index (CPI), for example, encompasses about 400 items—including golf balls, lawn mowers, hamburgers, funeral services, and dentists' fees. Prices are expressed in dollars per pound, box, yard, and many other different units. Only by converting the prices of these many diverse goods and services to one index number can the federal government and others concerned with inflation keep informed of the overall movement of consumer prices.
- Converting data to indexes also makes it easier to assess the trend in a series composed of exceptionally large numbers.
  - For example, total U.S. retail sales for the month of July 2005 were $357,013,000. For July 2004, the total retail sales were $323,604,000. This increase of $33,409,000 appears significant. Yet if the July 2005 retail sales are expressed as an index based on July 2004 retail sales the increase is 10.3 percent.

Indexes

- In many situations we wish to combine several items and develop an index to compare the cost of this aggregation of items in two different time periods.
  - 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, housing, meals, and entertainment.
- There are several ways we can combine the items to determine the index.

Indexes

- Unweighted Indexes
  - Simple Average of the Price Indexes
  - Simple Aggregate Index
- Weighted Indexes
  - Lespeyres Price Index
  - Paasche Price Index
- Fisher's Price Index
- Value Index
- Special Purpose Index
  - Consumer Price Index
  - Producer Price Index
  - S&P Index

Unweighted Indexes

SIMPLE AVERAGE OF THE PRICE RELATIVES

$$P = \frac{\Sigma P_i}{n} \qquad [15\text{–}2]$$

where P_i refers to the simple index for each of the items

n the number of items.

SIMPLE AGGREGATE INDEX

$$P = \frac{\Sigma p_t}{\Sigma p_0} \times 100 \qquad [15\text{–}3]$$

Where $\sum p_t$ is the sum of the prices (rather than the indexes) for the period t and $\sum p_0$ is the sum of the prices for the base period.

Laspeyres versus Paasche Index

When is Laspeyres most appropriate and when is Paasche the better choice?

- **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**
  - Advantages Because it uses quantities from the current period, it reflects current buying habits.
  - Disadvantages It requires quantity data for the current year. 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.

Simple Average - Example

TABLE 15–2 Computation of Index for Food Price 2005, 1995 = 100

Item	1995 Price	2005 Price	Simple Index
Bread, white, cost per pound	$ 0.77	$ 0.89	115.6
Eggs, dozen	1.85	1.84	99.5
Milk, gallon, white	0.88	1.01	114.8
Apples, Red Delicious, 1 pound	1.46	1.56	106.8
Orange Juice, 12 oz concentrate	1.58	1.70	107.6
Coffee, 100% ground roast, 1 pound	4.40	4.62	105.0
Total	$10.94	$11.62	

$$P = \frac{\Sigma P_i}{n} = \frac{115.6 + \cdots + 105.0}{6} = \frac{649.3}{6} = 108.2$$

Simple Aggregate Index – Example

TABLE 15–2 Computation of Index for Food Price 2005, 1995 = 100

Item	1995 Price	2005 Price	Simple Index
Bread, white, cost per pound	$ 0.77	$ 0.89	115.6
Eggs, dozen	1.85	1.84	99.5
Milk, gallon, white	0.88	1.01	114.8
Apples, Red Delicious, 1 pound	1.46	1.56	106.8
Orange Juice, 12 oz concentrate	1.58	1.70	107.6
Coffee, 100% ground roast, 1 pound	4.40	4.62	105.0
Total	$10.94	$11.62	

$$P = \frac{\Sigma p_t}{\Sigma p_0}(100) = \frac{\$11.62}{\$10.94}(100) = 106.2$$

Weighted Indexes

LASPEYRES PRICE INDEX

$$P = \frac{\Sigma p_t q_0}{\Sigma p_0 q_0} \times 100 \qquad [15\text{–}4]$$

where

P is the price index.
p_t is the current price.
p_0 is the price in the base period.
q_0 is the quantity used in the base period.

PAASCHE PRICE INDEX

$$P = \frac{\Sigma p_t q_t}{\Sigma p_0 q_t} \times 100 \qquad [15\text{–}5]$$

Where

p is the price index
p_t is the current price
p_0 is the price of the base period
q_t is the quantity used in the current period
q_0 is the quantity used in the base period

Lespeyres Index - Example

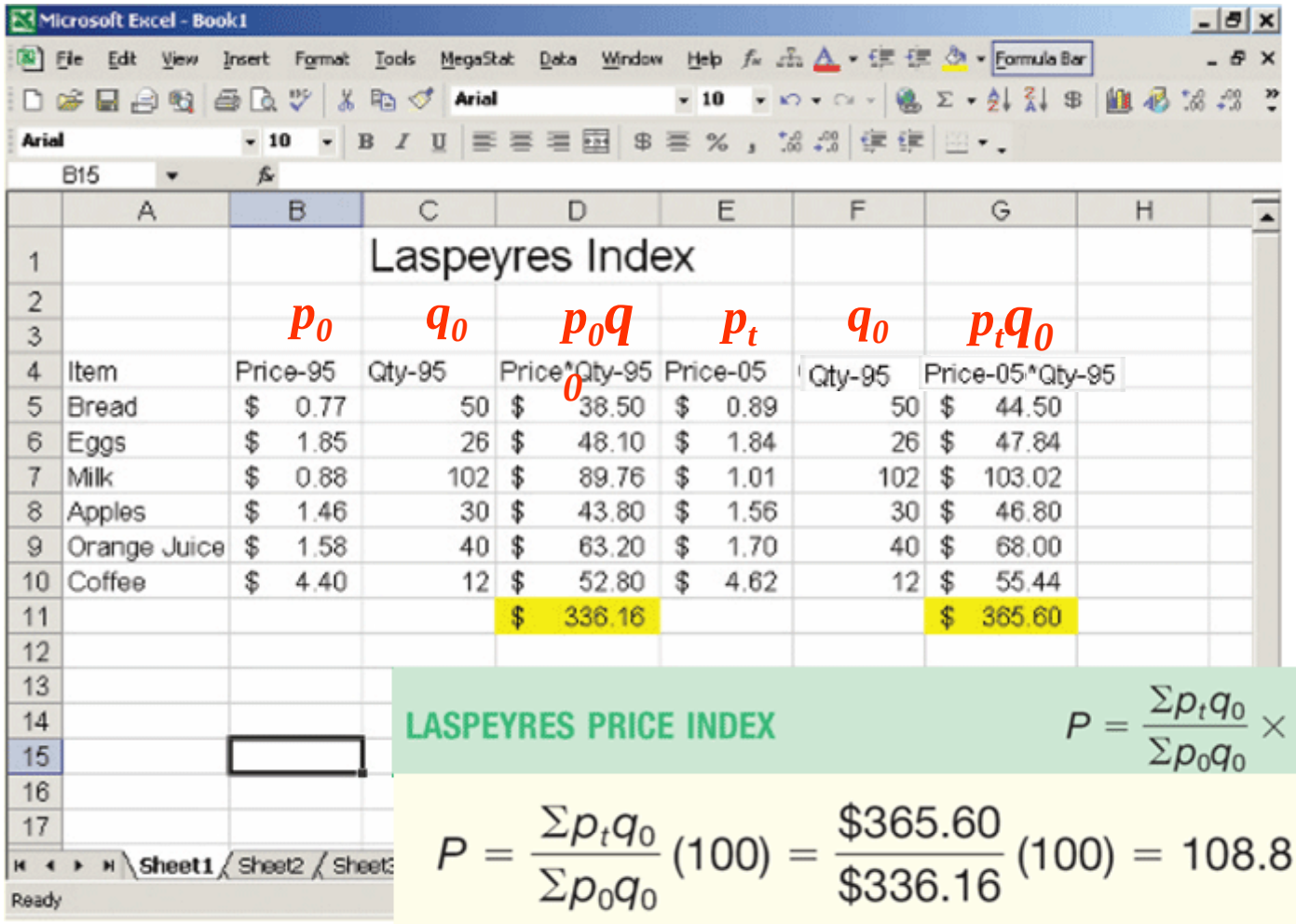
The prices for the six food items from Table 15–2 are repeated below in Table 15–3. Also included is the number of units of each consumed by a typical family in 1995 and 2005.

TABLE 15–3 Price and Quantity of Food Items in 1995 and 2005

Item	1995 Price	1995 Quantity	2005 Price	2005 Quantity
Bread, white, cost per pound	$0.77	50	$0.89	55
Eggs, dozen	1.85	26	1.84	20
Milk, gallon, white	0.88	102	1.01	130
Apples, Red Delicious, 1 pound	1.46	30	1.56	40
Orange Juice, 12 oz concentrate	1.58	40	1.70	41
Coffee, 100% ground roast, 1 pound	4.40	12	4.62	12

Determine a weighted price index using the Laspeyres method.

Lespeyres Index - Example



Laspeyres Index

		p_0	q_0	p_0q_0	p_t	q_0	p_tq_0
4	Item	Price-95	Qty-95	Price*Qty-95	Price-05	Qty-95	Price-05*Qty-95
5	Bread	$ 0.77	50	$ 38.50	$ 0.89	50	$ 44.50
6	Eggs	$ 1.85	26	$ 48.10	$ 1.84	26	$ 47.84
7	Milk	$ 0.88	102	$ 89.76	$ 1.01	102	$ 103.02
8	Apples	$ 1.46	30	$ 43.80	$ 1.56	30	$ 46.80
9	Orange Juice	$ 1.58	40	$ 63.20	$ 1.70	40	$ 68.00
10	Coffee	$ 4.40	12	$ 52.80	$ 4.62	12	$ 55.44
11				$ 336.16			$ 365.60

Sheet1 Sheet2 Sheet3

Ready

LASPEYRES PRICE INDEX

$$P = \frac{\Sigma p_t q_0}{\Sigma p_0 q_0} \times 100$$

$$P = \frac{\Sigma p_t q_0}{\Sigma p_0 q_0}(100) = \frac{\$365.60}{\$336.16}(100) = 108.8$$

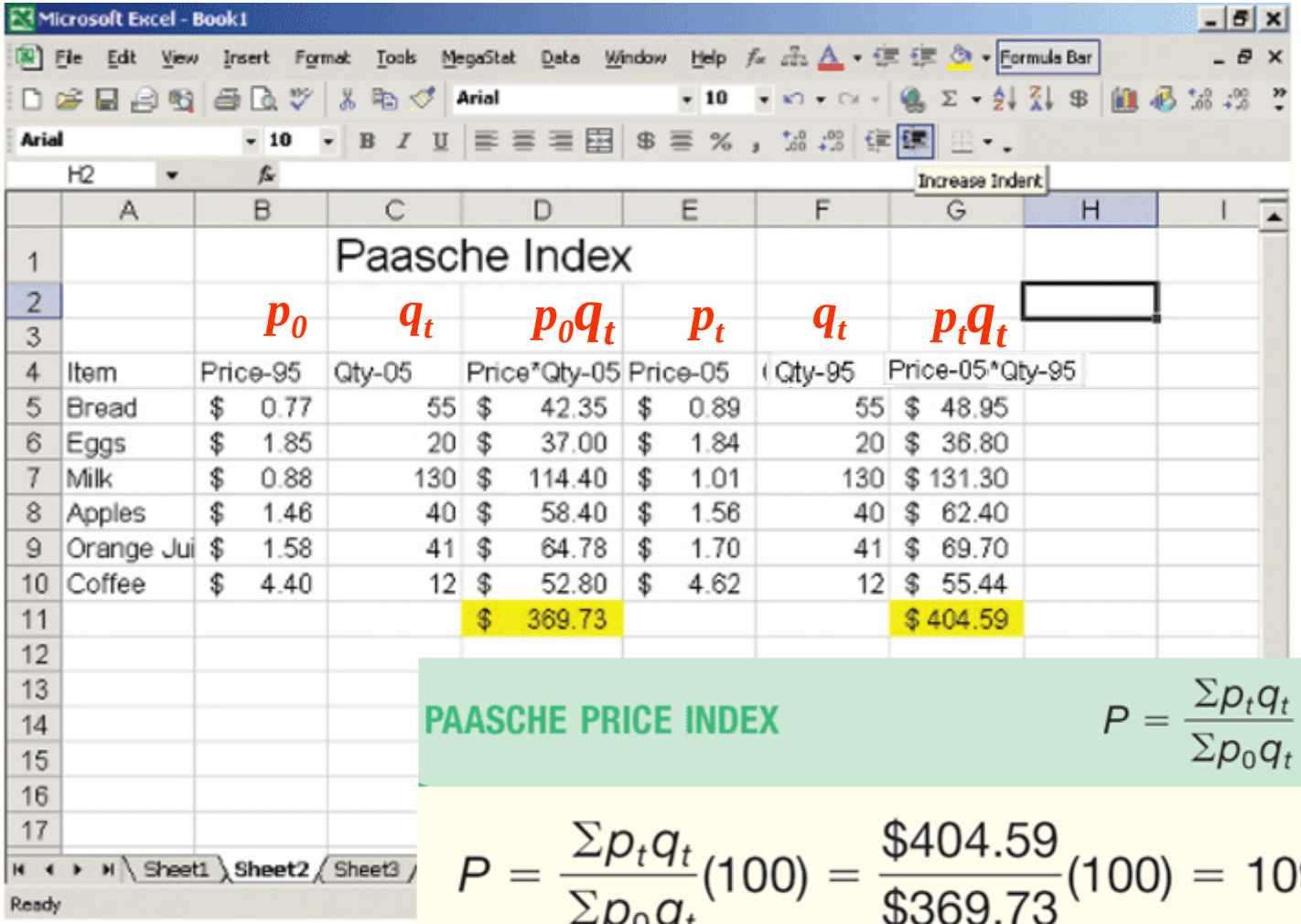
Paasche Index - Example

The prices for the six food items from Table 15–2 are repeated below in Table 15–3. Also included is the number of units of each consumed by a typical family in 1995 and 2005.

TABLE 15–3 Price and Quantity of Food Items in 1995 and 2005

Item	1995 Price	1995 Quantity	2005 Price	2005 Quantity
Bread, white, cost per pound	$0.77	50	$0.89	55
Eggs, dozen	1.85	26	1.84	20
Milk, gallon, white	0.88	102	1.01	130
Apples, Red Delicious, 1 pound	1.46	30	1.56	40
Orange Juice, 12 oz concentrate	1.58	40	1.70	41
Coffee, 100% ground roast, 1 pound	4.40	12	4.62	12

Paasche Index - Example



PAASCHE PRICE INDEX

$$P = \frac{\Sigma p_t q_t}{\Sigma p_0 q_t} \times 100$$

$$P = \frac{\Sigma p_t q_t}{\Sigma p_0 q_t}(100) = \frac{\$404.59}{\$369.73}(100) = 109.4$$

Fisher's Ideal Index

- Laspeyres' index tends to overweight goods whose prices have increased. Paasche's index, on the other hand, tends to overweight goods whose prices have gone down.
- **Fisher's ideal index** was developed in an attempt to offset these shortcomings.
- It is the geometric mean of the Laspeyres and Paasche indexes.

$$\text{Fisher's ideal index} = \sqrt{(\text{Laspeyres' index})(\text{Paasche's index})} \qquad \textbf{[15–6]}$$

Fisher's Ideal Index - Example

Determine Fisher's ideal index for the data in Table 15–3.

TABLE 15–3 Price and Quantity of Food Items in 1995 and 2005

Item	1995 Price	1995 Quantity	2005 Price	2005 Quantity
Bread, white, cost per pound	$0.77	50	$0.89	55
Eggs, dozen	1.85	26	1.84	20
Milk, gallon, white	0.88	102	1.01	130
Apples, Red Delicious, 1 pound	1.46	30	1.56	40
Orange Juice, 12 oz concentrate	1.58	40	1.70	41
Coffee, 100% ground roast, 1 pound	4.40	12	4.62	12

Fisher's ideal index is 109.1.

$$\text{Fisher's ideal index} = \sqrt{(\text{Laspeyres' index})(\text{Paasche's index})}$$

$$= \sqrt{(108.8)(109.4)} = 109.1$$

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:

VALUE INDEX

$$V = \frac{\Sigma p_t q_t}{\Sigma p_0 q_0} \times 100 \qquad \textbf{[15–7]}$$

Value Index - Example

The prices and quantities sold at the Waleska Clothing Emporium for various items of apparel for May 2000 and May 2005 are:

Item	2000 Price, p_0	2000 Quantity Sold (thousands), q_0	2005 Price, p_t	2005 Quantity Sold (thousands), q_t
Ties (each)	$ 1	1,000	$ 2	900
Suits (each)	30	100	40	120
Shoes (pair)	10	500	8	500

What is the index of value for May 2005 using May 2000 as the base period?

Value Index - Example

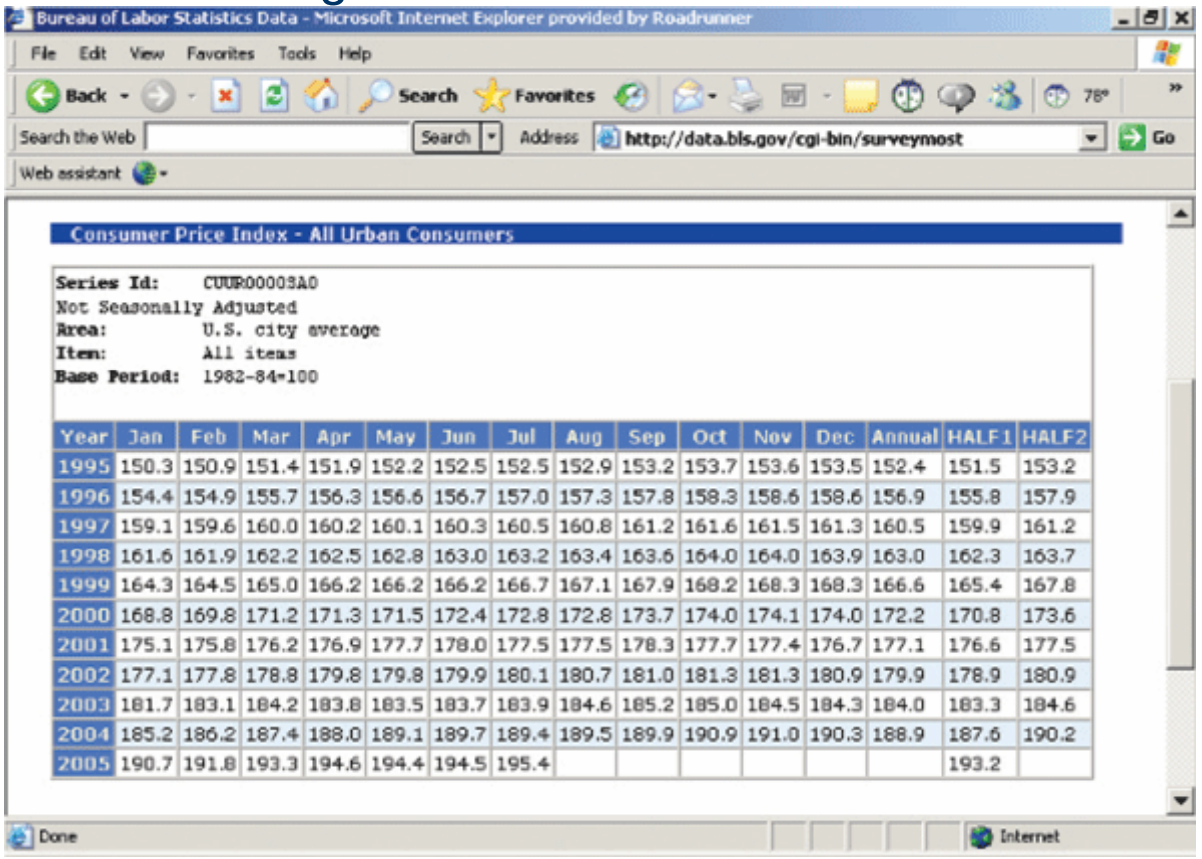
TABLE 15–4 Construction of a Value Index for 2005 (2000 = 100)

Item	2000 Price, p_0	2000 Quantity Sold (thousands), q_0	p_0q_0 ($ thousands)	2005 Price, p_t	2005 Quantity Sold (thousands), q_t	p_tq_t ($ thousands)
Ties (each)	$ 1	1,000	$1,000	$ 2	900	$ 1,800
Suits (each)	30	100	3,000	40	120	4,800
Shoes (pair)	10	500	5,000	8	500	4,000
			$9,000			$10,600

$$V = \frac{\Sigma p_t q_t}{\Sigma p_0 q_0}(100) = \frac{\$10{,}600{,}000}{\$9{,}000{,}000}(100) = 117.8$$

Consumer Price Index

The U.S. Bureau of Labor Statistics reports this index monthly. It describes the changes in prices from one period to another for a "market basket" of goods and services.



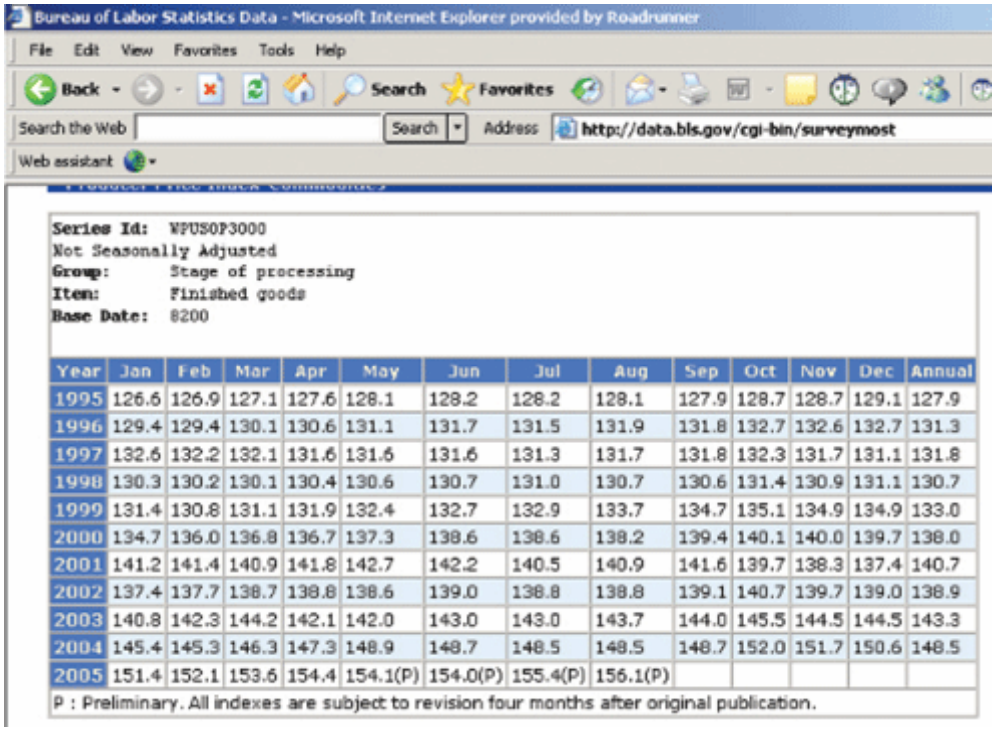
Consumer Price Index - All Urban Consumers

Series Id: CUUR0000SA0
Not Seasonally Adjusted
Area: U.S. city average
Item: All items
Base Period: 1982-84=100

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	HALF1	HALF2
1995	150.3	150.9	151.4	151.9	152.2	152.5	152.5	152.9	153.2	153.7	153.6	153.5	152.4	151.5	153.2
1996	154.4	154.9	155.7	156.3	156.6	156.7	157.0	157.3	157.8	158.3	158.6	158.6	156.9	155.8	157.9
1997	159.1	159.6	160.0	160.2	160.1	160.3	160.5	160.8	161.2	161.6	161.5	161.3	160.5	159.9	161.2
1998	161.6	161.9	162.2	162.5	162.8	163.0	163.2	163.4	163.6	164.0	164.0	163.9	163.0	162.3	163.7
1999	164.3	164.5	165.0	166.2	166.2	166.2	166.7	167.1	167.9	168.2	168.3	168.3	166.6	165.4	167.8
2000	168.8	169.8	171.2	171.3	171.5	172.4	172.8	172.8	173.7	174.0	174.1	174.0	172.2	170.8	173.6
2001	175.1	175.8	176.2	176.9	177.7	178.0	177.5	177.5	178.3	177.7	177.4	176.7	177.1	176.6	177.5
2002	177.1	177.8	178.8	179.8	179.8	179.9	180.1	180.7	181.0	181.3	181.3	180.9	179.9	178.9	180.9
2003	181.7	183.1	184.2	183.8	183.5	183.7	183.9	184.6	185.2	185.0	184.5	184.3	184.0	183.3	184.6
2004	185.2	186.2	187.4	188.0	189.1	189.7	189.4	189.5	189.9	190.9	191.0	190.3	188.9	187.6	190.2
2005	190.7	191.8	193.3	194.6	194.4	194.5	195.4							193.2	

Producers Price Index

- Formerly called the Wholesale Price Index, it dates back to 1890 and is also published by the U.S. Bureau of Labor Statistics.
- It reflects the prices of over 3,400 commodities. Price data are collected from the sellers of the commodities, and it usually refers to the first large-volume transaction for each commodity. It is a Laspeyres-type index.



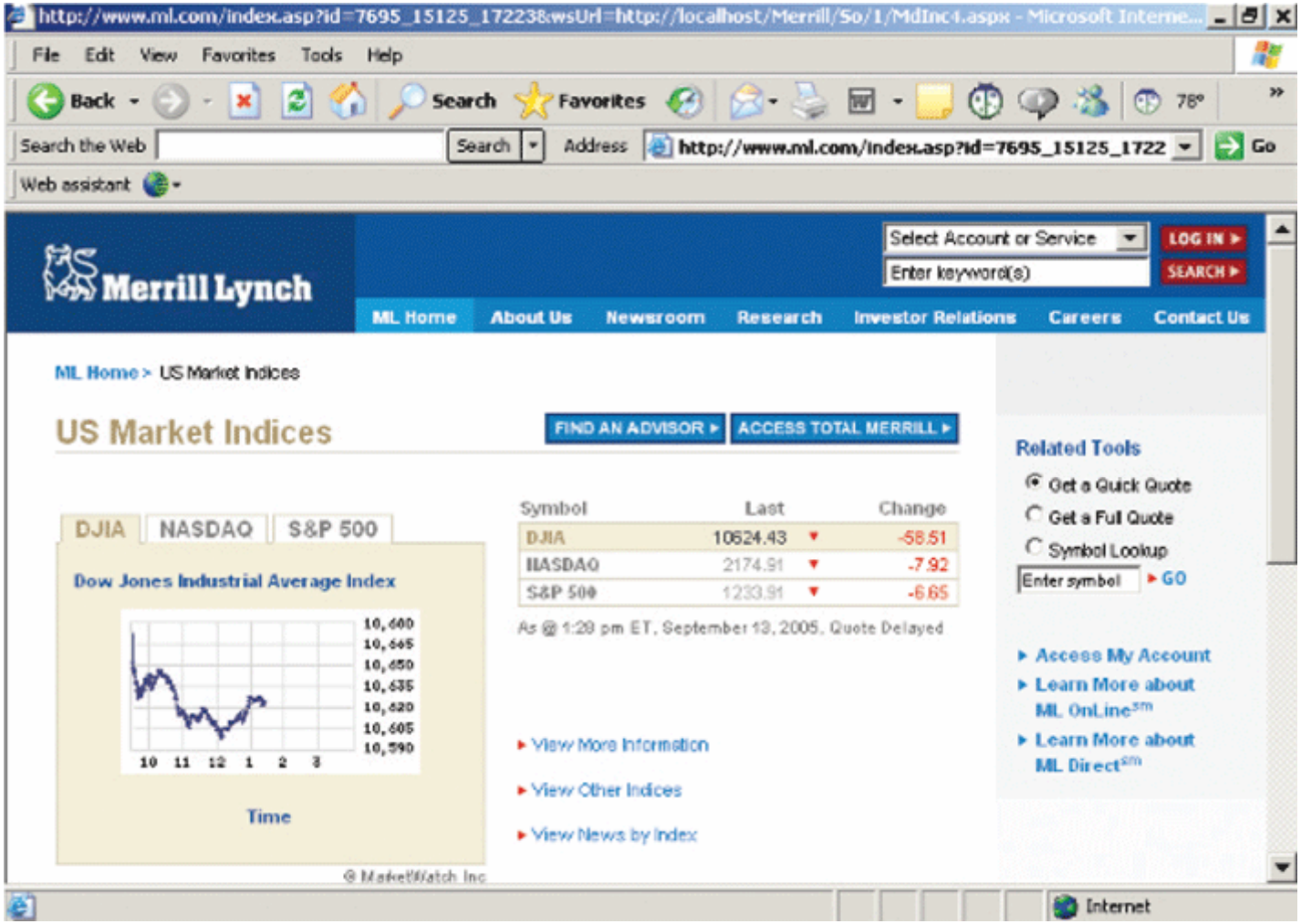
Series Id: WPUSOP3000
Not Seasonally Adjusted
Group: Stage of processing
Item: Finished goods
Base Date: 8200

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	126.6	126.9	127.1	127.6	128.1	128.2	128.2	128.1	127.9	128.7	128.7	129.1	127.9
1996	129.4	129.4	130.1	130.6	131.1	131.7	131.5	131.9	131.8	132.7	132.6	132.7	131.3
1997	132.6	132.2	132.1	131.6	131.6	131.6	131.3	131.7	131.8	132.3	131.7	131.1	131.8
1998	130.3	130.2	130.1	130.4	130.6	130.7	131.0	130.7	130.6	131.4	130.9	131.1	130.7
1999	131.4	130.8	131.1	131.9	132.4	132.7	132.9	133.7	134.7	135.1	134.9	134.9	133.0
2000	134.7	136.0	136.8	136.7	137.3	138.6	138.6	138.2	139.4	140.1	140.0	139.7	138.0
2001	141.2	141.4	140.9	141.8	142.7	142.2	140.5	140.9	141.6	139.7	138.3	137.4	140.7
2002	137.4	137.7	138.7	138.8	138.6	139.0	138.8	138.8	139.1	140.7	139.7	139.0	138.9
2003	140.8	142.3	144.2	142.1	142.0	143.0	143.0	143.7	144.0	145.5	144.5	144.5	143.3
2004	145.4	145.3	146.3	147.3	148.9	148.7	148.5	148.5	148.7	152.0	151.7	150.6	148.5
2005	151.4	152.1	153.6	154.4	154.1(P)	154.0(P)	155.4(P)	156.1(P)					

P : Preliminary. All indexes are subject to revision four months after original publication.

Dow Jones Industrial Average (DJIA)

- DJIA is an index of stock prices, but perhaps it would be better to say it is an “indicator” rather than an index.
- It is supposed to be the mean price of 30 specific industrial stocks.
- However, summing the 30 stock prices and dividing by 30 does not calculate its value. This is because of stock splits, mergers, and stocks being added or dropped.
- When changes occur, adjustments are made in the denominator used with the average.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File Edit View Favorites Tools Help
Back Search Favorites
Search the Web Search Address http://www.ml.com/index.asp?id=7695_15125_1722 Go
Web assistant
Merrill Lynch
Select Account or Service
LOG IN
Enter keyword(s)
SEARCH
ML Home About Us Newsroom Research Investor Relations Careers Contact Us
ML Home > US Market Indices
US Market Indices
FIND AN ADVISOR
ACCESS TOTAL MERRILL
DJIA NASDAQ S&P 500
Dow Jones Industrial Average Index
10,660
10,645
10,650
10,635
10,620
10,605
10,590
10 11 12 1 2 3
Time
Symbol Last Change
DJIA 10624.43 -58.51
NASDAQ 2174.91 -7.92
S&P 500 1233.91 -6.65
As @ 1:29 pm ET, September 13, 2005. Quote Delayed
View More Information
View Other Indices
View News by Index
Related Tools
Get a Quick Quote
Get a Full Quote
Symbol Lookup
Enter symbol
GO
Access My Account
Learn More about ML OnLine℠
Learn More about ML Direct℠
Internet

CPI Uses

- 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 is an economic indicator of the rate of inflation in the United States.
- It computes real income: real income = money income/CPI X (100)

CPI Uses - Formulas

REAL INCOME

$$\text{Real income} = \frac{\text{Money income}}{\text{CPI}} \times 100 \qquad \textbf{[15–8]}$$

USING AN INDEX AS A DEFLATOR

$$\text{Deflated sales} = \frac{\text{Actual sales}}{\text{An appropriate index}} \times 100 \qquad \textbf{[15–9]}$$

USING AN INDEX TO FIND PURCHASING POWER

$$\text{Purchasing power of dollar} = \frac{\$1}{\text{CPI}} \times 100 \qquad \textbf{[15–10]}$$

End of Chapter 15