15

Index Numbers

Learning Objectives

When you have completed this chapter, you will be able to:

LO1 Compute and interpret a simple index.

LO2 Describe the difference between a weighted and an unweighted index.

LO3 Compute and interpret a Laspeyres price index.

LO4 Compute and interpret a Paasche price index.

LO5 Compute and interpret a value index.

LO6 Explain how the Consumer Price Index is constructed and interpreted.

Information on prices and quantities for margarine, shortening, milk, and potato chips for the years 2000 and 2009 is provided in Exercise 27. Compute a simple price index for each of the four items, using 2000 as the base period. (See Exercise 27 and LO1.)

15.1 Introduction

In this chapter, we will examine a useful descriptive tool called an **index.** An index expresses the relative change in a value from one period to another. No doubt you are familiar with indexes such as the **Consumer Price Index,** which is released monthly by the U.S. Department of Labor. There are many other indexes, such as the **Dow Jones Industrial Average** (DJIA), **Nasdaq, NIKKEI 225,** and **Standard & Poor's 500 Stock Average.** Indexes are published on a regular basis by the federal government, by business publications such as *BusinessWeek* and *Forbes,* in most daily newspapers, and on the Internet.

Of what importance is an index? Why is the Consumer Price Index so important and so widely reported? As the name implies, it measures the change in the price of a large group of items consumers purchase. The Federal Reserve Board, consumer groups, unions, management, senior citizens organizations, and others in business and economics are very concerned about changes in prices. These groups closely monitor the Consumer Price Index as well as the **Producer Price Index,** which measures price fluctuations at all stages of production. To combat sharp price increases, the Federal Reserve often raises the interest rate to "cool down" the economy. Likewise, the Dow Jones Industrial Average, which is updated continuously during the business day, describes the overall change in common stock prices of 30 large companies.

A few stock market indexes appear daily in the financial section of most newspapers. Many are reported in real time such as in the business section of *USA Today*'s website (http://www.usatoday.com/money/default.htm). Shown below are the Dow Jones Industrial Average, Nasdaq, and S&P 500 from the *USA Today* website.

Market Summary

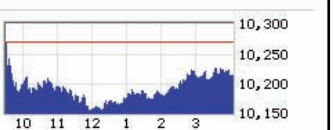
Latest Market Numbers

Index	Last	Change	% change	YTD
DOW	10,213.62	-57.59	-0.56%	-2.06%
NASDAQ	2,179.76	0.81	0.04%	-3.94%
S&P 500	1,071.69	-3.94	-0.37%	-3.89%

Quotes as of 5:16 PM ET ©Interactive Data

Stock Indexes

- Dow Jones
- Nasdaq
- S&P 500
- USA TODAY Internet 50



15.2 Simple Index Numbers

LO1 Compute and interpret a simple index.

What is an index number? An index or index number measures the change in a particular item (typically a product or service) between two time periods.

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

If the index number is used to measure the relative change in just one variable, such as hourly wages in manufacturing, we refer to this as a simple index. It is the ratio of two variables converted to a percentage. The following four examples will serve to illustrate the use of index numbers. As noted in the definition, the main use of an index number in business is to show the percent change in one or more items from one time period to another.

Example

According to the Bureau of Labor Statistics, in 2000 the average hourly earnings of production workers was $14.02. In 2009, it was $18.62. What is the index of hourly earnings of production workers for 2009 based on 2000 data?

Solution

It is 132.81, found by:

$$P = \frac{\text{Average hourly earnings in 2009}}{\text{Average hourly earnings in 2000}}(100) = \frac{\$18.62}{\$14.02}(100) = 132.81$$

Thus, the hourly earnings in 2009 compared to 2000 were 132.81 percent. This means there was a 32.81 percent increase in hourly earnings during the period, found by $132.81 - 100.0 = 32.81$.

You can check the latest information on wages, the Consumer Price Indexes, and other business-related values at the Bureau of Labor Statistics (BLS) website, http://www.bls.gov. The following chart shows some statistics from the BLS.

Example

An index can also compare one item with another. The population of the Canadian province of British Columbia in 2010 was 4,494,232, and for Ontario it was 13,069,182. What is the population index of British Columbia compared to Ontario?

Solution

The index of population for British Columbia is 34.4, found by:

$$P = \frac{\text{Population of British Columbia}}{\text{Population of Ontario}}(100) = \frac{4{,}494{,}232}{13{,}069{,}182}(100) = 34.4$$

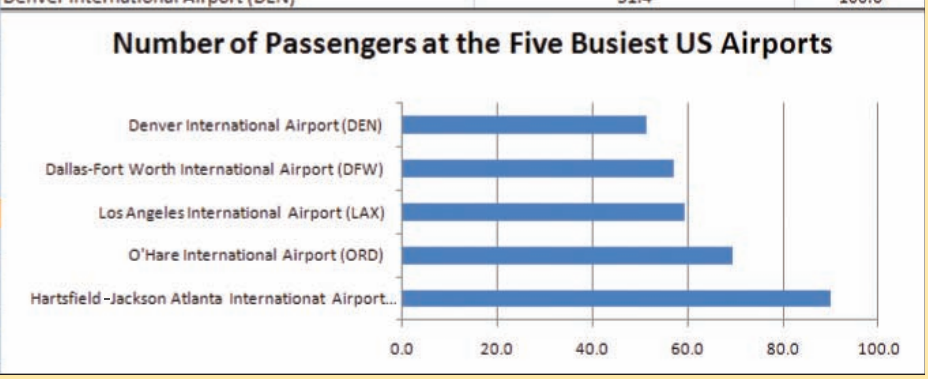
This indicates that the population of British Columbia is 34.4 percent (about one-third) of the population of Ontario, or the population of British Columbia is 65.6 percent less than the population of Ontario ($100 - 34.4 = 65.6$).

Example

The following Excel output shows the number of passengers (in millions) for the five busiest airports in the United States in 2009. What is the index for Atlanta, Chicago, Los Angeles, and Dallas/Ft. Worth compared to Denver?

Airport Indices

	A	B	C
1	Airport	Number of Passengers (millions)	Index
2	Hartsfield-Jackson Atlanta Internationat Airport (ATL)	90.0	175.1
3	O'Hare International Airport (ORD)	69.3	134.8
4	Los Angeles International Airport (LAX)	59.5	115.8
5	Dallas-Fort Worth International Airport (DFW)	57.0	110.9
6	Denver International Airport (DEN)	51.4	100.0



Solution

To find the four indexes, we divide the passengers for Atlanta, Chicago, Los Angeles, and Dallas/Ft. Worth by the number at Denver. We conclude that Atlanta had 75.1 percent more passengers than Denver, Chicago 34.8 percent more, Los Angeles 15.8 percent more, and Dallas/Ft. Worth 10.9 percent more.

Airport	Number of Passengers (millions)	Index	Found by
Hartsfield-Jackson Atlanta International Airport (ATL)	90.0	175.1	(90.0/51.4)(100)
O'Hare International Airport (ORD)	69.3	134.8	(69.3/51.4)(100)
Los Angeles International Airport (LAX)	59.5	115.8	(59.5/51.4)(100)
Dallas-Fort Worth International Airport (DFW)	57.0	110.9	(57.0/51.4)(100)
Denver International Airport (DEN)	51.4	100.0	(51.4/51.4)(100)

Note from the previous discussion that:

1. The index of average hourly earnings of production workers (132.81) is a percentage, but the percent symbol is usually omitted.
2. Each index has a **base period.** In the example regarding the average hourly earnings of production workers, we used 2000 as the base period. The base period for the Consumer Price Index is 1993–95. The parity ratio, which is the ratio of the prices received by farmers to the prices paid by farmers, still has 1910–14 as the base period.
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.

15.3 Why Convert Data to Indexes?

Indexes allow us to express a change in price, quantity, or value as a percent.

Compiling index numbers is not a recent innovation. An Italian, G. R. Carli, is credited with originating index numbers in 1764. They were incorporated in a report he made regarding price fluctuations in Europe from 1500 to 1750. No systematic approach to collecting and reporting data in index form was evident in the United States until about 1900. The cost-of-living index (now called the Consumer Price Index) was introduced in 1913, and a long list of indexes has been compiled since then.

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, the estimate of U.S. retail e-commerce sales for the fourth quarter of 2010, adjusted for seasonal variation, was $36,200,000. e-Commerce sales for the fourth quarter of 2009 was $30,700,000. This is an increase of $5,500,000. If e-commerce sales for the fourth quarter of 2010 are expressed as an index based on the fourth quarter of 2009, the increase is 17.9 percent.

$$\frac{\text{4th qtr 2010 e-commerce sales}}{\text{4th qtr 2009 e-commerce sales}}(100) = \frac{\$36{,}200{,}000}{\$30{,}700{,}000}(100) = 117.9$$

15.4 Construction of Index Numbers

We already discussed the construction of a simple price index. The price in a selected year (such as 2010) is divided by the price in the base year. The base-period price is designated as p_0, and a price other than the base period is often referred to as the *given period* or *selected period* and designated p_t. To calculate the simple price index P using 100 as the base value for any given period, use the formula:

SIMPLE INDEX

$$P = \frac{p_t}{p_0} \times 100 \qquad \textbf{[15–1]}$$

Suppose the price of a fall weekend package (including lodging and all meals) at Tryon Mountain Lodge in western North Carolina in 2000 was $450. The price rose to $795 in 2010. What is the price index for 2010 using 2000 as the base period and 100 as the base value? It is 176.7, found by:

$$P = \frac{p_t}{p_0}(100) = \frac{\$795}{\$450}(100) = 176.7$$

Interpreting this result, the price of the fall weekend package increased 76.7 percent from 2000 to 2010.

The base period need not be a single year. Note in Table 15–1 that if we use 2000–01 = 100, the base price for the stapler would be $21 [found by determining the mean price of 2000 and 2001, ($20 + $22)/2 = $21]. The prices $20, $22, and $23 are averaged if 2000–02 is selected as the base. The mean price would be $21.67. The indexes constructed using the three different base periods

are presented in Table 15–1. (Note that when 2000–02 = 100, the index numbers for 2000, 2001, and 2002 average 100.0, as we would expect.) Logically, the index numbers for 2010 using the three different bases are not the same.

TABLE 15–1 Prices of a Benson Automatic Stapler, Model 3, Converted to Indexes Using Three Different Base Periods

Year	Price of Stapler	Price Index (2000 = 100)	Price Index (2000–01 = 100)	Price Index (2000–02 = 100)
1995	$18	90.0	$\frac{18}{21} \times 100 = 85.7$	$\frac{18}{21.67} \times 100 = 83.1$
2000	20	100.0	$\frac{20}{21} \times 100 = 95.2$	$\frac{20}{21.67} \times 100 = 92.3$
2001	22	110.0	$\frac{22}{21} \times 100 = 104.8$	$\frac{22}{21.67} \times 100 = 101.5$
2002	23	115.0	$\frac{23}{21} \times 100 = 109.5$	$\frac{23}{21.67} \times 100 = 106.1$
2010	38	190.0	$\frac{38}{21} \times 100 = 181.0$	$\frac{38}{21.67} \times 100 = 175.4$

Self-Review 15–1

1. Listed below are the top steel-producing regions for the year 2009. Express the amount produced by China, the European Union, Japan, and Russia as an index, using the United States as a base. What percent more steel does China produce than the United States?

Region	Amount (millions of tons)
People's Republic of China	500.5
European Union	198.0
Japan	118.7
United States	91.4
Russia	68.5

2. The average hourly earnings of production workers for January of selected years are given below.

Year	Average Hourly Earnings
1995	$11.65
2000	14.02
2005	16.13
2010 (May)	19.01

(a) Using 1995 as the base period and 100 as the base value, determine the indexes for the other years. Interpret the index.
(b) Use the average of 1995 and 2000 as the base and determine indexes for the other years. Interpret the index.

Exercises

connect™

1. PNC Bank Inc., which has its headquarters in Pittsburgh, reported $17,446 (million) in commercial loans in 1995, $19,989 in 1997, $21,468 in 1999, $21,685 in 2000, $15,922 in 2002, $18,375 for 2004, and $54,818 in 2009. Using 1995 as the base, develop a simple

index for the change in the amount of commercial loans for the years 1997, 1999, 2000, 2002, 2004, and 2009, based on 1995.

2. The table below reports the earnings per share of common stock for Home Depot Inc. for recent years. Develop an index, with 2001 as the base, for the change in earnings per share over the period.

Year	Earnings per Share	Year	Earnings per Share
2001	$1.29	2006	$2.63
2002	1.56	2007	2.55
2003	1.88	2008	2.27
2004	2.26	2009	0.71
2005	2.72	2010	1.70

3. Listed below are the net sales for Blair Corporation, a mail-order retailer located in Warren, Pennsylvania, for the years 1997 to 2006. In 2007, Blair became a subsidiary of Appleseed's Topco. Its website is www.blair.com. Use the mean sales for the earliest three years to determine a base and then find the index for 2003 and 2006. By how much have net sales increased from the base period?

Year	Sales (millions)	Year	Sales (millions)
1997	$486.6	2002	$568.5
1998	506.8	2003	581.9
1999	522.2	2004	496.1
2000	574.6	2005	456.6
2001	580.7	2006	433.3

4. In January 1994, the price for a whole fresh chicken was $0.899 per pound. In April 2010, the price for the same chicken was $1.230 per pound. Use the January 1994 price as the base period and 100 as the base value to develop a simple index. By what percent has the cost of chicken increased?

15.5 Unweighted Indexes

LO2 Describe the difference between a weighted and an unweighted index.

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.

Simple Average of the Price Indexes

Table 15–2 on the next page reports the prices for several food items for the years 1999 and 2009. We would like to develop an index for this group of food items for 2009, using 1999 as the base. This is written in the abbreviated code 1999 = 100.

We could begin by computing a **simple average of the price indexes** for each item, using 1999 as the base year and 2009 as the given year. The simple index for bread is 147.1, found by using formula (15–1).

$$P = \frac{p_t}{p_0}(100) = \frac{1.28}{.87}(100) = 147.1$$

We compute the simple index for the other items in Table 15–2 similarly. The largest price increase was for eggs, 106.7 percent, and bread was second with 47.1 percent.

TABLE 15–2 Computation of Index for Food Price 2009, 1999 = 100

Item	1999 Price	2009 Price	Simple Index
Bread, white, cost per pound	$ 0.87	$ 1.28	147.1
Eggs, dozen	1.05	2.17	206.7
Milk, gallon, white	2.94	3.87	131.6
Apples, Red Delicious, 1 pound	0.86	1.16	134.9
Orange Juice, 12 oz concentrate	1.75	2.54	145.1
Coffee, 100% ground roast, 1 pound	3.43	3.68	107.3
Total	$10.90	$14.70	

The price of coffee increased 7.3 percent, found by 107.3 − 100 = 7.3. Then it would be natural to average the simple indexes. The formula is:

SIMPLE AVERAGE OF THE PRICE RELATIVES

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

where P_i refers to the simple index for each of the items and n the number of items. In our example, the index is 145.5, found by:

$$P = \frac{\Sigma P_i}{n} = \frac{147.1 + \cdots + 107.3}{6} = \frac{872.7}{6} = 145.5$$

This indicates that the mean of the group of indexes increased 45.5 percent from 1999 to 2009.

A positive feature of the simple average of price indexes is that we would obtain the same value for the index regardless of the units of measure. In the above index, if apples were priced in tons, instead of pounds, the impact of apples on the combined index would not change. That is, the commodity "apples" represents one of six items in the index, so the impact of the item is not related to the units. A negative feature of this index is that it fails to consider the relative importance of the items included in the index. For example, milk and eggs receive the same weight, even though a typical family might spend far more over the year on milk than on eggs.

Simple Aggregate Index

A second possibility is to sum the prices (rather than the indexes) for the two periods and then determine the index based on the totals. The formula is:

SIMPLE AGGREGATE INDEX

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

This is called a **simple aggregate index.** The index for the above food items is found by summing the prices in 1999 and 2009. The sum of the prices for the base period is $10.90 and for the given period it is $14.70. The simple aggregate index is 134.9. This means that the aggregate group of prices had increased 34.9 percent in the 10-year period.

$$P = \frac{\Sigma p_t}{\Sigma p_0}(100) = \frac{\$14.70}{\$10.90}(100) = 134.9$$

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 tons rather than pounds.

Also, note the effect of coffee on the total index. For both the current year and the base year, coffee is a significant contributor to the total index, so a change in the price of coffee will drive the index much more than any other item. Therefore, we need a way to appropriately "weight" the items according to their relative importance.

15.6 Weighted Indexes

Two methods of computing a **weighted price index** are the **Laspeyres** method and the **Paasche** method. They differ only in the period used for weighting. The Laspeyres method uses *base-period weights;* that is, the original prices and quantities of the items bought are used to find the percent change over a period of time in either price or quantity consumed, depending on the problem. The Paasche method uses *current-year weights*.

Laspeyres Price Index

Etienne Laspeyres developed a method in the latter part of the 18th century to determine a weighted price index using base-period quantities as weights. Applying his method, a weighted price index is computed by:

LO3 Compute and interpret a Laspeyres price index.

LASPEYRES PRICE INDEX

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

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.

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 1999 and 2009.

TABLE 15–3 Price and Quantity of Food Items in 1999 and 2009

Item	1999 Price	1999 Quantity	2009 Price	2009 Quantity
Bread, white, cost per pound	$0.87	50	$1.28	55
Eggs, dozen	1.05	26	2.17	20
Milk, gallon, white	2.94	102	3.87	130
Apples, Red Delicious, 1 pound	0.86	30	1.16	40
Orange Juice, 12 oz concentrate	1.75	40	2.54	41
Coffee, 100% ground roast, 1 pound	3.43	12	3.68	12

Determine a weighted price index using the Laspeyres method. Interpret the result.

Solution

First we determine the total amount spent for the six items in the base period, 1999. To find this value, we multiply the base period price for bread ($0.87) by the base period quantity of 50. The result is $43.50. This indicates that a total of $43.50 was spent in the base period on bread. We continue that for all items and total the results. The base period total is $507.64. The current period total is computed in a similar fashion. For the first item, bread, we multiply the quantity in 1999 by the

price of bread in 2009, that is, $1.28(50). The result is $64.00. We make the same calculation for each item and total the result. The total is $695.72. Because of the repetitive nature of these calculations, a spreadsheet is effective for carrying out the calculations. Following is a copy of the Excel output.

Food data [Compatibility Mode]

	A	B	C	D	E	F	G	H	I
1		Laspeyres Index							
2	Item	1999 Price	1999 Quantity		99 Price * '99 Quantity		2009 price		09 Price * '99 Quantity
3	Bread, white, cost per pound	$ 0.87	50		$ 43.50		$ 1.28		$ 64.00
4	Eggs, dozen	$ 1.05	26		$ 27.30		$ 2.17		$ 56.42
5	Milk, gallon, white	$ 2.94	102		$ 299.88		$ 3.87		$ 394.74
6	Apples, Red Delicious, 1 pound	$ 0.86	30		$ 25.80		$ 1.16		$ 34.80
7	Orange Juice, 12 oz concentrate	$ 1.75	40		$ 70.00		$ 2.54		$ 101.60
8	Coffee, 100% ground roast, 1 pound	$ 3.43	12		$ 41.16		$ 3.68		$ 44.16
9					$ 507.64				$ 695.72
10							P = 137.0		
11									

The weighted price index for 2009 is 137.0, found by

$$P = \frac{\Sigma p_t q_0}{\Sigma p_0 q_0}(100) = \frac{\$695.72}{\$507.64}(100) = 137.0$$

Based on this analysis, we conclude that the price of this group of items has increased 37.0 percent in the ten-year period. The advantage of this method over the simple aggregate index is that the weight of each of the items is considered. In the simple aggregate index, coffee had about 40 percent of the weight in determining the index. In the Laspeyres index, the item with the most weight is milk, because the product of the price and the units sold is the largest.

Paasche Price Index

LO4 Compute and interpret a Paasche price index.

The major disadvantage of the Laspeyres index is it assumes that the base-period quantities are still realistic in the given period. That is, the quantities used for the six items are about the same in 1999 as 2009. In this case, notice that the quantity of eggs purchased declined by 23 percent, the quantity of milk increased by nearly 28 percent, and the quantity of apples increased by 33 percent.

The Paasche index is an alternative. The procedure is similar, but instead of using base-period quantities as weights, we use current-period quantities as weights. We use the sum of the products of the 1999 prices and the 2009 quantities. This has the advantage of using the more recent quantities. If there has been a change in the quantities consumed since the base period, such a change is reflected in the Paasche index.

PAASCHE PRICE INDEX

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

Example

Use the information from Table 15–3 to determine the Paasche index. Discuss which of the indexes should be used.

Solution

Again, because of the repetitive nature of the calculations, Excel is used to perform the calculations. The results are shown in the following output.

Food data [Compatibility Mode]

	A	B	C	D	E	F	G	H	I
1		Paasche Index							
2		1999 Price	2009 Quantity		99 Price * '09 Quantity		2009 Price		09 Price * '09 Quantity
3	Bread, white, cost per pound	$ 0.87	55		$ 47.85		$ 1.28		$ 70.40
4	Eggs, dozen	$ 1.05	20		$ 21.00		$ 2.17		$ 43.40
5	Milk, gallon, white	$ 2.94	130		$ 382.20		$ 3.87		$ 503.10
6	Apples, Red Delicious, 1 pound	$ 0.86	40		$ 34.40		$ 1.16		$ 46.40
7	Orange Juice, 12 oz concentrate	$ 1.75	41		$ 71.75		$ 2.54		$ 104.14
8	Coffee, 100% ground roast, 1 pound	$ 3.43	12		$ 41.16		$ 3.68		$ 44.16
9					$ 598.36				$ 811.60
10							1.35637		

The Paasche index is 135.6, found by

$$P = \frac{\Sigma p_t q_t}{\Sigma p_0 q_t}(100) = \frac{\$811.60}{\$598.36}(100) = 135.6$$

This result indicates that there has been an increase of 35.6 percent in the price of this "market basket" of goods between 1999 and 2009. That is, it costs 35.6 percent more to purchase these items in 2009 than it did in 1999. The Laspeyres index is more widely used because there are fewer pieces of data to update each period. The Consumer Price Index, the most widely reported index, is an example of a Laspeyres index.

How do we decide which index to use? 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.

Fisher's Ideal Index

As noted earlier, 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. In an attempt to offset these 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. We described the geometric mean in Chapter 3. It is determined by taking the *k*th root of the product of *k* positive numbers.

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

Fisher's index seems to be theoretically ideal because it combines the best features of both Laspeyres' and Paasche's. That is, it balances the effects of the two indexes. However, it is rarely used in practice because it has the same basic set of problems as the Paasche index. It requires that a new set of quantities be determined for each period.

Example

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

Solution

Fisher's ideal index is 136.3.

$$\text{Fisher's ideal index} = \sqrt{(\text{Laspeyres' index})(\text{Paasche's index})}$$
$$= \sqrt{(137.0)(135.6)} = 136.3$$

Self-Review 15–2

An index of clothing prices for 2009 based on 2000 is to be constructed. The clothing items considered are shoes and dresses. The prices and quantities for both years are given below. Use 2000 as the base period and 100 as the base value.

	2000		2009	
Item	Price	Quantity	Price	Quantity
Dress (each)	$75	500	$85	520
Shoes (pair)	40	1,200	45	1,300

(a) Determine the simple average of the price indexes.
(b) Determine the aggregate price index for the two years.
(c) Determine Laspeyres' price index.
(d) Determine the Paasche price index.
(e) Determine Fisher's ideal index.

Exercises

connect

For exercises 5–8:

a. Determine the simple price indexes.
b. Determine the simple aggregate price index for the two years.
c. Determine Laspeyres' price index.
d. Determine the Paasche price index.
e. Determine Fisher's ideal index.

5. Below are the prices of toothpaste (9 oz), shampoo (7 oz), cough tablets (package of 100), and antiperspirant (2 oz) for August 2000 and August 2009. Also included are the quantity purchased. Use August 2000 as the base.

	August 2000		August 2009	
Item	Price	Quantity	Price	Quantity
Toothpaste	$2.49	6	$3.35	6
Shampoo	3.29	4	4.49	5
Cough tablets	1.59	2	4.19	3
Antiperspirant	1.79	3	2.49	4

6. Fruit prices and the amounts consumed for 2000 and 2009 are below. Use 2000 as the base.

	2000		2009	
Fruit	Price	Quantity	Price	Quantity
Bananas (pound)	$0.23	100	$0.69	120
Grapefruit (each)	0.29	50	1.00	55
Apples (pound)	0.35	85	1.89	85
Strawberries (basket)	1.02	8	3.79	10
Oranges (bag)	0.89	6	2.99	8

7. The prices and the numbers of various items produced by a small machine and stamping plant are reported below. Use 2000 as the base.

	2000		2009	
Item	Price	Quantity	Price	Quantity
Washer	$0.07	17,000	$0.10	20,000
Cotter pin	0.04	125,000	0.03	130,000
Stove bolt	0.15	40,000	0.15	42,000
Hex nut	0.08	62,000	0.10	65,000

8. Following are the quantities and prices for the years 2000 and 2009 for Kinzua Valley Geriatrics. Use 2000 as the base period.

	2000		2009	
Item	Price	Quantity	Price	Quantity
Syringes (dozen)	$ 6.10	1,500	$ 6.83	2,000
Thermometers	8.10	10	9.35	12
Advil (bottle)	4.00	250	4.62	250
Patient record forms (box)	6.00	1,000	6.85	900
Computer paper (box)	12.00	30	13.65	40

15.7 Value Index

Value index measures percent change in value

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

LO5 Compute and interpret a value index.

VALUE INDEX

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

Example

The prices and quantities sold at the Waleska Clothing Emporium for various items of apparel for May 2000 and May 2009 are:

Item	2000 Price, p_0	2000 Quantity Sold (thousands), q_0	2009 Price, p_t	2009 Quantity Sold (thousands), q_t
Ties (each)	$ 1	1,000	$ 2	900
Suits (each)	30	100	40	120
Shoes (pair)	10	500	8	500

Solution

What is the index of value for May 2009 using May 2000 as the base period?

Total sales in May 2009 were $10,600,000, and the comparable figure for 2000 is $9,000,000. (See Table 15–4.) Thus, the value index for May 2009 using 2000 = 100 is 117.8. The value of apparel sales in 2009 was 117.8 percent of the 2000 sales. To put it another way, the value of apparel sales increased 17.8 percent from May 2000 to May 2009.

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

TABLE 15–4 Construction of a Value Index for 2009 (2000 = 100)

Item	2000 Price, p_0	2000 Quantity Sold (thousands), q_0	p_0q_0 ($ thousands)	2009 Price, p_t	2009 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

Self-Review 15–3

The number of items produced by Houghton Products for 1996 and 2009 and the wholesale prices for the two periods are:

Item Produced	Price 1996	Price 2009	Number Produced 1996	Number Produced 2009
Shear pins (box)	$ 3	$4	10,000	9,000
Cutting compound (pound)	1	5	600	200
Tie rods (each)	10	8	3,000	5,000

(a) Find the value index of production for 2009 using 1996 as the base period.
(b) Interpret the index.

Exercises

connect

9. The prices and production of grains for August 1995 and August 2009 are listed on the following page.

Grain	1995 Price	1995 Quantity Produced (millions of bushels)	2009 Price	2009 Quantity Produced (millions of bushels)
Oats	$1.52	200	$5.95	214
Wheat	2.10	565	9.80	489
Corn	1.48	291	6.00	203
Barley	3.05	87	3.29	106

Using 1995 as the base period, find the value index of grains produced for August 2009.

10. Johnson Wholesale Company manufactures a variety of products. The prices and quantities produced for April 1994 and April 2009 are:

Product	1994 Price	2009 Price	1994 Quantity Produced	2009 Quantity Produced
Small motor (each)	$23.60	$28.80	1,760	4,259
Scrubbing compound (gallon)	2.96	3.08	86,450	62,949
Nails (pound)	0.40	0.48	9,460	22,370

Using April 1994 as the base period, find the value index of goods produced for April 2009.

15.8 Special-Purpose Indexes

Many important indexes are prepared and published by private organizations. J. D. Power & Associates surveys automobile purchasers to determine how satisfied customers are with their vehicle after one year of ownership. This special index is called the *Consumer Satisfaction Index.* Financial institutions, utility companies, and university research centers often prepare indexes on employment, factory hours and wages, and retail sales for the regions they serve. Many trade associations prepare indexes of price and quantity that are vital to their particular area of interest. How are these special indexes prepared? An example, simplified of course, will help to explain some of the details.

Example

The Seattle Chamber of Commerce wants to develop a measure of general business activity for the northwest portion of the United States. The director of economic development has been assigned to develop the index. It will be called the *General Business Activity Index of the Northwest.*

Solution

After considerable thought and research, the director has concluded that four factors should be considered: the regional department store sales (which are reported in $ millions), the regional employment index (which has a 2000 base and is reported by the State of Washington), the freight car loadings (reported in millions), and exports for the Seattle Harbor (reported in thousands of tons). Recent information on these variables is reported in Table 15–5.

TABLE 15–5 Data for the Computation of the General Business Activity Index of the Northwest

Year	Department Store Sales	Index of Employment	Freight Car Loadings	Exports
1999	20	100	50	500
2004	41	110	30	900
2009	44	125	18	700

After review and consultation, the director assigned weights of 40 percent to department store sales, 30 percent to employment, 10 percent to freight car loadings, and 20 percent to exports.

To develop the General Business Activity Index of the Northwest for 2009 using 1999 = 100, each 2009 value is expressed as a percentage, with the base-period value as the denominator. For illustration, department store sales for 2009 are converted to a percentage by ($44/$20)(100) = 220. This means that department store sales have increased 120 percent in the period. This percentage is then multiplied by the appropriate weight. For the department store sales, this is (220)(.40) = 88.0. The details of the calculations for the years 2004 and 2009 are shown below.

	2004		2009	
Department store sales	($41/$20)(100)(.40) =	82.0	($44/$20)(100)(.40) =	88.0
Employment	(110/100)(100)(.30) =	33.0	(125/100)(100)(.30) =	37.5
Freight car loadings	(30/50)(100)(.10) =	6.0	(18/50)(100)(.10) =	3.6
Exports	(900/500)(100)(.20) =	36.0	(700/500)(100)(.20) =	28.0
Total		157.0		157.1

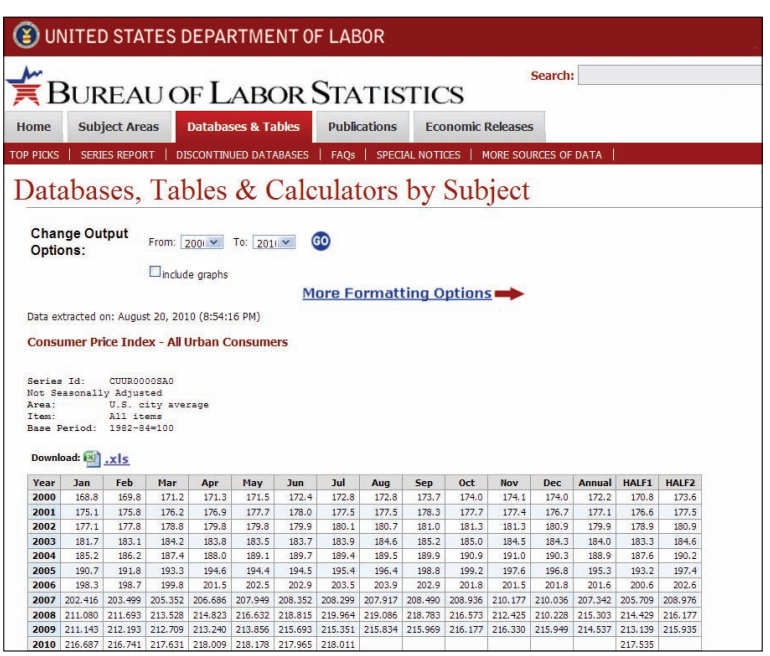
The General Business Activity Index of the Northwest for 2004 is 157.0 and for 2009 it is 157.1. Interpreting, business activity has increased 57.0 percent from 1999 to 2004 and 57.1 percent from the base period of 1999 to 2009.

As we stated at the start of the section, there are many special-purpose indexes. Here are a few examples.

Consumer Price Index

LO6 Explain how the Consumer Price Index is constructed and interpreted.

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. We discuss its history in detail and present some applications in the next section. You can access this information by going to www.bls.gov, then under **Inflation & Prices** select **Consumer Price Index,** then select **CPI databases,** then select **All Urban Consumers (Current Series), Top Picks,** and then click on **U.S. all items 1982–84 = 100.** You may elect to include different periods. Following is a recent summary report.


UNITED STATES DEPARTMENT OF LABOR

BUREAU OF LABOR STATISTICS

Search:

Home | Subject Areas | Databases & Tables | Publications | Economic Releases

TOP PICKS | SERIES REPORT | DISCONTINUED DATABASES | FAQs | SPECIAL NOTICES | MORE SOURCES OF DATA

Databases, Tables & Calculators by Subject

Change Output Options: From: 2001 To: 2011 GO

include graphs

More Formatting Options

Data extracted on: August 20, 2010 (8:54:16 PM)

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

Download: .xls

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	HALF1	HALF2
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	196.4	198.8	199.2	197.6	196.8	195.3	193.2	197.4
2006	198.3	198.7	199.8	201.5	202.5	202.9	203.5	203.9	202.9	201.8	201.5	201.8	201.6	200.6	202.6
2007	202.416	203.499	205.352	206.686	207.949	208.352	208.299	207.917	208.490	208.936	210.177	210.036	207.342	205.709	208.976
2008	211.080	211.693	213.528	214.823	216.632	218.815	219.964	219.086	218.783	216.573	212.425	210.228	215.303	214.429	216.177
2009	211.143	212.193	212.709	213.240	213.856	215.693	215.351	215.834	215.969	216.177	216.330	215.949	214.537	213.139	215.935
2010	216.687	216.741	217.631	218.009	218.178	217.965	218.011							217.535	

Producer 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. To access this information, go to www.bls.gov, then **Inflation & Prices.** Select **Producer Price Indexes,** then select **PPI databases,** then select **Commodity Data, Top Picks,** and finally select **Finished Goods.** You may select to include different periods. Below is a recent output.

UNITED STATES DEPARTMENT OF LABOR

BUREAU OF LABOR STATISTICS

Home | Subject Areas | Databases & Tables | Publications | Economic Releases

TOP PICKS | SERIES REPORT | DISCONTINUED DATABASES | FAQs | SPECIAL NOTICES | MORE SOURCES OF DATA |

Databases, Tables & Calculators by Subject

Change Output Options: From: 2000 To: 2010 GO

include graphs

More Formatting Options

Data extracted on: August 20, 2010 (9:06:16 PM)

Producer Price Index-Commodities

Series Id: WPUSOP3000
Not Seasonally Adjusted
Group: Stage of processing
Item: Finished goods
Base Date: 198200

Download: .xls

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
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	154.3	154.2	155.5	156.3	158.9	160.9	158.3	158.7	155.7
2006	159.9	158.0	159.1	160.7	161.2	161.8	161.7	162.3	160.3	158.9	159.8	160.5	160.4
2007	160.1	161.8	164.1	165.9	167.5	167.2	168.5	166.1	167.4	168.6	171.4	170.4	166.6
2008	172.0	172.3	175.1	176.5	179.8	182.4	185.1	182.2	182.2	177.4	172.0	168.8	177.1
2009	170.4	169.9	169.1	170.3	171.1	174.3	172.4	174.2	173.2	173.8	175.7(R)	176.0	172.5
2010	178.0	177.0	179.1	179.6(P)	180.1(P)	179.1(P)	179.7(P)						

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

Dow Jones Industrial Average (DJIA)

This 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. Today the DJIA is more of a psychological indicator than a representation of the general price movement on the New York Stock Exchange. The lack of representativeness of the stocks on the DJIA is one of the reasons for the development of the **New York Stock Exchange Index.** This index was developed as an average price of *all* stocks on the New York Stock Exchange. You can find more information about the DJIA by going to the website: www.dowjones.com and select **The Company,** then select about **Dow Jones;** finally, under Enterprise Media Group, select **Dow Jones Indexes.** You can find its current value as well as the 30 stocks that are now a part of its calculation. The chart below summarizes the DJIA for one day. It can be located at the Merrill Lynch website: www.ml.com.

S&P 500 Index

The full name of this index is the Standard and Poor's Composite Index of Stock Prices. It is an aggregate price index of 500 common stocks. It, too, is probably a better reflection of the market than is the DJIA. You can access information about the S&P 500 from the Merrill Lynch website. Below is a recent summary.

There are many other indexes that track business and economic behavior, such as the Nasdaq, the Russell 2000, and the Wilshire 5000.

Self-Review 15–4

As an intern in the Fulton County Economic Development Office, you have been asked to develop a special-purpose index for your county. Three economic series seem to hold promise as the basis of an index. These data are the price of cotton (per pound), the number of new automobiles sold in the county, and the rate of money turnover (published by the local bank). After discussing the project with your supervisor and the director, you decide that money turnover should have a weight of .60, the number of new automobiles sold a weight of .30, and the cotton price .10. The base period is 1999.

Year	Cotton Price	Automobiles Sold	Money Turnover
1999	$0.20	1,000	80
2004	0.25	1,200	90
2009	0.50	900	75

(a) Construct the index for 2004 and 2009.
(b) Interpret the index for 2004 and 2009.

Exercises

connect™

11. The index of leading economic indicators, compiled and published by the U.S. National Bureau of Economic Research, is composed of 12 time series, such as the average work hours of production in manufacturing, manufacturers' new orders, and money supply. This index and similar indexes are designed to move up or down before the economy begins to move the same way. Thus, an economist has statistical evidence to forecast future trends.

You want to construct a leading indicator for Erie County in upstate New York. The index is to be based on 2000 data. Because of the time and work involved, you decide to use only four time series. As an experiment, you select these four series: unemployment in the county, a composite index of county stock prices, the County Price Index, and retail sales. Here are the figures for 2000 and 2009.

	2000	2009
Unemployment rate (percent)	5.3	6.8
Composite county stocks	265.88	362.26
County Price Index (1982 = 100)	109.6	125.0
Retail sales ($ millions)	529,917.0	622,864.0

The weights you assign are: unemployment rate 20 percent, stock prices 40 percent, County Price Index 25 percent, and retail sales 15 percent.

a. Using 2000 as the base period, construct a leading economic indicator for 2009.
b. Interpret your leading index.

12. You are employed by the state bureau of economic development. There is a demand for a leading economic index to review past economic activity and to forecast future economic trends in the state. You decide that several key factors should be included in the index: number of new businesses started during the year, number of business failures, state income tax receipts, college enrollment, and the state sales tax receipts. Here are the data for 2000 and 2009.

	2000	2009
New businesses	1,088	1,162
Business failures	627	520
State income tax receipts ($ millions)	191.7	162.6
College student enrollment	242,119	290,841
State sales tax ($ millions)	41.6	39.9

a. Decide on the weights to be applied to each item in the leading index.
b. Compute the leading economic indicator for 2009.
c. Interpret the indexes.

15.9 Consumer Price Index

There are two consumer price indexes.

Frequent mention has been made of the Consumer Price Index (CPI) in the preceding pages. It measures the change in price of a fixed market basket of goods and services from one period to another. In January 1978, the Bureau of Labor Statistics began publishing CPIs for two groups of the population. One index, called the Consumer Price Index—All Urban Consumers, covers about 87 percent of the total population. The other index is for urban wage earners and clerical workers and covers about 32 percent of the population.

In brief, the CPI serves several major functions. It allows consumers to determine the degree to which their purchasing power is being eroded by price increases. In that respect, it is a yardstick for revising wages, pensions, and other income payments to keep pace with changes in prices. Equally important, it is an economic indicator of the rate of inflation in the United States.

The index includes about 400 items, and about 250 agents collect price data monthly. Prices are collected from more than 21,000 retail establishments and 60,000 housing units in 91 urban areas across the country. The prices of baby cribs, bread, beer, cigars, gasoline, haircuts, mortgage interest rates, physicians' fees, taxes, and operating-room charges are just a few of the items included in what is often termed a typical "market basket" of goods and services that you purchase.

The CPI originated in 1913 and has been published regularly since 1921. The standard reference period (the base period) has been updated periodically. The current base period is 1982–84. The earlier base periods were: 1967, 1957–59, 1947–49, 1935–39, and 1925–29. Why is it necessary to change the base? Our expenditure patterns change dramatically, and these changes must be reflected in the index. The most recent revision includes consumer items, such as VCRs, home computers, and cell phones. Earlier versions of the CPI did not include these items. By changing the base, the CPI captures the most recent expenditure patterns. You may want to go to www.bls.gov, click on the **Consumer Price Index,** and read more about it.

The CPI is actually not just one index. There are Consumer Price Indexes for New York, Chicago, Seattle, and Atlanta, as well as a number of other large cities. There are also price indexes for food, apparel, medical care, and other items. A few of them are shown below, 1982–84 = 100, for December 2009.

Item	CPI-U
All items	215.949
Food and beverage	218.049
Apparel	119.357
Transportation	188.318
Medical care	379.516
Housing	215.523

A perusal of this listing shows that a weighted index of all items has increased 115.949 percent since 1982–84; medical care has increased the most, 279.516 percent; and apparel went up the least, 19.357 percent.

Statistics in Action

Does it seem that prices only increase? The Consumer Price Index, computed and reported by the U.S. Department of Labor, is a relative measure of price changes. It shows interesting price information for categories of products and services. For example, did you know that the CPI shows a decrease from 2008 to 2009 in the relative prices of personal computers and peripheral equipment? In fact, using a base of 1982–1984 = 100, the CPI for computers and peripherals is 77.960. This means that relative prices for computers and peripherals have decreased about 22 percent from the 1982–1984 base.

Special Uses of the Consumer Price Index

In addition to measuring changes in the prices of goods and services, both consumer price indexes have a number of other applications. The CPI is used to determine real disposable personal income, to deflate sales or other variables, to find the

purchasing power of the dollar, and to establish cost-of-living increases. We first discuss the use of the CPI in determining **real income.**

Real income

Real Income As an example of the meaning and computation of *real income,* assume the Consumer Price Index is presently 200 with 1982–84 = 100. Also, assume that Ms. Watts earned $20,000 per year in the base period of 1982, 1983, and 1984. She has a current income of $40,000. Note that although her *money income* has doubled since the base period of 1982–84, the prices she paid for food, gasoline, clothing, and other items have also doubled. Thus, Ms. Watts' standard of living has remained the same from the base period to the present time. Price increases have exactly offset an increase in income, so her present buying power (real income) is still $20,000. (See Table 15–6 for computations.) In general:

Money income

REAL INCOME

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

TABLE 15–6 Computation of Real Income for 1982–84 and Present Year

Year	Annual Money Income	Consumer Price Index (1982–84 = 100)	Computation of Real Income	Real Income
1982–84	$20,000	100	$\frac{\$20,000}{100}(100)$	$20,000
Present year	40,000	200	$\frac{\$40,000}{200}(100)$	20,000

Deflated income and real income are the same.

The concept of real income is sometimes called *deflated income,* and the CPI is called the *deflator.* Also, a popular term for deflated income is *income expressed in constant dollars.* Thus, in Table 15–6, to determine whether Ms. Watts' standard of living changed, her money income was converted to constant dollars. We found that her purchasing power, expressed in 1982–84 dollars (constant dollars), remained at $20,000.

Self-Review 15–5 The take-home pay of Jon Greene and the CPI for 2000 and 2009 are:

Year	Take-Home Pay	CPI (1982–84 = 100)
2000	$25,000	170.8
2009	41,200	216.6

(a) What was Jon's real income in 2000?
(b) What was his real income in 2009?
(c) Interpret your findings.

Deflated sales important for showing the trend in "real" sales

Deflating Sales A price index can also be used to "deflate" sales or similar money series. Deflated sales are determined by

USING AN INDEX AS A DEFLATOR

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

Example

The sales of Hill Enterprises, a small injection molding company in upstate New York, increased from $875,000 in 1982 to $1,482,000 in 1995, $1,491,000 in 2000, $1,502,000 in 2004, $1,515,000 in 2007, and $1,596,000 in 2009. The owner, Harry Hill, realizes that the price of raw materials used in the process has also increased over the period, so Mr. Hill wants to deflate sales to account for the increase in raw material prices. What are the deflated sales for 1995, 2000, 2004, 2007, and 2009 based on 1982 dollars? That is, what are sales for 1995, 2000, 2004, 2007, and 2009 expressed in constant 1982 dollars?

Solution

The Producer Price Index (PPI) is an index released every month and published in the *Monthly Labor Review* and is also available at the Bureau of Labor Statistics website. The prices included in the PPI reflect the prices charged the manufacturer for the metals, rubber, and other items purchased. So the PPI seems an appropriate index to use to deflate the manufacturer's sales. The manufacturer's sales are listed in the second column of Table 15–7, and the PPI for each year is in the third column. The next column shows sales divided by the PPI. The right-hand column details the calculations.

TABLE 15–7 Calculation of Deflated Sales for Hill Enterprises

Year	Sales	PPI	Constant Dollars	Found By
1982	$ 875,000.00	100.0	$ 875,000.00	($ 875,000.00/100.0)*100.0
1995	1,482,000.00	127.9	1,158,717.75	($1,482,000.00/127.9)*100.0
2000	1,491,000.00	139.0	1,072,661.87	($1,491,000.00/139.0)*100.0
2004	1,502,000.00	148.5	1,011,447.81	($1,502,000.00/148.4)*100.0
2007	1,515,000.00	166.6	909,363.75	($1,515,000.00/166.6)*100.0
2009	1,596,000.00	172.5	925,217.39	($1,596,000.00/172.5)*100.0

Sales increased from 1995 through 2009, but if we compare the sales in constant dollars, sales declined during the period. That is, deflated sales were $1,072,661.87 in 2000 but declined to $1,011,477.81 in 2004. Deflated sales declined even further to $909,363.75 in 2007. This is so because the prices Hill Enterprises paid for raw materials grew more rapidly than sales. Then, in 2009 deflated sales increased from the 2007 level.

What has happened to the purchasing power of your dollar?

Purchasing Power of the Dollar The Consumer Price Index is also used to determine the *purchasing power of the dollar.*

USING AN INDEX TO FIND PURCHASING POWER

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

Example

Suppose the Consumer Price Index this month is 200.0 (1982–84 = 100). What is the purchasing power of the dollar?

Solution

From formula (15–10), it is 50 cents, found by:

$$\text{Purchasing power of dollar} = \frac{\$1}{200.0}(100) = \$0.50$$

The CPI of 200.0 indicates that prices have doubled from the years 1982–84 to this month. Thus, the purchasing power of a dollar has been cut in half. That is, a 1982–84 dollar is worth only 50 cents this month. To put it another way, if you lost $1,000 in the period 1982–84 and just found it, the $1,000 could only buy half of what it could have bought in the years 1982, 1983, and 1984.

CPI used to adjust wages, pensions, and so on

Cost-of-Living Adjustments The Consumer Price Index (CPI) is also the basis for cost-of-living adjustments, or COLA, in many management–union contracts. The specific clause in the contract is often referred to as the "escalator clause." About 31 million Social Security beneficiaries, 2.5 million retired military and federal civil service employees and survivors, and 600,000 postal workers have their incomes or pensions pegged to the CPI.

The CPI is also used to adjust alimony and child support payments; attorneys' fees; workers' compensation payments; rentals on apartments, homes, and office buildings; welfare payments; and so on. In brief, say a retiree receives a pension of $500 a month and the CPI increases 5 points from 165 to 170. Suppose for each point that the CPI increases, the pension benefits increase 1.0 percent, so the monthly increase in benefits will be $25, found by $500 (5 points)(.01). Now the retiree will receive $525 per month.

Self-Review 15–6 Suppose the Consumer Price Index for the latest month is 195.4 (1982–84 = 100). What is the purchasing power of the dollar? Interpret.

15.10 Shifting the Base

If two or more time series have the same base period, they can be compared directly. As an example, suppose we are interested in the trend in the prices of food and beverages, housing, medical care, and so on since the base period, 1982–84. Note in Table 15–8 that all of the consumer price indexes use the same base. Hence,

TABLE 15–8 Trend in Consumer Prices to 2009 (1982–84 = 100)

Year	All Items	Food and Beverages	Housing	Apparel and Upkeep	Medical Care
1982–84	100.0	100.0	100.0	100.0	100.0
1990	130.7	132.1	128.5	124.1	162.8
1995	152.4	148.9	148.5	132.0	220.5
2000	172.2	168.4	169.6	129.6	260.8
2004	188.9	186.6	189.5	120.4	310.1
2005	195.3	191.2	195.7	119.5	323.2
2007	207.392	203.300	209.586	118.257	369.302
2009	214.537	218.249	217.057	120.078	375.613

we conclude that the price of all consumer items combined increased 114.537 percent from the base period (1982–84) to the year 2009. (Beginning with January 2007, the CPI is reported to three decimal places instead of one.) Likewise, housing prices increased 117.057 percent, medical care 375.613 percent, and so on.

A problem arises, however, when two or more series being compared do not have the same base period. The following example compares the two most widely reported business indexes, the DJIA and Nasdaq.

Example

We want to compare the price changes in the Dow Jones Industrial Average (DJIA) with the Nasdaq. The two indexes for selected periods since 1995 follow. The information is reported on July 1 of each year.

Date	DJIA	Nasdaq
1-Jul-95	4,708.47	1,001.21
1-Jul-00	10,521.98	3,766.99
1-Jul-01	10,522.81	2,027.13
1-Jul-02	8,736.59	1,328.26
1-Jul-03	9,233.80	1,735.02
1-Jul-04	10,139.71	1,887.36
1-Jul-05	10,640.91	2,184.83
1-Jul-06	11,228.02	2,190.43
1-Jul-07	13,535.43	2,632.30
1-Jul-08	11,382.26	1,875.42
1-Jul-09	8,504.06	1,845.72

Solution

From the information given, we are not sure the base periods are the same. Hence, a direct comparison is not appropriate. Because we want to compare the changes in the two business indexes, the logical approach is to let a particular year, say 1995, be the base for both indexes. For the DJIA, the base is 4,708.47, and for the Nasdaq it is 1,001.21.

The calculation of the index for the DJIA in 2005 is:

$$\textit{Index} = \frac{10{,}640.91}{4{,}708.47}(100) = 226.0$$

The following table reports the complete set of indexes.

	Comparison of DJIA and NASDAQ			
Date	DJIA	Index	NASDAQ	Index
1-Jul-95	4,708.47	100.0	1,001.21	100.0
1-Jul-00	10,521.98	223.5	3,766.99	376.2
1-Jul-01	10,522.81	223.5	2,027.13	202.5
1-Jul-02	8,736.59	185.6	1,328.26	132.7
1-Jul-03	9,233.80	196.1	1,735.02	173.3
1-Jul-04	10,139.71	215.4	1,887.36	188.5
1-Jul-05	10,640.91	226.0	2,184.83	218.2
1-Jul-06	11,228.02	238.5	2,190.43	218.8
1-Jul-07	13,535.43	287.5	2,632.30	262.9
1-Jul-08	11,382.26	241.7	2,304.97	230.2
1-Jul-09	8,504.06	180.6	1,845.72	184.3

We conclude that both indexes have increased over the period. The DJIA has increased 187.5 percent and the Nasdaq 162.9 percent for the period from July 1, 1995, until July 1, 2007. Notice that both indexes reached a peak in 2000, declined to their lowest points in 2002 and increased up to 2007. Both indexes declined in 2008 and 2009.

The following chart, obtained from the financial section of Yahoo!, is a line graph of the DJIA and Nasdaq. The vertical axis shows the percent change from the base period of June 2003 for both indexes. From this graph we conclude that both indexes reached their largest percent increase in late 2007, then declined in 2008 and 2009. Of course, if we select different periods as the base, the results may not be exactly the same.

Self-Review 15–7

(a) From the preceding example, verify that the DJIA price index for 2004, using 1995 as the base period, is 215.4.

(b) The changes in industrial production and in the prices manufacturers paid for raw materials since 1982 are to be compared. Unfortunately, the index of industrial production, which measures changes in production, and the Producer Price Index for crude materials, have different base periods. The production index has a 2002 base period, and the Producer Price Index uses 1982 as the base period. Shift the base to 2002 and make the two series comparable. Interpret.

Year	Industrial Production Index (2002 = 100)	Producer Price Index (1982 = 100)
2004	103.8	159.1
2005	107.2	182.3
2006	109.7	185.0
2007	111.3	206.9
2008	108.8	251.0

Exercises

connect™

13. In April 2008, the mean salary for a nurse manager with a bachelor's degree was $89,673. The Consumer Price Index for April 2009 was 213.240 (1982–84 = 100). The mean annual salary for a nurse in the base period of 1982–84 was $19,800. What was the real income of the nurse in April 2009? How much had the mean salary increased?

14. The Trade Union Association of Orlando, Florida, maintains indexes on the hourly wages for a number of the trades. Unfortunately, the indexes do not all have the same base periods. Listed below is information on plumbers and electricians. Shift the base periods to 2000 and compare the hourly wage increases for the period from 2000 to 2009.

Year	Plumbers (1995 = 100)	Electricians (1998 = 100)
2000	133.8	126.0
2009	159.4	158.7

15. In 1995, the mean salary of classroom teachers in Tinora School District was $28,650. By 2004, the mean salary increased to $33,972, and further increased in 2009 to $37,382. The American Federation of Classroom Teachers maintains information on the trends throughout the United States in classroom teacher salaries. Its index, which has a base period of 1995, was 122.5 for 2004 and 136.9 for 2009. Compare the Tinora teachers to the national trends.

16. Sam Steward is a freelance Web page designer. Listed below are his yearly wages for several years between 2002 and 2008. Also included is an industry index for Web page designers that reports the rate of wage inflation in the industry. This index has a base period of 1995.

Year	Wage ($000)	Index (1995 = 100)
2002	134.8	160.6
2004	145.2	173.6
2006	156.6	187.9
2008	168.8	203.3

Compute Sam's real income for the selected years during the six-year period. Did his wages keep up with inflation, or did he lose ground?

Chapter Summary

I. An index number measures the relative change from one period to another.
- **A.** The major characteristics of an index are:
  - **1.** It is a percentage, but the percent sign is usually omitted.
  - **2.** It has a base period.
  - **3.** Most indexes are reported to the nearest tenth of a percent, such as 153.1.
  - **4.** The base of most indexes is 100.
- **B.** The reasons for computing an index are:
  - **1.** It facilitates the comparison of unlike series.
  - **2.** If the numbers are very large, often it is easier to comprehend the change of the index than the actual numbers.

II. There are two types of price indexes, unweighted and weighted.
- **A.** In an unweighted index, we do not consider the quantities.
  - **1.** In a simple index, we compare the base period to the given period.

$$P = \frac{p_t}{p_0} \times 100 \qquad \textbf{[15–1]}$$

where p_t refers to the price in the current period, and p_0 is the price in the base period.
  - **2.** In the simple average of price indexes, we add the simple indexes for each item and divide by the number of items.

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

  - **3.** In a simple aggregate price index, the price of the items in the group are totaled for both periods and compared.

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

- **B.** In a weighted index, the quantities are considered.
  - **1.** In the Laspeyres method, the base period quantities are used in both the base period and the given period.

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

  - **2.** In the Paasche method, current period quantities are used.

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

Statistics in Action

In the 1920s, wholesale prices in Germany increased dramatically. In 1920, wholesale prices increased about 80 percent, in 1921 the rate of increase was 140 percent, and in 1922 it was a whopping 4,100 percent! Between December 1922 and November 1923, wholesale prices increased another 4,100 percent. By that time government printing presses could not keep up, even by printing notes as

(*continued*)

large as 500 million marks. Stories are told that workers were paid daily, then twice daily, so their wives could shop for necessities before the wages became too devalued.

3. Fisher's ideal index is the geometric mean of Laspeyres' index and Paasche's index.

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

C. A value index uses both base period and current period prices and quantities.

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

III. The most widely reported index is the Consumer Price Index (CPI).
- **A.** It is often used to show the rate of inflation in the United States.
- **B.** It is reported monthly by the U.S. Bureau of Labor Statistics.
- **C.** The current base period is 1982–84.
- **D.** It is used by the Social Security system, so when the CPI changes, retirement benefits also change.

Chapter Exercises

connect™

The following information was taken from Johnson & Johnson annual reports. The principal office of Johnson & Johnson is in New Brunswick, New Jersey. Its common stock is listed on the New York Stock Exchange, using the symbol JNJ.

Year	Domestic Sales ($ million)	International Sales ($ million)	Total Sales ($ million)	Employees (thousands)
2000	17,316	11,856	29,172	100.9
2001	19,825	12,492	32,317	101.8
2002	22,455	13,843	36,298	108.3
2003	25,274	16,588	41,862	110.6
2004	27,770	19,578	47,348	109.9
2005	28,377	22,137	50,514	115.6
2006	29,775	23,549	53,324	122.2
2007	32,444	28,651	61,095	119.2
2008	32,309	31,438	63,747	118.7
2009	30,889	31,008	61,897	115.5

17. Refer to the Johnson & Johnson data. Use 2000 as the base period and compute a simple index of domestic sales for each year from 2000 until 2009. Interpret the trend in domestic sales.

18. Refer to the Johnson & Johnson data. Use the period 2000–02 as the base period and compute a simple index of domestic sales for each year from 2003 to 2009.

19. Refer to the Johnson & Johnson data. Use 2000 as the base period and compute a simple index of international sales for each year from 2001 until 2009. Interpret the trend in international sales.

20. Refer to the Johnson & Johnson data. Use the period 2000–02 as the base period and compute a simple index of international sales for each year from 2003 to 2009.

21. Refer to the Johnson & Johnson data. Use 2000 as the base period and compute a simple index of the number of employees for each year from 2001 until 2009. Interpret the trend in the number of employees.

22. Refer to the Johnson & Johnson data. Use the period 2000–02 as the base period and compute a simple index of the number of employees for each year from 2003 to 2009.

The following information is from the General Electric Corporation annual reports.

Year	Revenue ($ million)	Employees (000)	Year	Revenue ($ million)	Employees (000)
2004	134	325	2007	168	319
2005	152	307	2008	177	327
2006	157	316	2009	183	323

23. Compute a simple index for the revenue of GE. Use 2004 as the base period. What can you conclude about the change in revenue over the period?

24. Compute a simple index for the revenue of GE using the period 2004–06 as the base. What can you conclude about the change in revenue over the period?

25. Compute a simple index for the number of employees for GE. Use 2004 as the base period. What can you conclude about the change in the number of employees over the period?

26. Compute a simple index for the number of employees for GE using the period 2004–06 as the base. What can you conclude about the change in the number of employees over the period?

Below is information on food items for the years 2000 and 2009.

	2000		2009	
Item	**Price**	**Quantity**	**Price**	**Quantity**
Margarine (pound)	$0.81	18	$2.00	27
Shortening (pound)	0.84	5	1.88	9
Milk (½ gallon)	1.44	70	2.89	65
Potato chips	2.91	27	3.99	33

27. Compute a simple price index for each of the four items. Use 2000 as the base period.

28. Compute a simple aggregate price index. Use 2000 as the base period.

29. Compute Laspeyres' price index for 2009 using 2000 as the base period.

30. Compute Paasche's index for 2009 using 2000 as the base period.

31. Determine Fisher's ideal index using the values for the Laspeyres and Paasche indexes computed in the two previous problems.

32. Determine a value index for 2009 using 2000 as the base period.

Betts Electronics purchases three replacement parts for robotic machines used in its manufacturing process. Information on the price of the replacement parts and the quantity purchased is given below.

	Price		Quantity	
Part	**2000**	**2009**	**2000**	**2009**
RC-33	$0.50	$0.60	320	340
SM-14	1.20	0.90	110	130
WC50	0.85	1.00	230	250

33. Compute a simple price index for each of the three items. Use 2000 as the base period.

34. Compute a simple aggregate price index for 2009. Use 2000 as the base period.

35. Compute Laspeyres' price index for 2009 using 2000 as the base period.

36. Compute Paasche's index for 2009 using 2000 as the base period.

37. Determine Fisher's ideal index using the values for the Laspeyres and Paasche indexes computed in the two previous problems.

38. Determine a value index for 2009 using 2000 as the base period.

Prices for selected foods for 2000 and 2009 are given in the following table.

	Price		Quantity	
Item	**2000**	**2009**	**2000**	**2009**
Cabbage (pound)	$0.06	$0.05	2,000	1,500
Carrots (bunch)	0.10	0.12	200	200
Peas (quart)	0.20	0.18	400	500
Endive (bunch)	0.15	0.15	100	200

39. Compute a simple price index for each of the four items. Use 2000 as the base period.

40. Compute a simple aggregate price index. Use 2000 as the base period.

41. Compute Laspeyres' price index for 2009 using 2000 as the base period.

42. Compute Paasche's index for 2009 using 2000 as the base period.

43. Determine Fisher's ideal index using the values for the Laspeyres and Paasche indexes computed in the two previous problems.

44. Determine a value index for 2009 using 2000 as the base period.

The prices of selected items for 1990 and 2009 follow. Production figures for those two periods are also given.

	Price		Quantity	
Item	1990	2009	1990	2009
Aluminum (cents per pound)	$ 0.287	$ 0.76	1,000	1,200
Natural gas (1,000 cu. ft.)	0.17	2.50	5,000	4,000
Petroleum (barrel)	3.18	26.00	60,000	60,000
Platinum (troy ounce)	133.00	490.00	500	600

45. Compute a simple price index for each of the four items. Use 1990 as the base period.

46. Compute a simple aggregate price index. Use 1990 as the base period.

47. Compute Laspeyres' price index for 2009 using 1990 as the base period.

48. Compute Paasche's index for 2009 using 1990 as the base period.

49. Determine Fisher's ideal index using the values for the Laspeyres and Paasche indexes computed in the two previous problems.

50. Determine a value index for 2009 using 1990 as the base period.

51. A special-purpose index is to be designed to monitor the overall economy of the Southwest. Four key series were selected. After considerable deliberation, it was decided to weight retail sales 20 percent, total bank deposits 10 percent, industrial production in the area 40 percent, and nonagricultural employment 30 percent. The data for 1996 and 2009 are:

Year	Retail Sales ($ millions)	Bank Deposits ($ billions)	Industrial Production (1990 = 100)	Employment
1996	1,159.0	87	110.6	1,214,000
2009	1,971.0	91	114.7	1,501,000

Construct a special-purpose index for 2009 using 1996 as the base period and interpret.

52. We are making a historical study of the American economy from 1950 to 1980. Data on prices, the labor force, productivity, and the GNP were collected. Note in the following table that the CPI has a base period of 1967, employment is in millions of persons, and so on. A direct comparison, therefore, is not feasible.

a. Make whatever calculations are necessary to compare the trend in the four series from 1950 to 1980.

b. Interpret.

Year	Consumer Price Index (1967 = 100)	Total Labor Force (millions)	Index of Productivity in Manufacturing (1967 = 100)	Gross National Product ($ billions)
1950	72.1	64	64.9	286.2
1967	100.0	81	100.0	789.6
1971	121.3	87	110.3	1,063.4
1975	161.2	95	114.9	1,516.3
1980	246.8	107	146.6	2,626.0

53. The management of Ingalls Super Discount stores, with several stores in the Oklahoma City area, wants to construct an index of economic activity for the metropolitan area. Management contends that, if the index reveals that the economy is slowing down, inventory should be kept at a low level.

Three series seem to hold promise as predictors of economic activity—area retail sales, bank deposits, and employment. All of these data can be secured monthly from the U.S. government. Retail sales is to be weighted 40 percent, bank deposits 35 percent, and employment 25 percent. Seasonally adjusted data for the first three months of the year are:

Month	Retail Sales ($ millions)	Bank Deposits ($ billions)	Employment (thousands)
January	8.0	20	300
February	6.8	23	303
March	6.4	21	297

Construct an index of economic activity for each of the three months, using January as the base period.

54. The following table gives information on the Consumer Price Index and the monthly take-home pay of Bill Martin, an employee at Jeep Corporation.

Year	Consumer Price Index (1982–84 = 100)	Mr. Martin's Monthly Take-Home Pay
1982–84	100.0	$ 600
2009	214.537	2,000

a. What is the purchasing power of the dollar in 2009, based on the period 1982–84?
b. Determine Mr. Martin's "real" monthly income for 2009.

55. Suppose that the Producer Price Index and the sales of Hoskin's Wholesale Distributors for 1995 and 2009 are:

Year	Producer Price Index	Sales
1995	127.9	$2,400,000
2009	172.5	3,500,000

What are Hoskin's real sales (also called deflated sales) for the two years?

Software Commands

1. The Excel commands for the spreadsheet on page 582 are:

a. Enter the data for the prices and quantities. We entered the label *Item* in cell A2, and the item names in cells A3 through A8. The label *1999 Price* was entered in B2, and the price data for 1999 in cells B3 through B8. The label *1999 Quantity* was entered in cell C2, with the 1999 quantities in cells C3 through C8. Cell E2 was labeled *1999 Price*1999 Quantity.*

b. To determine the product of the 1999 prices and quantities, highlight the cell E3. Type = *B2*C2* in cell E3 and hit **Enter.** The value of 43.5 should appear. This is the product of the price of bread ($0.87) and the quantity of bread (50) sold in 1999.

c. With cell E3 still highlighted, move the cursor to the bottom right corner of cell E3, hold the left mouse button and drag the cell down to cell E8. The remaining products should appear.

d. Move to cell E9, click on Σ on the menu and hit **Enter.** The value of 507.64 will appear. This is the denominator for the Laspeyres price index. The other products and column totals are determined in a similar manner. The other Excel output in the chapter is computed similarly.