a. Compute the price relatives for the three ingredients.
b. Compute a weighted average of the price relatives to develop a one-year cost index for raw materials used in the product. What is your interpretation of this index value?

8. An investment portfolio consists of four stocks. The purchase price, current price, and number of shares are reported in the following table.

Stock	Purchase Price/Share ($)	Current Price/Share ($)	Number of Shares
Holiday Trans	15.50	17.00	500
NY Electric	18.50	20.25	200
KY Gas	26.75	26.00	500
PQ Soaps	42.25	45.50	300

Construct a weighted average of price relatives as an index of the performance of the portfolio to date. Interpret this price index.

9. Compute the price relatives for the R&B Beverages products in exercise 4. Use a weighted average of price relatives to show that this method provides the same index as the weighted aggregate method.

20.4 Some Important Price Indexes

We identified the procedures used to compute price indexes for single items or groups of items. Now let us consider some price indexes that are important measures of business and economic conditions. Specifically, we consider the Consumer Price Index, the Producer Price Index, and the Dow Jones averages.

Consumer Price Index

The CPI includes charges for services (e.g., doctor and dentist bills) and all taxes directly associated with the purchase and use of an item.

The **Consumer Price Index (CPI)**, published monthly by the U.S. Bureau of Labor Statistics, is the primary measure of the cost of living in the United States. The group of items used to develop the index consists of a *market basket* of 400 items including food, housing, clothing, transportation, and medical items. The CPI is a weighted aggregate price index with fixed weights.[1] The weight applied to each item in the market basket derives from a usage survey of urban families throughout the United States.

The February 2012 CPI, computed with a 1982–1984 base index of 100, was 227.7. This figure means that the cost of purchasing the market basket of goods and services increased 127.7% since the base period 1982–1984. The 50-year time series of the CPI from 1960–2010 is shown in Figure 20.1. Note how the CPI measure reflects the sharp inflationary behavior of the economy in the late 1970s and early 1980s.

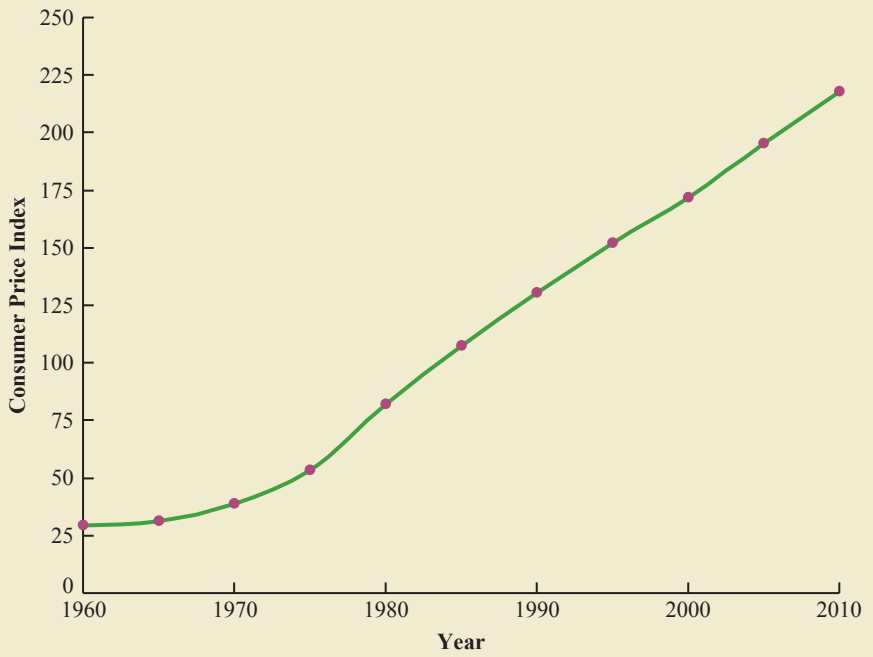
Producer Price Index

The PPI is designed as a measure of price changes for domestic goods; imports are not included.

The **Producer Price Index (PPI)**, also published monthly by the U.S. Bureau of Labor Statistics, measures the monthly changes in prices in primary markets in the United States. The PPI is based on prices for the first transaction of each product in nonretail markets. All

[1]The Bureau of Labor Statistics actually publishes two Consumer Price Indexes: one for all urban consumers (CPI-U) and a revised Consumer Price Index for urban wage earners and clerical workers (CPI-W). The CPI-U is the one most widely quoted, and it is published regularly in *The Wall Street Journal*.

FIGURE 20.1 CONSUMER PRICE INDEX, 1960–2010 (BASE 1982–1984 = 100)



commodities sold in commercial transactions in these markets are represented. The survey covers raw, manufactured, and processed goods at each level of processing and includes the output of industries classified as manufacturing, agriculture, forestry, fishing, mining, gas and electricity, and public utilities. One of the common uses of this index is as a leading indicator of the future trend of consumer prices and the cost of living. An increase in the PPI reflects producer price increases that will eventually be passed on to the consumer through higher retail prices.

Weights for the various items in the PPI are based on the value of shipments. The weighted average of price relatives is calculated by the Laspeyres method. The February 2012 PPI, computed with a 1982 base index of 100, was 201.6.

Dow Jones Averages

The **Dow Jones averages** are indexes designed to show price trends and movements associated with common stocks. The best known of the Dow Jones indexes is the Dow Jones Industrial Average (DJIA), which is based on common stock prices of 30 large companies. It is the sum of these stock prices divided by a number, which is revised from time to time to adjust for stock splits and switching of companies in the index. Unlike the other price indexes that we studied, it is not expressed as a percentage of base-year prices. The specific firms used in February 2012 to compute the DJIA are listed in Table 20.7.

Charles Henry Dow published his first stock average on July 3, 1884, in the Customer's Afternoon Letter. *Eleven stocks, nine of which were railroad issues, were included in the first index. An average comparable to the DJIA was first published on October 1, 1928.*

Other Dow Jones averages are computed for 20 transportation stocks and for 15 utility stocks. The Dow Jones averages are computed and published daily in *The Wall Street Journal* and other financial publications.

TABLE 20.7 THE 30 COMPANIES USED IN THE DOW JONES INDUSTRIAL AVERAGE (FEBRUARY 2012)

3m	Disney	Kraft Foods
Alcoa	DuPont	McDonald's
American Express	ExxonMobil	Merck
AT&T	General Electric	Microsoft
Bank of America	Hewlett-Packard	Pfizer
Boeing	Home Depot	Procter & Gamble
Caterpillar	IBM	Travelers
Chevron Corp.	Intel	United Technologies
Cisco Systems	Johnson & Johnson	Verizon
Coca-Cola	J. P. Morgan Chase	Wal-Mart Stores

20.5 Deflating a Series by Price Indexes

Time series are deflated to remove the effects of inflation.

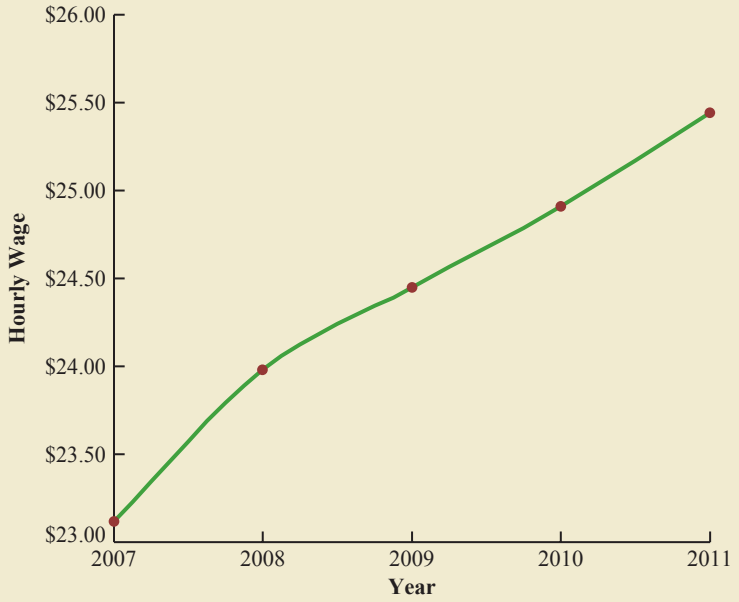
Many business and economic series reported over time, such as company sales, industry sales, and inventories, are measured in dollar amounts. These time series often show an increasing growth pattern over time, which is generally interpreted as indicating an increase in the physical volume associated with the activities. For example, a total dollar amount of inventory up by 10% might be interpreted to mean that the physical inventory is 10% larger. Such interpretations can be misleading if a time series is measured in terms of dollars, and the total dollar amount is a combination of both price and quantity changes. Hence, in periods when price changes are significant, the changes in the dollar amounts may not be indicative of quantity changes unless we are able to adjust the time series to eliminate the price change effect.

For example, from 1976 to 1980, the total amount of spending in the construction industry increased approximately 75%. That figure suggests excellent growth in construction activity. However, construction prices were increasing just as fast as—or sometimes even faster than—the 75% rate. In fact, while total construction spending was increasing, construction activity was staying relatively constant or, as in the case of new housing starts, decreasing. To interpret construction activity correctly for the 1976–1980 period, we must adjust the total spending series by a price index to remove the price increase effect. Whenever we remove the price increase effect from a time series, we say we are *deflating the series.*

In relation to personal income and wages, we often hear discussions about issues such as "real wages" or the "purchasing power" of wages. These concepts are based on the notion of deflating an hourly wage index. For example, Figure 20.2 shows the pattern of hourly wages of electricians for the period 2007–2011. We see a trend of wage increases from $23.12 per hour to $25.44 per hour. Should electricians be pleased with this growth in hourly wages? The answer depends on what happened to the purchasing power of their wages. If we can compare the purchasing power of the $23.12 hourly wage in 2007 with the purchasing power of the $25.44 hourly wage in 2011, we will be better able to judge the relative improvement in wages.

Table 20.8 reports both the hourly wage rate and the CPI (computed with a 1982–1984 base index of 100) for the period 2007–2011. With these data, we will show how the CPI can be used to deflate the index of hourly wages. The deflated series is found by dividing

FIGURE 20.2 ACTUAL AVERAGE HOURLY WAGES OF ELECTRICIANS



the hourly wage rate in each year by the corresponding value of the CPI and multiplying by 100. The deflated hourly wage index for electricians is given in Table 20.9; Figure 20.3 is a graph showing the deflated, or real, wages.

Real wages are a better measure of purchasing power than actual wages. Indeed, many union contracts call for wages to be adjusted in accordance with changes in the cost of living.

What does the deflated series of wages tell us about the real wages or purchasing power of electricians during the 2007–2011 period? In terms of base period dollars (1982–1984 = 100), the hourly wage rate remained relatively flat over the period. After removing the inflationary effect we see that the purchasing power of the workers only increased by $.16 over the four-year period. This effect is seen in Figure 20.3. Thus, the advantage of using price indexes to deflate a series is that they give us a clearer picture of the real dollar changes that are occurring.

This process of deflating a series measured over time has an important application in the computation of the gross domestic product (GDP). The GDP is the total value of all

TABLE 20.8 HOURLY WAGES OF ELECTRICIANS AND CONSUMER PRICE INDEX, 2007–2011

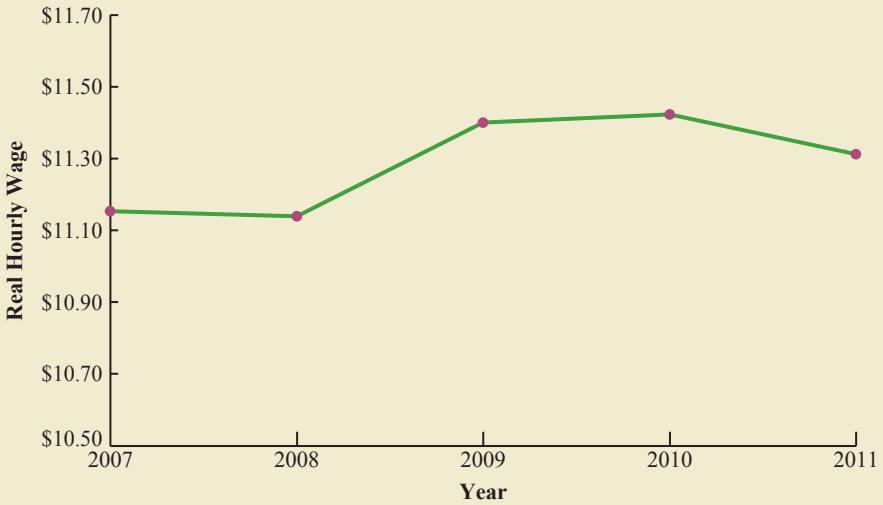
Year	Hourly Wage ($)	CPI
2007	23.12	207.3
2008	23.98	215.3
2009	24.45	214.5
2010	24.91	218.1
2011	25.44	224.9

Source: Bureau of Labor Statistics. CPI is computed with a 1982–1984 base index of 100.

TABLE 20.9 DEFLATED SERIES OF HOURLY WAGES FOR ELECTRICIANS, 2007–2011

Year	Deflated Hourly Wage
2007	($23.12/207.3)(100) = $11.15
2008	($23.98/215.3)(100) = $11.14
2009	($24.45/214.5)(100) = $11.40
2010	($24.91/218.1)(100) = $11.42
2011	($25.44/224.9)(100) = $11.31

FIGURE 20.3 REAL HOURLY WAGES OF ELECTRICIANS, 2007–2011



goods and services produced in a given country. Obviously, over time the GDP will show gains that are in part due to price increases if the GDP is not deflated by a price index. Therefore, to adjust the total value of goods and services to reflect actual changes in the volume of goods and services produced and sold, the GDP must be computed with a price index deflator. The process is similar to that discussed in the real wages computation.

Exercises

Applications

SELF test

10. Registered nurses in 2007 made an average hourly wage of $30.04. In 2011, their hourly wage had risen to $33.23. Given that the CPI for 2007 was 207.3 and the 2011 CPI was 224.9, answer the following.
    a. Give the real wages for registered nurses for 2007 and 2011 by deflating the hourly wage rates.
    b. What is the percentage change in the actual hourly wage for registered nurses from 2007 to 2011?
    c. For registered nurses, what was the percentage change in real wages from 2007 to 2011?

11. The average hourly wage rate for construction laborers in 2001 was $13.36. In 2011 construction laborers made $16.43 per hour. The CPI for 2001 was 177.1 and for 2011, 224.9. Calculate the percentage increase or decrease in real hourly wages from 2001 to 2011.

12. Shipments of product from manufacturer to the retailer are tracked by the U.S. Census Bureau. The value of shipments for computer and electronic products in September 2009, 2010, and 2011 are shown in the table below, along with the CPI and PPI for each of these months.

	Manufacturer Shipments ($ billions)	CPI	PPI
2009	$29.1	216.0	173.4
2010	$33.3	218.4	180.2
2011	$32.9	226.9	192.5

a. Use the CPI to deflate the value of the shipped computer and electronics products.
b. Use the PPI to deflate the value of the shipped computer and electronics products.
c. Which index, the CPI or PPI, do you feel is more appropriate for deflating these shipment values? Why?

13. Athletic wear company Nike Inc.'s revenues for the years 2007–2011 are shown in the table below (Nike Inc. Annual Reports). Deflate the revenue dollars based on the CPI (1982–1984 based). Comment on the company's revenues in terms of deflated dollars.

	Revenue ($ billions)	CPI
2007	16.3	207.3
2008	18.6	215.3
2009	19.2	214.5
2010	19.0	218.1
2011	20.9	224.9

20.6 Price Indexes: Other Considerations

In the preceding sections we described several methods used to compute price indexes, discussed the use of some important indexes, and presented a procedure for using price indexes to deflate a time series. Several other issues must be considered to enhance our understanding of how price indexes are constructed and how they are used. Some are discussed in this section.

Selection of Items

The primary purpose of a price index is to measure the price change over time for a specified class of items, products, and so on. Whenever the class of items is very large, the index cannot be based on all items in the class. Rather, a sample of representative items must be used. By collecting price and quantity information for the sampled items, we hope to obtain a good idea of the price behavior of all items that the index is representing. For example, in the Consumer Price Index the total number of items that might be considered in the population of normal purchase items for a consumer could be 2000 or more. However, the index is based on the price-quantity characteristics of just 400 items. The selection of the specific items in the index is not a trivial task. Surveys of user purchase patterns as well as good judgment go into the selection process. A simple random sample is not used to select the 400 items.

After the initial selection process, the group of items in the index must be periodically reviewed and revised whenever purchase patterns change. Thus, the issue of which items to include in an index must be resolved before an index can be developed and again before it is revised.

Selection of a Base Period

Most indexes are established with a base-period value of 100 at some specific time. All future values of the index are then related to the base-period value. What base period is appropriate for an index is not an easy question to answer. It must be based on the judgment of the developer of the index.

Many of the indexes established by the U.S. government as of 2011 use a 1982 base period. As a general guideline, the base period should not be too far from the current period. For example, a Consumer Price Index with a 1945 base period would be difficult for most individuals to understand because of unfamiliarity with conditions in 1945. The base period for most indexes therefore is adjusted periodically to a more recent period of time. The CPI base period was changed from 1967 to the 1982–1984 average in 1988. The PPI currently uses 1982 as its base period (i.e., 1982 = 100).

Quality Changes

The purpose of a price index is to measure changes in prices over time. Ideally, price data are collected for the same set of items at several times, and then the index is computed. A basic assumption is that the prices are identified for the same items each period. A problem is encountered when a product changes in quality from one period to the next. For example, a manufacturer may alter the quality of a product by using less expensive materials, fewer features, and so on, from year to year. The price may go up in following years, but the price is for a lower-quality product. Consequently, the price may actually go up more than is represented by the list price for the item. It is difficult, if not impossible, to adjust an index for decreases in the quality of an item.

A substantial quality improvement may also cause an increase in the price of a product. A portion of the price related to the quality improvement should be excluded from the index computation. However, adjusting an index for a price increase that is related to higher quality of an item is extremely difficult, if not impossible.

Although common practice is to ignore minor quality changes in developing a price index, major quality changes must be addressed because they can alter the product description from period to period. If a product description is changed, the index must be modified to account for it; in some cases, the product might be deleted from the index.

In some situations, however, a substantial improvement in quality is followed by a decrease in the price. This less typical situation has been the case with personal computers during the 1990s and early 2000s.

20.7 Quantity Indexes

In addition to the price indexes described in the preceding sections, other types of indexes are useful. In particular, one other application of index numbers is to measure changes in quantity levels over time. This type of index is called a **quantity index**.

Recall that in the development of the weighted aggregate price index in Section 20.2, to compute an index number for period t we needed data on unit prices at a base period (P_0) and period t (P_t). Equation (20.3) provided the weighted aggregate price index as

$$I_t = \frac{\Sigma P_{it} Q_i}{\Sigma P_{i0} Q_i} (100)$$

The numerator, $\Sigma P_{it}Q_i$, represents the total value of fixed quantities of the index items in period t. The denominator, $\Sigma P_{i0}Q_i$, represents the total value of the same fixed quantities of the index items in year 0.

Computation of a weighted aggregate quantity index is similar to that of a weighted aggregate price index. Quantities for each item are measured in the base period and period t, with Q_{i0} and Q_{it}, respectively, representing those quantities for item i. The quantities are then weighted by a fixed price, the value added, or some other factor. The "value added" to a product is the sales value minus the cost of purchased inputs. The formula for computing a weighted aggregate quantity index for period t is

$$I_t = \frac{\Sigma Q_{it} w_i}{\Sigma Q_{i0} w_i}(100) \qquad \textbf{(20.9)}$$

In some quantity indexes the weight for item i is taken to be the base-period price (P_{i0}), in which case the weighted aggregate quantity index is

$$I_t = \frac{\Sigma Q_{it} P_{i0}}{\Sigma Q_{i0} P_{i0}}(100) \qquad \textbf{(20.10)}$$

Quantity indexes can also be computed on the basis of weighted quantity relatives. One formula for this version of a quantity index follows.

$$I_t = \frac{\sum \frac{Q_{it}}{Q_{i0}}(Q_{i0}P_i)}{\Sigma Q_{i0} P_i}(100) \qquad \textbf{(20.11)}$$

This formula is the quantity version of the weighted price relatives formula developed in Section 20.3 as in equation (20.8).

The **Index of Industrial Production**, developed by the Federal Reserve Board, is probably the best-known quantity index. It is reported monthly and the base period is 2002. The index is designed to measure changes in volume of production levels for a variety of manufacturing classifications in addition to mining and utilities. In February 2012 the index was 96.2.

Exercises

Methods

SELF test

14. Data on quantities of three items sold in 1997 and 2011 are given here along with the sales prices of the items in 1997. Compute a weighted aggregate quantity index for 2011.

	Quantity Sold		
Item	1997	2011	Price/Unit 1997 ($)
A	350	300	18.00
B	220	400	4.90
C	730	850	15.00

Applications

SELF test

15. A trucking firm handles four commodities for a particular distributor. Total shipments for the commodities in 1996 and 2011, as well as the 1996 prices, are reported in the following table.

Commodity	Shipments 1996	Shipments 2011	Price/Shipment 1996
A	120	95	$1200
B	86	75	$1800
C	35	50	$2000
D	60	70	$1500

Develop a weighted aggregate quantity index with a 1996 base. Comment on the growth or decline in quantities over the 1996–2011 period.

16. An automobile dealer reports the 1994 and 2011 sales for three models in the following table. Compute quantity relatives and use them to develop a weighted aggregate quantity index for 2011 using the two years of data.

Model	Sales 1994	Sales 2011	Mean Price per Sale (1994)
Sedan	200	170	$15,200
Sport	100	80	$17,000
Wagon	75	60	$16,800

Summary

Price and quantity indexes are important measures of changes in price and quantity levels within the business and economic environment. Price relatives are simply the ratio of the current unit price of an item to a base-period unit price multiplied by 100, with a value of 100 indicating no difference in the current and base-period prices. Aggregate price indexes are created as a composite measure of the overall change in prices for a given group of items or products. Usually the items in an aggregate price index are weighted by their quantity of usage. A weighted aggregate price index can also be computed by weighting the price relatives by the usage quantities for the items in the index.

The Consumer Price Index and the Producer Price Index are both widely quoted indexes with 1982–1984 and 1982, respectively, as base years. The Dow Jones Industrial Average is another widely quoted price index. It is a weighted sum of the prices of 30 common stocks of large companies. Unlike many other indexes, it is not stated as a percentage of some base-period value.

Often price indexes are used to deflate some other economic series reported over time. We saw how the CPI could be used to deflate hourly wages to obtain an index of real wages. Selection of the items to be included in the index, selection of a base period for the index, and adjustment for changes in quality are important additional considerations in the development of an index number. Quantity indexes were briefly discussed, and the Index of Industrial Production was mentioned as an important quantity index.

Glossary

Price relative A price index for a given item that is computed by dividing a current unit price by a base-period unit price and multiplying the result by 100.
Aggregate price index A composite price index based on the prices of a group of items.
Weighted aggregate price index A composite price index in which the prices of the items in the composite are weighted by their relative importance.