CHAPTER Cc

Prices

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Prices and Price Indexes

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This chapter presents series that measure changes over time in prices, excluding the price series closely associated with the national income and product accounts. Some of the series included in this chapter represent prices of specific things, such as nails or turpentine, but most are constructed from prices of many different goods and services in a general class, combined or "aggregated" to produce a series with one number for each point in time. Movements in series that aggregate relatively wide classes of things are often taken to indicate "changes in the price level." This phrase usually refers to changes in prices that are in some sense universal, common to all or nearly all goods and services in an economy. A general increase in prices – an increase in the price level – is called price inflation, or simply inflation. A general decrease in prices – a decrease in the price level – is deflation. The price level is stable when there are no general changes in prices.

The Basics: How Price Indexes Are Constructed and Used

Table Cc-A shows some examples of price series for individual goods taken from Table Cc205–266. Column 1 of the table lists prices for cotton sheeting in each year for the period 1820–1830 (series Cc231). Column 2 shows an "index number" constructed from the prices in column 1 by dividing the price of cotton cloth in each year by the price in one particular year, the base year. The year chosen to be the base year was 1820, though any other year would have done as well. The resulting index number equals 1 in 1820. The proportional or percent change in the index number between any two years is the same as the corresponding change in the price found in column 1. In any year, the index number equals that year's cotton cloth price as a proportion or multiple of the price in 1820. Thus, the value of the cotton cloth price index in 1830, which is 0.64, indicates that the 1830 price was 64 percent of the 1820 price.

Column 3 of the table lists prices for cut nails sold in Philadelphia from 1820 through 1828 (series Cc248). This series is unavailable for years after 1828. Column 4 is an index number constructed from the Philadelphia nails prices, with 1820 as the base year. Column 5 lists prices for cut nails sold in New York City from 1828 through 1830 (series Cc249). This series is unavailable for years before 1828. Column 6 is an index number constructed from the New York nails prices, with 1828 chosen to be the base year as there is no 1820 value for the New York price. Because the Philadelphia and New York price series overlap in 1828 – in that year values are available for *both* series – the price index for Philadelphia nails can be "linked" to the price index for New York nails, to give the series shown in column 7. For years from 1820 through 1828, column 7 is the same as column 4. For years after that, column 7 increases or decreases in proportion to the change between the same years in column 6 (or column 5). Thus, between years from 1820 through 1828, the percent change in column 7 is the same as the percent change in column 4 (or column 3); between years from 1828 through 1830, the percent change in the index in column 7 is the same as the percent change in column 6 (or column 5). If one could assume that percent changes in nail prices from year to year were the same in Philadelphia and New York – which may or may not have been the case – one could take the value of the index number in 1830, which is 0.53, to indicate that in either city the price of nails in 1830 was 53 percent of the 1820 price.

Columns 8–11 show examples of *aggregate* price indexes constructed from price indexes for cotton cloth and nails seen in columns 2 and 7. Column 8 is an arithmetic average, with the cotton cloth price index weighted 30 percent and the nails price index weighted 70 percent. Column 9 is an arithmetic average with the reverse set of weights: 70 percent cotton, 30 percent nails. Columns 10 and 11 are *geometric* rather than arithmetic averages (see the formulas shown with Table Cc-A). Although many people are unfamiliar with geometric averages, many price indexes incorporate them in one way or another. Note that the choice of weights makes a difference for either the arithmetic or geometric average: column 9 can be different from column 8; column 11 can be different from column 10. The use of geometric rather than arithmetic averages also matters, although in this particular case it matters less than the choice of weights: column 10 can be a bit different from 8; column 11 can be different from 9. For the year 1830, the values of the aggregate price indexes range from 0.561 to 0.607 – that is, from 56.1 to 60.7 percent of their values for 1820. One might take these numbers to indicate the general level of prices in 1830 for the class "cotton cloth and nails" relative to the 1820 price level. But one would have to decide which was the appropriate set of weights and averaging method.

Acknowledgments

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TABLE Cc-A Examples of price index construction

	Cotton cloth		Nails					Aggregate price indexes – cotton and nails			
			Philadelphia		New York						
	Price	Price index	Price	Price index	Price	Price index	Linked price index	Arithmetic		Geometric	
	Dollars per piece	1820 = 1	Dollars per 100 pounds	1820 = 1	Dollars per 100 pounds	1828 = 1	1820 = 1	30% cotton 70% nails	70% cotton 30% nails	30% cotton 70% nails	70% cotton 30% nails
Year	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11
1820	16.00	1.000	9.80	1.000	—	—	1.000	1.000	1.000	1.000	1.000
1821	16.00	1.000	9.80	1.000	—	—	1.000	1.000	1.000	1.000	1.000
1822	15.00	0.938	9.80	1.000	—	—	1.000	0.981	0.957	0.981	0.956
1823	14.50	0.906	9.80	1.000	—	—	1.000	0.972	0.934	0.971	0.933
1824	9.80	0.613	8.87	0.905	—	—	0.905	0.817	0.701	0.805	0.689
1825	10.52	0.658	7.33	0.748	—	—	0.748	0.721	0.685	0.720	0.684
1826	9.94	0.621	7.21	0.736	—	—	0.736	0.702	0.656	0.699	0.653
1827	9.17	0.573	6.76	0.690	—	—	0.690	0.655	0.608	0.653	0.606
1828	8.99	0.562	7.08	0.722	7.50	1.000	0.722	0.674	0.610	0.670	0.606
1829	9.44	0.590	—	—	7.10	0.947	0.684	0.656	0.618	0.654	0.617
1830	10.24	0.640	—	—	5.50	0.733	0.530	0.563	0.607	0.561	0.605

Documentation

The mathematical formulas for the price indexes shown in this table are as follows:

$$(\text{Column 2}) = (\text{Column 1})/16.0$$
$$(\text{Column 4}) = (\text{Column 3})/9.8$$
$$(\text{Column 6}) = (\text{Column 5})/7.5$$
$$(\text{Column 7}) = (\text{Column 4}) \text{ for } 1820-1828.$$

Thereafter, values are computed so that year-to-year percent changes match those in column 6. For example, the 1829 value for column 7 equals 0.722 * (0.947/1.000).

$$(\text{Column 8}) = 0.30 * (\text{Column 2}) + 0.70 * (\text{Column 7})$$
$$(\text{Column 9}) = 0.70 * (\text{Column 2}) + 0.30 * (\text{Column 7})$$
$$(\text{Column 10}) = (\text{Column 2})^{0.30} * (\text{Column 7})^{0.70}$$
$$(\text{Column 11}) = (\text{Column 2})^{0.70} * (\text{Column 7})^{0.30}$$

Most of the aggregate price indexes presented in this chapter were constructed like the examples in Table Cc-A, although they incorporate prices of many more goods (or services) and are meant to represent classes that are more meaningful than cotton cloth and nails.

Cost-of-living or consumer price indexes (CPIs) aggregate *prices paid by consumers* for the class of goods and services typically purchased by households – that is, families or individuals living alone – for their own use. CPIs are often used as measures of the "price level." They are also used to "deflate" measures of wages or family incomes at different points in time, converting them to "real" values. That is, values for wages or incomes originally expressed in dollars are divided by the values of the CPI for the corresponding points in time. The resulting ratio, sometimes referred to as the real wage or income, remains the same from one period to the next if the percent change in the wage or income measure between the periods is exactly the same as the percent change in the CPI. The ratio increases – real income rises – if the percent change in the wage or income measure is bigger than the percent change in the CPI. The ratio decreases – real income falls – if the percent change in wages or incomes is less than the percent change in the CPI.

Producer price indexes (PPIs) aggregate prices *received by producers* – firms, farms, or other institutions that produce goods and services for sale. Wholesale price indexes (WPIs) are constructed from prices in "wholesale markets," that is, prices paid or received in transactions somewhere preceding sale to the final consumer. In the United States, WPIs have been superseded by PPIs, but for historical periods in which PPIs are unavailable, WPIs are often used as a substitute. Like CPIs, WPIs and PPIs are often used to indicate movements in the price level. They are also used along with measures of production costs and other data relating to the situation of producers.

Changes in the Price Level, 1800–1997

The lower panel of Figure Cc-B plots one of the CPIs presented in this chapter along with a series of linked WPIs and PPIs. Both the CPI and the WPI-PPI were "rebased" to equal 1 in the year 1800 (original series values for each year were divided by values for 1800), so that values for each year are expressed as proportions or multiples of 1800 values. The upper panel of Figure Cc-B presents the same data as the lower panel, except it excludes the years after 1950 and expands the vertical scale to focus on the fluctuations in the price level during the late eighteenth, nineteenth, and early twentieth centuries. Figure Cc-C plots annual inflation rates, that is, the percentage change in the indexes from the previous year. The CPI and the WPI-PPI follow broadly similar paths over time. If the common movements in the two series are taken to indicate changes in the U.S. price level, how would one describe the evolution of the price level over the nineteenth and twentieth centuries?

From 1800 through the early 1890s, the long-run trend in the price level was flat or falling. In the mid-1890s, the price level was not much more than half of what it had been at the beginning of the nineteenth century. During two periods in the nineteenth century, the price level rose sharply above its long-run trend and remained relatively high for years while gradually falling back to the trend. The first of these periods coincided with the War of 1812. The second began with the Civil War: from 1861 through 1864, inflation rates were very high, whereas there was deflation in most years from 1866 through the 1870s.

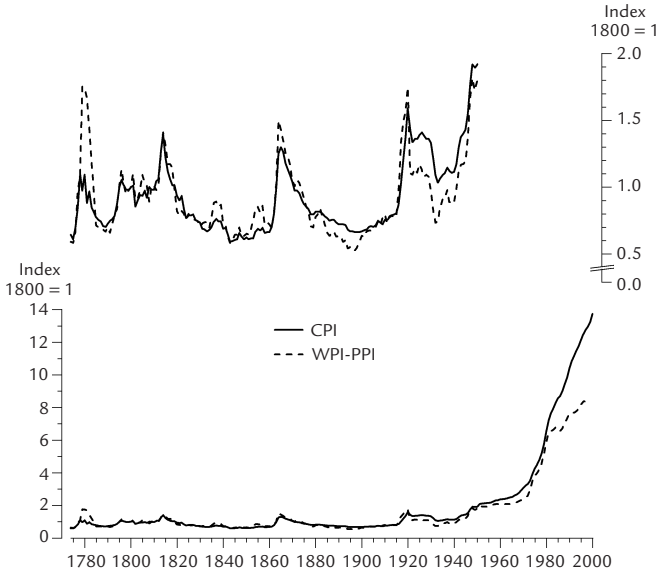

FIGURE Cc-B Consumer and wholesale-producer price indexes: 1774–2000

Sources

Consumer price index (CPI): series Cc1, rebased to the year 1800. Wholesale-producer price index (WPI-PPI): series Cc113 linked to series Cc66, rebased to the year 1800.

Documentation

By excluding the modern period, the top half of this figure is able to illustrate the fluctuations in the price level during the late eighteenth, nineteenth, and early twentieth centuries.

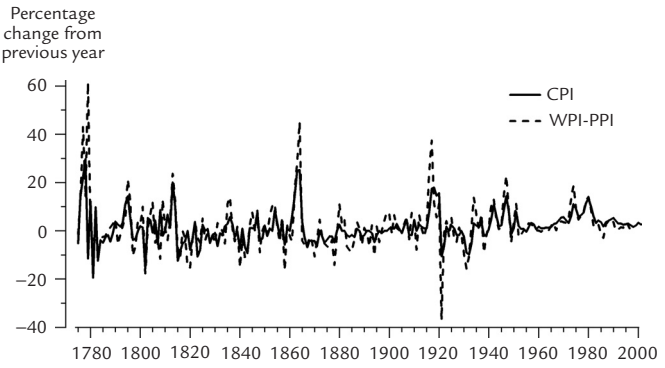

FIGURE Cc-C Annual rate of inflation in the consumer and wholesale-producer price indexes: 1774–2000

Sources

See the source for Figure Cc-B.

Documentation

This figure plots the annual percentage change in the indexes shown in Figure Cc-B.

Around the turn of the twentieth century, the long-run trend in the price level turned up. There were several years of inflation from the late 1890s through 1914. The First World War, like the earlier wars, was marked by sharp inflation. The price level fell after the war but remained above its prewar trend until the early 1930s, when another spell of deflation left the price level close to its 1800 value. Thus, there had been very little net movement in the price level over 130 years.

After the 1930s, the behavior of the price level diverged from its earlier patterns. The price level did not rise much during the Second World War; instead it popped up *after* the war and never returned to its prewar trend. The price level rose at an accelerating rate over the 1960s and 1970s. Similar rates of inflation had occurred in the past, but not so persistently, year after year. Inflation slowed in the 1980s and remained low in the 1990s, but the price level continued to rise. By 1997, prices were far above the levels of the 1930s and the 1800s.

What accounts for the behavior of the price level from 1800 through 2000, especially the shift from long-run price stability before the 1930s to persistent inflation from the 1940s on?

For much of the earlier period, a dollar was effectively defined to be a certain amount and fineness of gold, in the sense that anyone owed a certain number of "dollars" by a private debtor or a government agency (such as the U.S. Treasury or a Federal Reserve bank) could demand to be paid the corresponding quantity and quality of gold. Money units of some other nations, most importantly Great Britain, were similarly defined to be quantities of gold. Governments did not attempt to control shipments of gold between countries or exchanges of one country's money for another's. This state of affairs is referred to as the international gold standard. Under the international gold standard, rates of exchange between the dollar and other gold-defined monies were fixed within narrow limits: the points at which it became worthwhile to convert dollars to gold, ship the gold to the foreign country, and convert the gold to the foreign money unit, or vice versa. The U.S. price level could not persistently rise or fall faster than price levels in other countries with gold money; otherwise, all transportable goods would be shipped to the country where they fetched the highest gold price (where the price level was highest relative to the fixed exchange rate). The international gold standard ceased to operate in periods when important countries redefined their monies to be something other than gold, or blocked international exchanges. Countries often went "off gold" during major wars, in order to allow the government to pay war expenses with issues of paper currency and other forms of "fiat" money. Britain was off gold during and after the Napoleonic Wars (1797–1819). Most countries other than the United States were off gold for periods during and after the First World War. The United States was off gold from 1862 through 1878. During that period, most dollar debts could be settled with paper "greenbacks" printed by the U.S. Treasury Department, and the Treasury refused to exchange gold for greenbacks at any fixed rate.

When the international gold standard was in operation, the trend price level in all gold-standard countries was determined by the balance between the world's gold supply and the demand for gold by households, businesses, and institutions, such as banks that held stocks of gold to settle current payments or as a reserve against debts that might come due at unpredictable times. Growth in the volume of payments and debt in gold-standard countries tended to increase the demand for gold relative to the supply and raise the price of gold relative to other goods and services, which is to say, *decrease* the price level. Production of new gold, and financial innovations that allowed greater volumes of debt to perch on a given base of gold, tended to increase the supply of gold relative to the demand and, hence, *increase* the price level. In principle, the balance of these forces could tip toward deflation or inflation, or happen to poise precisely at price stability. In fact, the balance

tipped to deflation through most of the nineteenth century. The balance reversed in the later 1890s, when gold supply was boosted by the opening of rich new mines in Alaska and South Africa and by the discovery of the cyanide process for extracting gold from ore. In the 1920s, the concentration of gold in central banks and the practice by some central banks of holding short-term foreign assets rather than gold (the "gold exchange standard") tended to reduce gold demand and support a higher price level. As a matter of happy accident, however – or perhaps because a low price level (high gold price) tended to draw forth greater monetary gold supply – the balance of world gold supply and demand never tipped in one direction very much for very long. Thus, the trend of the U.S. price level was fairly stable outside of the Napoleonic Wars, the Civil War, and the First World War. At the same time, the operation of the international gold standard did not ensure a stable price level from year to year. Figure Cc-C shows many years of sharp inflation or deflation even when the United States and other major countries were on gold.

In the 1930s, the international gold standard broke down once and for all. During the Great Depression and the Second World War, nearly all countries other than the United States imposed controls on international exchanges and ceased to define their monies in terms of gold. The U.S. Treasury continued to exchange gold for dollars at a fixed rate, but only for payments to foreigners: U.S. residents were forced to accept payments in paper currency or in "reserve balances" at Federal Reserve banks. In the early 1970s, the Treasury ceased to give *anyone* gold in exchange for dollars at any fixed rate. Thus, since the 1930s, the U.S. price level has been determined mainly by the policies followed by the Federal Reserve (often under pressure from Congress or the President) with respect to the supply of currency and reserve balances. In the late 1960s and 1970s, Federal Reserve policies allowed the supply of this money to grow rapidly relative to demand, resulting in a great inflation. Since then, the Federal Reserve has managed to hold inflation to a lower rate, but it does not attempt to fix the price *level*. Apart from the effects of Federal Reserve policy, U.S. government agencies have occasionally attempted to control inflation directly by laying out guidelines for businesses, setting prices, and punishing those who violate the guidelines. In 1933 and 1934, the National Recovery Administration tried to force prices *up*. During the Second World War, controls were applied to hold prices *down*. At the end of the war, controls were released and prices popped up to the level determined by Federal Reserve policies. Controls meant to reduce inflation were also applied during the Korean War (from 1951 through early 1953) and the early 1970s (1971–1974).

In addition to the movements common to the CPI and the WPI-PPI, Figures Cc-B and Cc-C show some obvious differences in the behavior of the two series. Short-term ups and downs are bigger in the WPI-PPI than in the CPI. Beginning in the 1950s, the CPI tends to rise faster than the WPI-PPI. The 1997 CPI is more than twelve times its average value for the nineteenth century, while the WPI-PPI is only about nine times its nineteenth-century average value. To some degree, these differences reflect changes in markups of retail prices over wholesale or producer prices, and differences in the methods by which individual price series were averaged to create the two sets of aggregate series. More important, however, are differences in the classes of things covered by CPIs and WPIs or PPIs, especially the particular WPI-PPI series plotted here. Prices of housing and services such as medical care are important components of the CPI, but not the WPI-PPI, which is dominated by prices of goods produced by farms, mines, and factories. Since the 1950s, prices of housing and services as measured for the CPI have risen faster than measured prices of commodities and manufactures.

Using a Price Index to Deflate Another Series: An Example

Table Cc-D shows an example of using a price index to deflate a number originally expressed in terms of dollars. Column 1 of the table gives estimates of average salaries of assistant professors in public universities in three years: 1929, 1936, and 1997. Column 2 shows the percentage changes in the average salary from 1929 to 1936 and from 1936 to 1997. Column 3 shows an index for the price of nails constructed like column 7 in Table Cc-A, but with a 1929 base year. Column 5 shows the average assistant professor's salary deflated by the nails price index. That is to say, column 5 is the salaries as originally expressed in dollars (column 1) *divided by* the price index (column 3). The change in the deflated salary between two years is equivalent to the change in the quantity of nails that could be bought with an assistant professor's salary, if a professor bought nothing but nails. Thus, from 1929 to 1936, assistant professors' dollar salaries fell by 7.6 percent, but nail prices fell more, and so the deflated salary rose 10.5 percent: that is to say, the average assistant professor's salary bought 10.5 percent more nails in 1936 than it bought in 1929. From 1936 to 1997, assistant professors' dollar salaries rose by 1,561 percent (about 16 times the amount of the 1936 salary), but the price of nails rose almost as much, and so the deflated salary rose by only about 5.6 percent, which is to say that one could buy 5.6 percent more nails with an assistant professor's salary in 1997 than one could buy with an assistant professor's salary in 1936. Of course, professors do not actually buy a lot of nails, and so it is hard to imagine why anyone might care about these numbers.

Columns 9 and 10 show results of deflating the average assistant professor's salary by a CPI. Column 7 shows the level of the CPI, here rebased so that the 1929 value is equal to 1. Column 9 shows the salary deflated by the CPI (column 1 divided by column 7). At first glance, this exercise appears no more complicated than deflation by the nails price index, and it may be much more interesting. One may take the CPI to measure changes in the general level of prices for the class "things people consume." Under that interpretation, column 9 would indicate the change in the quantity of consumer goods and services that could be bought with an assistant professor's salary. Thus, from 1929 to 1936, while dollar salaries fell by 7.6 percent, consumer prices fell by 19.0 percent, and so the real consumption value of the average assistant professor's salary actually increased by 14.1 percent. From 1936 to 1997, while dollar salaries rose by about 1,561 percent, consumer prices rose by 1,055 percent, leaving a 43.8 percent increase in the quantity of real consumer goods and services that could be bought with the average assistant professor's salary.

The meaning of Table Cc-D cannot be quite as simple as that, however. Some things a professor could buy in 1936 were unavailable to most people in 1997 – for example, public transportation and groceries delivered to one's home. Other things professors routinely bought in 1936 had become prohibitively expensive in 1997, as their prices rose much more than the CPI or professors' salaries. For example, in 1936, many families with incomes equal

TABLE Cc-D Example: average assistant professor's salary deflated by two price indexes

	Average assistant professor's salary		Price index for nails		Salary deflated by price index for nails		Consumer price index		Salary deflated by consumer price index	
	Dollars	Percentage change	1929 = 1	Percentage change	Index	Percentage change	1929 = 1	Percentage change	Index	Percentage change
Year	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
1929	2,691	—	1	—	2691	—	1.000	—	2691	—
1936	2,486	−7.6	0.836	−16.4	2975	10.5	0.810	−19.0	3070	14.1
1997	41,300	1561.3	13.151	1473.6	3140	5.6	9.356	1055.4	4414	43.8

Sources

Average salary of assistant professors in state universities: 1929 and 1936, from George J. Stigler, Employment and Compensation in Education, National Bureau of Economic Research Occasional Paper number 33 (1950), Table 28, p. 42; 1997, from U.S. Bureau of the Census, *Statistical Abstract of the United States, 1998,* Table 314, p. 195.

Price index for nails: constructed from series Cc250–252, in the same manner described for Table Cc-A. These series lack a value for the year 1961. For the purpose of this example, the price of nails was assumed to remain constant from 1960 to 1962.

Consumer price index: series Cc2, rebased to 1929.

to the average assistant professor's salary employed full-time domestic servants.[1] That would hardly have been possible in 1997 on the average assistant professor's salary. Likewise, many goods and services a professor could buy in 1997 could not be bought by anyone in 1936 – for example, televisions and antibiotics. Thus, the numbers in columns 9 and 10 cannot mean that in 1997, the average assistant professor's salary would buy 43.8 percent more of the real goods and services that assistant professors could buy in 1936 with a 1936 salary. Nor can they mean that, compared to 1936, the 1997 salary bought 43.8 percent more of the goods and services that assistant professors bought in 1997.

Undoubtedly, the salary deflated by the CPI is a better measure of an assistant professor's consumption opportunities than is the undeflated dollar salary or the salary deflated by nails' prices. At the same time, it is not clear *exactly* what the CPI-deflated salary means.

The Construction of Aggregate Price Indexes, and Cautions for the User

Anyone using aggregate price indexes should be aware of some problems that complicate the interpretation of any aggregate price index. There are also some problems that apply specifically to historical price series – that is, series that cover periods relatively far in the past.

Price Indexes Depend on the Items Covered and the Aggregation Formula

Some events affect almost all prices in an economy, more or less proportionately. The results of these events are what most people mean by "changes in the price level." Other events affect just a few prices, or the relation between one price and another price. These are often described as changes in "relative prices" as distinct from the price level. It would be easy to construct aggregate price indexes if most movements in prices reflected the events that affect all prices proportionately; then just about any sample of prices, averaged together in just about any way, would give a price index suitable for most purposes. In American data, however, the opposite is usually the case. Over most periods, factors that affect different types of prices in different ways seem to be much more important. Movements in retail prices are different from movements in prices for the same items at wholesale; prices in one place move differently from prices in another place; prices of goods purchased by rich people move differently from prices of things purchased by poor people; and so on. Thus, the behavior of an aggregate price index constructed from American data depends on the types of prices included in the class the index is meant to cover.

Within any class, prices of individual items can evolve in quite different ways, and so the behavior of an aggregate price index also depends on the exact formula that is applied to combine individual prices into one series. Economic theory can guide the selection of an appropriate formula, but the formula that is ideal from a theoretical point of view usually depends on the purpose to which the price index is to be applied and relies on a set of debatable assumptions about human behavior. Almost always, the ideal formula requires more information than the statistician can get, and so the formula applied in practice is a compromise between theory and the data, and the resulting index is less than ideal from any point of view.

Goods Change over Time

Some goods have remained essentially unchanged over many years. A steel nail, a bottle of bourbon whiskey, or a man's haircut produced in 1999 is not very different from the 1899 version. But other goods, as conventionally defined, have changed very much, for example, "an automobile" or "surgery." Any general class of goods is subject to the occasional introduction of goods that are so novel they seem to be entirely new goods, rather than new versions of old goods, while goods that had once been important practically disappear. In essence, all these developments are changes in the *set* of goods making up the class that an aggregate price index is meant to represent. Is there a sensible way to define a change from one period to the next in prices per se when the set of goods is changing, too?

Consider how a statistician constructing a PPI ought to deal with a change in the set of goods produced. From a producer's point of

[1] A survey of consumer expenditures in 1935–1936 asked families whether they employed domestic servants, and if so, the number of days servants were employed (U.S. Bureau of Labor Statistics 1941b, Table 8). One type of family surveyed was made up of a husband, a wife, and two young children, with annual income between $2,250 and $2,499, a range that includes the average assistant professor's salary in 1936. In the northeastern United States, 37 percent of such families employed servants; in the Southeast, 78 percent did. The average number of employment days implies that most families employing servants had them at least forty hours per week.

view, what matters is the way the change affects cost and profit: Does the new set of goods cost more or less to make than the old one? Thus, economic theory prescribes that a PPI should account for a change in goods by linking the price of the old good(s) to the price of the new *minus* any associated increase in production cost (or *plus* the cost savings, if the new is cheaper to produce). Unfortunately, it can be quite hard for a statistician to come up with a solid number for a production cost differential. (Indeed, any accountant will tell you that it is often hard for a firm's managers to come up with a cost differential between two goods, even if the firm is producing both goods at the same time.) Worse, the cost differential can vary across producers. It might be relatively small, for example, for the firm that was the first to produce a new good. (Why else would that particular firm have been first?) Also, cost differentials can vary over time: a good may be especially costly to make when it is first introduced, but less so later on. Whose cost differential, at what point in time, should be used to adjust a producer price index?

A CPI is subject to similar problems when there is a change in the set of goods purchased, although here what matters is whether the consumer prefers the new good(s) to the old one(s), that is, whether the consumer would choose the new (an improvement in quality) or the old (a deterioration in quality) *absent* any difference in price. In principle, a consumer can place a money value on any change in goods; it is the price differential that would make the consumer just indifferent between buying the new good(s) and the old. Intuitively, it seems sensible to link the price of the old good or set of goods to the price of the new *minus* this price premium (for an improvement in quality) or *plus* the discount (for a deterioration). That is indeed the technique prescribed by economic theory. But how is the statistician to come up with this value? One method is to use the difference in price between the new good(s) and the old that was observed to hold at a time and place when both goods or sets of goods were being purchased in meaningful quantities, under the same conditions. This differential was obviously enough to persuade *someone* to buy the new item(s) rather than the old, and vice versa. Unfortunately, it is often impossible to observe prices in the right circumstances.

Worse, just as production costs vary across producers, different consumers place different values on the special qualities of a novel good. Consider, for example, the introduction of central air-conditioning systems for houses in the 1950s. Then as now, some people would have been willing to pay a great deal for central air-conditioning, perhaps because they were rich and could pay a lot for anything, or because they lived in especially hot places or were gluttons for comfort. Other people would have been willing to pay almost nothing for the same good because they were poor, or lived in cool climates, or were ascetics. Most people would have been somewhere between the extremes. At any point in time, the prevailing price for a central air-conditioning system (or the price premium for an air-conditioned house) must have been *less* than some people were willing to pay and *more* than others were willing to pay. Otherwise, everyone would have had a centrally air-conditioned house, which is not the case even today. Whose valuation should be used in the construction of a CPI?

In general, it can be hard to defend any particular number for the change in consumption value or production cost associated with a change in goods. But there is no way to sidestep the issue. Suppose a statistician simply ignores a change in goods and calculates the price change from one period to the next to be equal to the difference between the price of the old good(s) in the earlier period and the new good(s) in the later period. That is equivalent to choosing a value of *zero* for the difference in production cost or consumption quality. Alternatively, suppose a slightly more careful statistician finds a point in time at which there are prices for both the new and old good(s) and the statistician "links" the price series at that point, so that changes in the series up to that point from earlier points reflect the evolution of the price of the old good(s), while changes after the point of the link reflect changes in the price of the new good(s). In the case of a PPI, that would be equivalent to an assumption that all producers faced a production cost differential exactly as big as the differential in price prevailing at the point in time that the price series are linked. (Then why is any producer bothering to produce the new good?) In a CPI, it would mean that the statistician effectively assumes that all consumers are willing to pay that price differential to gain the novelty – nothing more, nothing less.

Cautions for the User of Any Aggregate Price Index

In reality, there is probably no such thing as the price level. There is certainly no such thing as a universal aggregate price index suitable for all purposes. The user of these volumes will find a variety of price indexes for any given historical period. Each series can be thought of as an approximation to a particular theoretical definition of a price level. Take care to choose the price series that is most appropriate for your purpose: for example, a CPI *versus* a PPI. Think about the aggregation formula and the way the index deals with changes in goods. Inevitably, the best available series will fall short of the ideal. Consider how its shortcomings could affect your results. Is it possible that some changes in the actual price level, however defined for your purpose, do not show up in the index – that is, could the index give *incomplete* measures of price changes? Could some movements in the index reflect the error in the price index rather than changes in the "true" price level – that is, could the index give *noisy* measures of changes in the price level? Could the error have a trend over time? Could it be systematically related to economic variables?

Special Cautions for Users of Historical Price Series

Most price indexes covering periods relatively far in the past are worse than their counterparts covering recent years. Some historical series were created long ago, when statisticians were less able (and, in some cases, less willing) than they are nowadays to define meaningful classes of prices, collect representative price samples, and follow economic theory in creating aggregation formulas and techniques for dealing with changes in goods. Other series were constructed retrospectively by researchers who had to use whatever scanty data history had left behind. Either way, historical series are on shaky ground. Gaps in time series are bridged by questionable interpolations. Information is absent for whole categories of prices within the class the index is meant to represent; other types of prices serve as proxies. Little is known about characteristics of priced goods, and so there may be unaccounted-for changes in quality. The aggregation formula may be hard to defend from any theoretical point of view.

Thus, the user of a historical series should keep in mind that it is probably subject to bigger errors than its modern counterpart. It may be a *noisier* and *less complete* measure of the price level, however defined. Its errors may be differently related to economic

variables and have a different trend. This complicates interpretation of the behavior of price series and variables deflated by price series over long spans of time, or comparisons across historical periods. What appear to be changes over time in the behavior of prices or deflated variables may actually reflect differences in the behavior of the price index error.

After all these warnings, the user may agree with an economist of the 1890s who wrote that "the only possible conclusion seems to be that all attempts to calculate and represent average movements of prices, either by index-numbers or otherwise, ought to be abandoned" (Pierson 1896). A hundred years later, an economist known for his work on price indexes expressed particular doubt about comparisons using historical series:

> As far as long-run comparisons are concerned, I do not think that they are really possible.... We have now, approximately, three times the [real] per capita income of what our grandparents had, perhaps even more. Are we three times as happy as they were? Are we that much wealthier? I do not think that is a question that can really be answered. One can easily think of things that go in the other direction that have been lost. (Griliches 1993, p. 358)

On the other hand, John Maynard Keynes observed that there was an "unavoidable element of vagueness which admittedly attends the concept of the general price-level," but he argued that this

> need not, of course, prevent us from making approximate statistical comparisons, depending on some broad element of judgement rather than of strict calculation, which may possess significance and validity within certain limits. But the proper place for such things as net real output and the general level of prices lies within the field of historical and statistical description, and their purpose should be to satisfy historical or social curiosity, a purpose for which perfect precision... is neither usual nor necessary. (Keynes 1936, pp. 39, 40)

The essential thing is to keep the limits in mind and not pretend to more precision than the data allow.

A Brief History of U.S. Wholesale and Producer Price Series

Early Work

In 1806, Samuel Blodgett Jr. published a collection of prices for sixteen commodities over the period 1785–1805 in *Economica: A Statistical Manual for the United States of America*. In 1881, Horatio C. Burchard, the Director of the U.S. Mint, presented a report to the Secretary of the Treasury that contained time series of wholesale prices and an index number. In 1891, data on wholesale prices over the period 1840–1891 were collected for a Senate committee. They were published in 1893 as part of the "Aldrich Reports" (U.S. Senate Committee on Finance 1893). The report included a wholesale price index constructed by Roland Falkner that was inaccurately described as an index of wage earners' cost of living.

Interest in price statistics heightened in the late 1890s, stimulated by a turnaround in the secular trend of prices from deflation to inflation. In 1900, Falkner extended his indexes to 1899 with data collected by the U.S. Department of Labor (a function now performed by the U.S. Bureau of Labor Statistics), and John R. Commons published a wholesale price index covering the period 1878–1900 (U.S. Department of Labor 1900, pp. 237–313; Commons 1900). Bradstreet's indexes of wholesale prices were established in 1897 and carried back to 1890. Dun's index numbers were published in *Dun's Review* beginning in 1901 and extended back to 1860.

Series by the U.S. Bureau of Labor Statistics

In 1902, the agency that became the U.S. Bureau of Labor Statistics (BLS) began regular publication of wholesale price indexes, with monthly series carried back to 1890. This program has been maintained continuously ever since, evolving into today's BLS *Producer Price Index*.

In the beginning, the class of prices covered by the program was vaguely defined to be "prices at which commodities could be purchased in the wholesale market" (U.S. Department of Labor 1902, p. 214). The prices actually collected were chiefly those that were easy to get, for goods that were easy to define. This included prices of some imports (for example, raw rubber) but excluded most finished goods, and so coverage was largely limited to raw materials and goods in the early stages of processing. Most prices in the sample were taken from trade journals. Index numbers were constructed as unweighted arithmetic averages of "price relatives." A price relative was the price for an individual good expressed as a ratio to its price in a base year. A comprehensive "all commodities" index was meant to indicate changes in the overall wholesale price level. Indexes were also constructed for various "commodity groups." Ten "major" groups were defined haphazardly by end-use or material composition. For example, the major group "building materials" included goods such as lumber, bricks, and ingredients for paint, while the goods in the "metals and metal products" ranged from pig iron to farm machinery. In addition to the commodity group series, series were constructed on other classification schemes that were thought to be useful for one reason or another. For example, starting in 1913, the BLS constructed special indexes for goods classified as "raw," "semimanufactured," or "manufactured."

In 1914, the BLS recalculated its indexes back to 1890 as *weighted* arithmetic averages of price relatives. Weights corresponded to estimated total U.S. sales or "shipments" of the good represented by a price series. Changes in commodities or sets of commodities in a group were dealt with by linking the old series to the new one, so that changes in the series from that point to earlier periods reflected the evolution of the price of the old set of goods, while changes from that point forward reflected the prices of the new set. Over the 1920s, 1930s, and 1940s, the BLS gradually expanded the geographic areas and number of goods covered by its price samples, and occasionally revised weights in response to new information on shipments. Lower-level commodity groupings were reorganized from time to time, but the set of major groups remained the same.

In 1952, the BLS introduced a new set of major commodity groups and roughly doubled the number of goods covered by its price samples. It also began regular publication of series organized on an alternative scheme, by "economic sectors," under which prices were categorized by type of buyer and degree of processing. Both of the new sets of series were carried back to 1947. The aggregation formula for indexes was still arithmetic averaging of price relatives weighted by estimates of shipment values, but otherwise, techniques were somewhat different from the early

days. The weight for a good was now the value of shipments for a good *and* other goods whose price movements were assumed to behave similarly. Most prices were now collected by mail from the manufacturer or other producer. Sellers were clearly and specifically requested to report prices not including excise taxes, f.o.b. the production or central marketing point (that is, excluding shipping charges), *less* any discounts received by most buyers. Prices for imported commodities were those received by the first seller of the good in the United States. Price samples represented finished goods as well as less-finished commodities. New items were added to the sample when "they have become established in the market." For some changes in goods, "an attempt is made to obtain data from the reporters on the value of the additional (or deleted) features and to adjust the price index accordingly" (U.S. Bureau of Labor Statistics 1966b, pp. 96 and 93).

In 1978, the BLS changed the name of the program to "Producer Price Index" and shifted its focus to the series categorized by type of buyer and degree of processing, which were now referred to as "stage-of-processing" series. The series for "finished goods, total" replaced the "all commodities" series as the standard measure of overall changes in the price level. These rather abrupt innovations reflected changes in BLS thinking that had actually developed quite gradually during previous years. The BLS had come to understand that the old commodity group scheme was subject to an indefensible form of double-counting: goods that passed through many stages of sale received more weight than goods that moved directly from primary processors to final user. The BLS had also come to define the class of prices covered by the program as producer prices, that is, prices received by producers of goods, specifically revenue received by *domestic* producers in the first commercial transaction for a good. Under this definition, prices of imports were excluded from the aggregates, and weights reflected shipments by domestic producers alone. When possible, adjustments for changes in goods' quality were based on estimates of differentials in production cost – "the usual method for quality adjustment involves the collection of data from reporting companies on the costs they have incurred in connection with a quality change" (U.S. Bureau of Labor Statistics 1997, p. 132).

Retrospective Historical Series

In 1929, the International Scientific Committee on Price History was formed. In the United States, the committee supported a project by George F. Warren and Frank A. Pearson (1933) to create wholesale price indexes for the entire nineteenth century that would "correspond with" the BLS wholesale price indexes, which began with 1890. Most of the price data used by Warren and Pearson came from newspapers and government reports, and they referred specifically to prices at New York City. Like the BLS data for the 1890s, they covered few finished goods, and so movements in the indexes largely reflected movements in prices of raw materials and goods in the early stages of processing. Working in association with Warren and Pearson, Herman M. Stoker extended the series back into the eighteenth century. The Warren and Pearson and Stoker series are presented here in Table Cc113–124.

The committee also sponsored research to create wholesale price indexes for cities other than New York, focusing on periods before the Civil War. The resulting series for Charleston, South Carolina; Philadelphia; Cincinnati; and New Orleans are presented here as Tables Cc138–187. (Series were also constructed for Boston, but they are especially unreliable and are not presented here.) The data underlying these series were taken from newspapers, merchants' price lists, and account books and are generally scantier than the New York data used by Warren and Pearson. The committee planned to construct series for San Francisco but "with considerable regret, this area was stricken from the original list" because of "lack of funds" (Cole 1938, p. xxiii). Years later, Thomas Senior Berry, who had constructed the committee-sponsored series for Cincinnati, fulfilled the original plan by constructing the series for San Francisco given here as Table Cc188–204 (Berry 1943).

A Brief History of U.S. Consumer Price Series

Early Work

Although nineteenth-century discussions of economic matters often turned on questions about consumer prices, early statisticians collected less information about retail prices than wholesale prices. A special report for the 1880 census, overseen by Joseph D. Weeks and usually referred to as the Weeks Report, included data on retail prices and house rents from 1851 through 1880 (U.S. Bureau of the Census 1886). In 1891, retail prices for more than 200 commodities over twenty-eight months ending September 1891 were collected for a Senate committee and published in the Aldrich Report (U.S. Senate Committee on Finance 1892). In 1904, the agency that became the BLS began to publish indexes of retail food prices, beginning with data for 1890 (U.S. Department of Labor 1904).

The BLS Consumer Price Index

Today's BLS CPI originated in disputes among labor unions, employers, and government arbitrators during the First World War. To provide information for wage negotiations in the shipbuilding industry, the BLS collected data on blue-collar workers' household budgets in 1918 and 1919, as well as rents and retail prices in a set of industrial cities in December of each year from 1914 through 1917 (U.S. Bureau of Labor Statistics 1924). Following up on this study, the BLS collected retail prices and rents in December 1918 and June 1919. In the *Monthly Labor Review* for October 1919, the BLS published a time-series index of retail prices and rents, weighted by average budget shares in the 1918–1919 expenditure surveys, beginning with December 1914. Later BLS publications began consumer price series with a number for 1913, but that is merely an extrapolation based on data for retail food prices and *wholesale* prices of some consumer commodities (U.S. Bureau of Labor Statistics 1920, p. 97). In 1921, the BLS began to collect retail prices and rents on a regular basis in two months of each year and to publish indexes constructed from them. In 1935, the BLS began to collect data one month in each quarter, and in late 1940, for every month in the year. Monthly BLS CPI series for periods before 1940 are interpolations based mainly on food prices (U.S. Bureau of Labor Statistics 1966a, p. 10). Genuine monthly data on consumer prices during the 1920s and 1930s were collected by the National Industrial Conference Board (Sayre 1948).

In the beginning, the BLS program focused specifically on goods and services purchased by families of urban, male, employed "wage-earners and lower-salaried clerical workers," each having a wife and at least one child (U.S. Bureau of Labor Statistics 1924). In 1953, the target population was expanded to include families of all urban wage and clerical workers; in 1964, workers without

families were added. In 1978, the population was expanded to include all urban residents, of any social status (except members of the armed forces and inmates of prisons, hospitals, and insane asylums). The current CPI-U series is based on consumption patterns of all urban consumers, while the CPI-W continues the older approach, with weights based on consumption of employed urban wage earners and clerical workers.

The theoretical concepts underlying the series were at first quite vague. From its inception through the early 1940s, its official name was the "Cost of Living" index. In practice, it was an arithmetically weighted index of rents and retail prices of goods and a few services, for the same list of items of the same qualities and bought from the same stores from one period to the next. During the Second World War, this method became controversial. Union leaders claimed that the index failed to account for increases in the "true cost of living" caused by schemes to evade rent and price controls, such as quality downgrades on "standard" grades of products. In response, the BLS changed the name of the index, in September 1945, to "Consumers' Price Index" and began to state clearly and often that the index was *not* meant to measure the cost of maintaining a certain standard of living or welfare, but rather the cost of purchasing an unchanging "basket" of goods and services (U.S. Bureau of Labor Statistics 1966a, p. 6).

Indeed, as a proxy for a true cost-of-living (or "constant-utility") price index, the CPI of the period from the 1920s through the 1950s has some obvious flaws. New goods were introduced only at the time of a major survey of household spending patterns, which was performed rarely. The survey following the original 1918–1919 survey was performed in 1934–1936. Important new goods of the 1920s, such as automobiles, radios, and electric refrigerators, did not enter the index until 1935, even though they had been important to working-class families long before that and had already affected consumption patterns in a variety of ways.[2] New goods of the late 1940s, such as television sets and frozen foods, entered the index in 1950 (U.S. Bureau of Labor Statistics 1966a, p. 12). Changes in goods were dealt with mainly by attempting to specify as precisely as possible the characteristics of goods included in the CPI basket, so that the priced goods did not change at all from one period to the next (Weiss 1955). When an old good disappeared from stores, it was usually replaced by a new good with the price series linked at the point of changeover, so that none of the price differential between the two goods was treated as a price change. As late as the 1940s, however, for some important goods such as automobiles, radios, and large appliances, a change in price from one period to the next was taken to be equal to the raw difference in price between an old model and a newer model, even if the newer model had significantly different characteristics.[3] In 1959, the BLS began to adjust changes in new automobile prices by estimates of the *cost* of model changes obtained from manufacturers (Stotz 1966).

In 1960, a federally sponsored commission on price indexation headed by George Stigler recommended that "the CPI should be moved toward becoming an index of welfare or constant utility." The BLS rejected this recommendation but accepted in principle the importance of making explicit adjustments for quality changes and more timely introduction of new goods (U.S. Bureau of Labor Statistics 1966a, p. 8). In practice, little was done to improve the CPI along these lines until 1978, when procedures were adopted that allowed for more frequent introduction of new items and points of purchase; similar steps were taken in 1987 (Shishkin 1974; U.S. Bureau of Labor Statistics 1978; Cage 1996). In 1991, the BLS began to adjust clothing prices for changes in quality using statistical estimates of price differentials associated with clothing characteristics (Liegey 1994). In 1996, a federally sponsored commission chaired by Michael Boskin echoed the advice of the 1960 commission and recommended that the BLS "adopt production of a cost-of-living [constant-utility] index as its objective." This time the BLS replied that they had already done just that (Greenleas and Mason 1996, p. 2).

The late 1990s saw many important innovations to CPI procedures, including the adjustment of personal computer and television prices for changes in quality using methods similar to those already applied to clothing. The most radical innovation was the application of a method long recommended by economists but previously scorned by the BLS: geometric rather than arithmetic averaging of individual goods' prices to construct an index number (Fisher 1922). In January 1999, the BLS began to use geometric averaging within groups of very closely related goods, for example, to combine prices of different types of apples for an "apple" group index. Arithmetic averaging was still applied to combine component indexes for larger groups and aggregate series (Dalton, Greenlees, and Stewart 1998). The total effect of these and other technical changes of the late 1990s was to reduce the rate of growth of the CPI-U by about one-half percent per year, relative to the rate of growth the CPI would have shown had the BLS stuck with the methods of the early 1990s (U.S. Council of Economic Advisers 1999, p. 93; Stewart and Reed 1999).

Other than issues associated with new goods and quality changes, the most vexing problem faced by the BLS in CPI construction has been the treatment of housing costs. Housing costs are especially tricky even in theory because many people own their own homes.[4] At first, housing costs were represented by rents for apartments and houses. In 1956, house purchase prices, mortgage rates, and property taxes were incorporated into the index to account for housing costs for families that owned their homes. In the 1980s (1983 for the CPI-U, 1985 for the CPI-W), the 1956 move was reversed, so that the housing cost component was once again based on rents alone (including a calculation of "rental equivalence" cost of homeowning) (U.S. Bureau of Labor Statistics 1985, p. 346). BLS research indicates that such changes in the treatment of housing costs may have had a bigger effect on CPI growth rates than the innovations of the late 1990s (Stewart and Reed 1999).

[2] In 1940, it was observed that "in recent years, baby carriages have become increasingly difficult to price in stores patronized by wage-earners and lower-salaried workers. Demand for new baby carriages has fallen off among families in this group. Those with automobiles are apt to take the baby to ride in a basket in the car" (U.S. Bureau of Labor Statistics 1940, p. 377).

[3] "When new models of automobiles, radios, refrigerators, vacuum cleaners, and washing machines are introduced, the practice is to use the price of the largest selling lines of the current model . . . and allow the full effect of price changes of the most popular model to enter into the index. Thus, when refrigerator prices went down more than 10 percent in the spring of 1940 this decline was reflected in the cost-of-living index without adjustment, even though quality had improved so that price, without regard to quality, might have shown a greater decline" (U.S. Bureau of Labor Statistics 1941a, p. 8).

[4] For example, for a homeowner, an increase in house prices or rents relative to money income, as usually defined, need not reduce real consumption. That is because the increase in the implicit cost of "housing services" is offset by an increase in wealth – the value of the house – or income more broadly defined.

Retrospective Historical Series

Because historical data on retail prices and rents are so scarce, CPIs covering years before the beginning of the BLS series in 1914 may be less reliable than wholesale price series for the same periods. Many historical CPI series use wholesale prices as stand-ins for retail prices. Some contain component indexes of "rents" that are really indexes of construction costs or straight-line interpolations benchmarked to actual housing costs in just a few widely spaced years. In most cases, the underlying data are from the Northeast and Midwest, rather than the country as a whole. Like the BLS CPI for years before the 1970s, the series are designed to indicate changes in the cost of goods and services purchased by lower-class households.

Series covering years from the 1850s through 1880 are arguably the best of a bad lot because they can draw on the data originally collected for the Weeks Report. In 1908, Wesley C. Mitchell published an index of retail prices and rents spanning 1860–1880 constructed from a selection of Weeks Report data (Mitchell 1908, p. 91). In 1960, Ethel Hoover published a CPI for 1851–1880, given here as Table Cc49–57 and the 1851–1860 portion of Table Cc1–2, based mainly on the Weeks Report (Hoover 1960). Stanley Lebergott constructed a CPI for 1860–1880, given here as the 1860–1880 portion of Table Cc1–2, using Mitchell's food price indexes, Hoover's indexes for clothing and fuel, and, as a proxy for house rents, an index of construction costs benchmarked to data on rents in 1860 and 1868 (Lebergott 1964).

Series for 1890 through 1914 can rely on BLS retail price series for food and, starting in 1907, fuel. In 1926, Paul H. Douglas published an index of the "Cost of Living for Workingmen's Families" spanning 1890 to 1914, constructed from the BLS series supplemented by wholesale price data. Douglas did not attempt to construct measures of rents.[5] In 1958, Albert Rees published an index for 1890–1914, given here as the 1890–1914 portion of Table Cc1–2, based on Douglas's series for food, tobacco, and alcohol, combined with mail-order catalog prices for clothing, house furnishings, and house rents collected from newspaper advertisements.[6]

Series for periods before 1851 and between 1880 and 1890 are the product of heroic research and equally heroic assumptions. They must be used with special care. In the 1940s, T. M. Adams published series on retail prices paid by Vermont farmers over the period 1790–1940, based on figures spotted in farmers' journals and general store daybooks (Adams 1944). Clarence Long constructed a consumer price index for 1880–1890, given here as the 1880–1890 portion of Table Cc1–2, from scanty retail price data and a series for rent that is nothing more than a straight-line interpolation between observations for 1880 and 1890 (Long 1960). A series for years before 1851, given here as the early portion of Table Cc1–2, was constructed by Paul David and Peter Solar (David and Solar 1977, p. 2). For 1800–1851, the retail price component of this series is from Adams's Vermont farmers' prices, benchmarked on more comprehensive retail price data from Massachusetts and Pennsylvania in 1809, 1834, 1836, 1839, 1844, and 1849, while the rent component is actually an index of construction costs benchmarked on house prices in 1839, 1849, and 1859. For years before 1800, the series is a transformation of the Philadelphia wholesale price series given here as Table Cc155–169.

[5] Douglas 1926; series also given in Douglas 1930, p. 60.

[6] National Bureau of Economic Research 1958, pp. 59–60; series also given in Rees 1961.

References

Adams, Thurston Madison. 1944. "Prices Paid by Farmers for Goods and Services and Received by Them for Farm Products, 1790–1940: Wages of Vermont Farm Labor, 1780–1940." Vermont Agricultural Experiment Station, Bulletin number 507, February.

Berry, Thomas. 1943. *Western Prices before 1861*. Harvard University Press.

Cage, Robert. 1996. "New Methodology for Selecting CPI Outlet Samples." *Monthly Labor Review* 119 (December): 49–56.

Cole, Arthur Harrison. 1938. *Wholesale Commodity Prices in the United States 1700–1861*. Harvard University Press.

Commons, John R. 1900. *Quarterly Bulletin of the Bureau of Economic Research* 1 (1 and 2) (July and October).

Dalton, Kenneth V., John S. Greenlees, and Kenneth J. Stewart. 1998. "Incorporating a Geometric Mean Formula into the CPI." *Monthly Labor Review* 121 (October): 3–7.

David, Paul A., and Peter Solar. 1977. "A Bicentenary Contribution to the History of the Cost of Living in America." *Research in Economic History* 2: 1–80.

Douglas, Paul H. 1926. "The Movement of Real Wages and Its Economic Significance." *American Economic Review* 16 (1) supplement: 17–53.

Douglas, Paul H. 1930. *Real Wages in the United States, 1890–1926*. Houghton Mifflin.

Fisher, Irving. 1922. *The Making of Index Numbers*. Houghton Mifflin.

Greenleas, John S., and Charles C. Mason. 1996. "Overview of the 1998 Revision of the Consumer Price Index." *Monthly Labor Review* 119 (12): 3–9.

Griliches, Zvi. 1993. "Panel Discussion: Implications of BEA's Treatment of Computer Prices and Productivity Measurement." In Murray F. Foss, Marilyn E. Manser, and Allan H. Young, editors. *Price Measurements and Their Uses*. University of Chicago Press.

Hoover, Ethel D. 1960. "Prices in the 19th Century." In *Trends in the American Economy in the Nineteenth Century.* Studies in Income and Wealth, volume 24. Princeton University Press.

Keynes, John Maynard. 1936. *The General Theory of Employment, Interest and Money.* Harcourt, Brace.

Lebergott, Stanley. 1964. *Manpower in Economic Growth*. McGraw-Hill.

Liegey, Paul R., Jr. 1994. "Apparel Price Indexes: Effects of Hedonic Adjustment." *Monthly Labor Review* 117 (May): 38–45.

Long, Clarence. 1960. *Wages and Earnings in the United States 1860–1890*. Princeton University Press.

Mitchell, Wesley C. 1908. *Gold, Prices, and Wages under the Greenback Standard*. University of California Publications in Economics, volume 1, March.

National Bureau of Economic Research. 1958. *Thirty-eighth Annual Report*. National Bureau of Economic Research, May.

Pierson, N. G. 1896. "Further Considerations on Index-Numbers." *Economic Journal* 6 (21): 127–31.

Rees, Albert. 1961. *Real Wages in Manufacturing, 1890–1914.* General Series number 70. Princeton University Press for the National Bureau of Economic Research.

Sayre, Robert A. 1948. *Consumers' Prices, 1914–1948*. National Industrial Conference Board.

Shishkin, Julius. 1974. "Updating the Consumer Price Index: An Overview." *Monthly Labor Review* 97 (July): 3–20.

Stewart, Kenneth J., and Stephen B. Reed. 1999. "Consumer Price Index Research Series Using Current Methods, 1978–98." *Monthly Labor Review* 122 (June): 29–38.

Stotz, Margaret S. 1966. "Introductory Prices of 1966 Automobile Models." *Monthly Labor Review* 89 (February): 178–81.

U.S. Bureau of Labor Statistics. 1920. "Changes in Cost of Living in the United States, 1913 to October 1919." *Monthly Labor Review* 10 (January): 97.

U.S. Bureau of Labor Statistics. 1924. *Cost of Living in the United States*. Bulletin number 357, May.

U.S. Bureau of Labor Statistics. 1940. "The Bureau of Labor Statistics' New Index of Cost of Living." *Monthly Labor Review* 51 (August): 367–404.

U.S. Bureau of Labor Statistics. 1941a. *Changes in Costs of Living in Large Cities in the United States, 1913–41*. Bulletin number 699.
U.S. Bureau of Labor Statistics. 1941b. *Family Expenditures in Selected Cities*, volume 1, *Housing.* Bulletin number 648.
U.S. Bureau of Labor Statistics. 1966a. *The Consumer Price Index: History and Techniques*. Bulletin number 1,517.
U.S. Bureau of Labor Statistics. 1966b. *Handbook of Methods for Surveys and Studies*. Bulletin number 1,458.
U.S. Bureau of Labor Statistics. 1978. *The Consumer Price Index: Concepts and Contents over the Years*. Report number 517, May.
U.S. Bureau of Labor Statistics. 1985. *Handbook of Labor Statistics*. Bulletin number 2,217, June.
U.S. Bureau of Labor Statistics. 1997. *BLS Handbook of Methods*. Bulletin number 2,490, April.
U.S. Bureau of the Census. 1886. *Tenth Census of the United States*, volume 20, *Report on the Statistics of Wages in Manufacturing Industries*. U.S. Government Printing Office.
U.S. Council of Economic Advisers. 1999. "Economic Report of the President." February.
U.S. Department of Labor. 1900. "Wholesale Prices: 1890 to 1899." Bulletin number 27.
U.S. Department of Labor. 1902. *Course of Wholesale Prices, 1890–1901*. Bulletin number 39, March.
U.S. Department of Labor. 1904. *Eighteenth Annual Report of the Commissioner of Labor, 1903: Cost of Living and Retail Prices of Food*. U.S. Government Printing Office.
U.S. Senate Committee on Finance. 1892. *Retail Prices and Wages* (3 parts). Senate Report number 986. U.S. Government Printing Office.
U.S. Senate Committee on Finance. 1893. *Wholesale Prices, Wages, and Transportation* (4 parts). Senate Report number 1,394. U.S. Government Printing Office.
Warren, George F., and Frank A. Pearson. 1933. *Prices.* Wiley.
Weiss, Samuel. 1955. "The Development of Index Numbers in the BLS." *Monthly Labor Review* 78 (January): 20–5.