CHAPTER 2

The Data of Macroeconomics

Notes to the Instructor

Chapter Summary

Chapter 2 is a straightforward chapter on economic data that emphasizes real GDP, the consumer price index, and the unemployment rate. This chapter contains a standard discussion of GDP and its components, explains the different measures of inflation, and discusses how the population is divided among the employed, the unemployed, and those not in the labor force. This chapter also introduces the circular flow and the relationship between stocks and flows.

Comments

Students may have seen this material in principles classes, so it can often be covered quickly. I prefer not to get involved in the details of national income accounting; my aim is to get students to understand the sort of issues that arise in looking at economic data and to know where to look if and when they need more information. From the point of view of the rest of the course, the most important things for students to learn are the identity of income and output, the distinction between real and nominal variables, and the relationship between stocks and flows.

Use of the Web Site

The discussion of economic data can be made more interesting by encouraging students to use the data plotter and look at the series being discussed. In using the software, the students should be encouraged to look at the data early to try to familiarize themselves with the basic stylized facts. The transform data option on the plotter can be used to help the students gain an understanding of growth rates and percentage changes and to show them the distinction between real and nominal GDP.

Use of the Dismal Scientist Web Site

Use the Dismal Scientist Web site to download data for the past 40 years on nominal GDP and the components of spending (consumption, investment, government purchases, exports, and imports). Compute the shares of spending accounted for by each component. Discuss how the shares have changed over time.

Chapter Supplements

This chapter includes the following supplements:

2-1 Measuring Output
2-2 Nominal and Real GDP Since 1929
2-3 Chain-Weighted Real GDP
2-4 The Components of GDP (Case Study)
2-5 Defining National Income
2-6 Seasonal Adjustment and the Seasonal Cycle
2-7 Measuring the Price of Light

2-8 Improving the CPI
2-9 CPI Improvements and the Decline in Inflation During the 1990s
2-10 The Billions Prices Project
2-11 Alternative Measures of Unemployment
2-12 Improving the National Accounts

Lecture Notes

Introduction

An immense amount of economic data is gathered on a regular basis. Every day, newspapers, radio, television, and the Internet inform us about some economic statistic or other. Although we cannot discuss all these data here, it is important to be familiar with some of the most important measures of economic performance.

2-1 Measuring the Value of Economic Activity: Gross Domestic Product

The single most important measure of overall economic performance is *Gross Domestic Product* (GDP), which aims to summarize all economic activity over a period of time in terms of a single number. GDP is a measure of the economy's total output *and* of total income. Macroeconomists use the terms "output" and "income" interchangeably, which seems somewhat mysterious. The reason is that, for the economy as a whole, total production equals total income. Our first task is to explain why.

Income, Expenditure, and the Circular Flow

Suppose that the economy produces just one good—bread—using labor only. (Notice what we are doing here: We are making simplifying assumptions that are obviously not literally true to gain insight into the working of the economy.) We assume that there are two sorts of economic actors—households and firms (bakeries). Firms hire workers from the households to produce bread and pay wages to those households. Workers take those wages and purchase bread from the firms. These transactions take place in two markets—the *goods market* and the *labor market*.

➢ Figure 2-1

GDP is measured by looking at the flow of dollars in this economy. The *circular flow of income* indicates that we can think of two ways of measuring this flow—by adding up all incomes or by adding up all expenditures. The two will have to be equal simply by the rules of accounting. Every dollar that a firm receives for bread either goes to pay expenses or else increases profit. In our example, expenses simply consist of wages. Total expenditure thus equals the sum of wages and profit.

➢ Supplement 2-1, "Measuring Output"

FYI: Stocks and Flows

Goods are not produced instantaneously—production takes time. Therefore, we must have a period of time in mind when we think about GDP. For example, it does not make sense to say a bakery produces 2,000 loaves of bread. If it produces that many in a day, then it produces 4,000 in two days, 10,000 in a (five-day) week, and about 130,000 in a quarter. Because we always have to keep a time dimension in mind, we say that GDP is a flow. If we measured GDP at any tiny instant of time, it would be almost zero.

Other variables can be measured independent of time—we refer to these as *stocks.* For example, economists pay a lot of attention to the factories and machines that firms use to produce goods. This is known as the *capital stock*. In principle, you could measure this at any instant of time. Over time this capital stock will change because firms purchase new factories and machines. This change in the stock is called *investment*; it is a flow. Flows are changes in stocks; stocks change as a result of flows. In understanding the macroeconomy, it is often crucial to keep the distinction between stocks and flows in mind. A classic example of the stock–flow relationship is that of water flowing into a bathtub.

➢ Figure 2-2

Rules for Computing GDP

Naturally, the measurement of GDP in the economy is much more complicated in practice than our simple bread example suggests. There are any number of technical details of GDP measurement that we ignore, but a few important points should be mentioned.

First, what happens if a firm produces a good but does not sell it? What does this mean for GDP? If the good is thrown out, it is as if it were never produced. If one fewer loaf of bread is sold, then both expenditure and profits are lower. This is appropriate, since we would not want

➢

GDP to measure wasted goods. Alternatively, the bread may be put into *inventory* to be sold later. Then the rules of accounting specify that it is as if the firm purchases the bread from itself. Both expenditure and profit are the same as if the bread were sold immediately.

Second, what happens if there is more than one good in the economy? We add up different commodities by valuing them at their *market price*. For each commodity, we take the number produced and multiply by the price per unit. Adding this over all commodities gives us total GDP.

Many goods are *intermediate goods*—they are not consumed for their own sake but are used in the production of other goods. Sheet metal is used in the production of cars; beef is used in the production of hamburgers. The GDP statistics include only *final goods*. If a miller produces flour and sells that flour to a baker, then only the final sale of bread is included in GDP. An alternative but equivalent way of measuring GDP is to add up the *value added* at all stages of production. The value added of the miller is the difference between the value of output (flour) and the value of intermediate goods (wheat). The sum of the value added at each stage of production equals the value of the final output.

Finally, we need to take account of the fact that not all goods and services are sold in the marketplace. To include such goods it is necessary to calculate an *imputed value*. An important example is owner-occupied housing. Since rent payments to landlords are included in GDP, it would be inconsistent not to include the equivalent housing services that homeowners enjoy. It is thus necessary to impute a value of housing services, which is simply like supposing that homeowners pay rent to themselves. Imputed values are also calculated for the services of public servants; they are simply valued by the wages that they are paid.

Real GDP versus Nominal GDP

➢ Supplement 2-2, "Nominal and Real GDP Since 1929"

Valuing goods at their market price allows us to add different goods into a composite measure but also means we might be misled into thinking we are producing more if prices are rising. Thus, it is important to correct for changes in prices. To do this, economists value goods at the prices at which they sold in some given year. For example, we might measure GDP at 1998 prices (often referred to as measuring GDP in 1998 dollars). This is then known as real GDP. GDP measured at current prices (in current dollars) is known as nominal GDP. The distinction between real and nominal variables arises time and again in macroeconomics.

The GDP Deflator

The *GDP deflator* is the ratio of nominal to real GDP:

$$\text{GDP Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}$$

The GDP deflator measures the price of output relative to prices in the base year, which we denote by P. Hence, nominal GDP equals PY.

Chain-Weighted Measures of Real GDP

➢ Supplement 2-3, "Chain-Weighted Real GDP"

In 1996, the Bureau of Economic Analysis changed its approach to indexing GDP. Instead of using a fixed base year for prices, the Bureau began using a moving base year. Previously, the Bureau used prices in a given year—say, 1990—to measure the value of goods produced in all years. Now, to measure the change in real GDP from, say, 2014 to 2015, the Bureau uses the prices in both 2014 and 2015. To measure the change in real GDP from 2015 to 2016, prices in 2015 and 2016 are used.

FYI: Two Arithmetic Tricks for Working with Percentage Changes

➢ Supplement 8-5, "Growth Rates, Logarithms, and Elasticities"

The percentage change of a product in two variables equals (approximately) the sum of the percentage changes in the individual variables. The percentage change of the ratio of two variables equals (approximately) the difference between the percentage change in the numerator and the percentage change in the denominator.

The Components of Expenditure

Although GDP is the most general measure of output, we also care about what this output is used for. National income accounts thus divide total expenditure into four categories, corresponding approximately to who does the spending, in an equation known as the national income identity,

$$Y = C + I + G + NX,$$

where C is consumption, I is investment, G is government purchases, and NX is net exports, or exports minus imports. Consumption is expenditure on goods and services by households; it is thus the spending that individuals carry out every day on food, clothes, movies, DVD players, automobiles, and the like. Food, clothing, and other goods that last for short periods of time are classified as nondurable goods, whereas automobiles, DVD players, and similar goods are classified as durable goods. (The distinction is somewhat arbitrary: A good pair of hiking boots might last for many years while the latest laptop computer might be out of date in a matter of months!) The third category of consumption, known as services, includes the purchase of intangible items, such as doctor visits, legal advice, and haircuts.

Investment is for the most part expenditure by firms on factories, machinery, and intellectual property products; this is known as *business fixed investmen*t. We noted earlier that goods put into inventory by firms are counted as part of expenditure; they are classified as *inventory investment.* This can be negative if firms are running down their stocks of inventory rather than increasing them. A third component of investment spending is actually carried out by households and landlords—*residential fixed investment*. This is the purchase of new housing.

The third category of expenditure corresponds to purchases by government (at all levels—federal, state, and local). It includes, most notably, defense expenditures, as well as spending on highways, bridges, and so forth. It is important to realize that it includes only spending on goods and services that make up GDP. This means that it *excludes* unemployment insurance payments, Social Security payments, and other *transfer payments.* When the government pays transfers to individuals, there is an indirect effect on GDP only, to the extent that individuals take those transfer payments and use them for consumption.

Finally, some of the goods that we produce are purchased by foreigners. These purchases represent another component of spending—exports—that must be added in. But, conversely, expenditures on goods produced in other countries do not represent purchases of goods that we produce. Since the idea of GDP is to measure total production in our country, imports must be subtracted. Net exports simply equal exports minus imports.

FYI: What Is Investment?

➢ Supplement 3-5, “Economists’ Terminology”

Economists use the term “investment” in a very precise sense. To the economist, investment means the purchase of newly created goods and services to add to the capital stock. It does not apply to the purchase of already existing assets, since this simply changes the ownership of the capital stock.

Case Study: GDP and Its Components

➢ Table 2-1

For the year 2013, U.S. GDP equaled about $16.8 trillion, or about $53,000 per person. Approximately two-thirds of GDP was spent on consumption (about $11.5 trillion). Private investment was about 16 percent of GDP (about $2.7 trillion), while government purchases were nearly 19 percent of GDP (about $3.1 trillion). Imports exceeded exports by $500 billion.

Other Measures of Income

➢ Supplement 2-4, “The Components of GDP”

There are other measures of income apart from GDP. The most important are as follows: *gross national product* (GNP) equals GDP minus income earned domestically by foreign nationals plus income earned by U.S. nationals in other countries; *net national product* (NNP) equals GNP minus a correction for the *depreciation* or wear and tear of the capital stock (*consumption of fixed capital*). The capital consumption allowance equaled about 16 percent of GNP in 2013. Net national product is approximately equal to *national income*. The two measures differ by a small

➢ Supplement 2-5, "Defining National Income"

amount known as the *statistical discrepancy*, which reflects differences in data sources that are not completely consistent. By adding dividends, transfer payments, and personal interest income and subtracting indirect business taxes, corporate profits, social insurance contributions, and net interest, we move from national income to *personal income*. Finally, if we subtract income taxes and nontax payments, we obtain *disposable personal income*. This is a measure of the after-tax income of consumers. Most of the differences among these measures of income are not important for our theoretical models, but we do make use of the distinction between GDP and disposable income.

Seasonal Adjustment

Many economic variables exhibit a seasonal pattern—for example, GDP is lowest in the first quarter of the year and highest in the last quarter. Such fluctuations are not surprising since some sectors of the economy, such as construction, agriculture, and tourism, are influenced by the weather and the seasons. For this reason, economists often correct for such seasonal variation and look at data that are seasonally adjusted.

Case Study: The New, Improved GDP of 2013

➢ Supplement 2-6, "Seasonal Adjustment and the Seasonal Cycle"

An important change in how the Bureau of Economic Analysis calculates GDP occurred with the 2013 comprehensive revision of the national income and product accounts. This change involves treating expenditures associated with creating intangible assets, such as artistic works or research and development, in the same manner as tangible assets, such as machine tools or factory buildings. Prior to this change, expenditures on intangible assets were treated as spending on intermediate goods. The revision now treats such expenditures as part of investment spending. For example, expenditures on filming movies previously counted as expenditures on intermediate goods, and the only contribution to GDP came from expenditures on ticket sales. With this revision, expenditures on filming movies are added to the investment component of GDP. As with all major revisions of the national income accounts, the Bureau of Economic Analysis has incorporated this change by revising the data back to 1929.

2-2 Measuring the Cost of Living: The Consumer Price Index

➢ Figure 2-3

We noted earlier the difference between real and nominal GDP: Real GDP takes GDP measured in dollars—nominal GDP—and adjusts for inflation. There are two basic measures of the inflation rate: the percentage change in the GDP deflator and the percentage change in the *consumer price index* (CPI).

The Price of a Basket of Goods

The percentage change in the consumer price index is a good measure of inflation as it affects the typical household. The CPI is calculated on the basis of a typical "basket of goods," based on a survey of consumers' purchases. The point of having a basket of goods is that price changes are weighted according to how important the good is for a typical consumer. If the price of bread doubles, that will have a bigger effect on consumers than if the price of matches doubles because consumers spend more of their income on bread than they do on matches. The CPI is defined as

$$\text{CPI} = \frac{\text{Current Price of Base-Year Basket of Goods}}{\text{Base-Year Price of Base-Year Basket of Goods}}$$

Like the GDP deflator, the CPI is a measure of the price level P.

The CPI versus the GDP Deflator

The GDP deflator is a measure of the price of all goods produced in the United States that go into GDP. In particular, the GDP deflator accounts for changes in the price of investment goods and goods purchased by the government, which are not included in the CPI. It is, thus, a good measure of the price of "a unit of GDP." The CPI is a poorer measure of the price of GDP, but it provides a better measure of the price level as it affects the average consumer. Since the CPI measures the cost of a typical set of consumer purchases, it does not include the prices of, say, earthmoving equipment or Stealth bombers. It does include the prices of imported goods that consumers purchase, such as Japanese televisions. Both of these factors make the CPI differ from the GDP deflator.

A final difference between these two measures of inflation is more subtle. The CPI is calculated on the basis of a fixed basket of goods, whereas the GDP deflator is based on a changing basket of goods. For example, when the price of apples rises and consumers purchase more oranges and fewer apples, the CPI does not take into account the change in quantities purchased and continues to weight the prices of apples and oranges by the quantities that were purchased during the base year. The GDP deflator, by contrast, allows the basket of goods to change over time as the composition of GDP changes. Thus, the CPI "overweights" products whose prices are rising rapidly and "underweights" products whose prices are rising slowly, thereby overstating the rate of inflation. By updating the basket of goods, the GDP deflator captures the tendency of consumers to substitute away from more expensive goods and toward cheaper goods. The GDP deflator, however, may actually understate the rate of inflation because people may be worse off when they substitute away from goods that they really enjoy—someone who likes apples much better than oranges may be unhappy eating fewer apples and more oranges when the price of apples rises.

Another measure of inflation is the implicit price deflator for personal consumption expenditures, or PCE deflator. This measure, computed as the ratio of nominal consumption expenditures to real consumption expenditures, is similar to the GDP deflator but includes only the consumption component of GDP. Like the CPI, the PCE deflator excludes goods purchased by government and by businesses and includes imported goods. Like the GDP deflator, it allows the basket of goods to change over time. Because of these characteristics, the Federal Reserve uses the PCE deflator as its preferred measure of inflation.

Does the CPI Overstate Inflation?

- Supplement 2-7, "Measuring the Price of Light"

Many economists believe that changes in the CPI are an overestimate of the true inflation rate. We already noted that the CPI overstates inflation because consumers substitute away from more expensive goods. There are two other considerations.

- Supplement 2-8, "Improving the CPI"
- Supplement 2-9, "CPI Improvements and the Decline in Inflation During the 1990s"

- *New Goods* When producers introduce a new good, consumers have more choices and can make better use of their dollars to satisfy their wants. Each dollar will, in effect, buy more for an individual, so the introduction of new goods is like a decrease in the price level. This value of greater variety is not measured by the CPI.
- *Quality Improvements* Likewise, an improvement in the quality of goods means that each dollar effectively buys more for the consumer. An increase in the price of a product thus may reflect an improvement in quality and not simply a rise in cost of the "same" product. The Bureau of Labor Statistics makes adjustments for quality in measuring price increases for some products, including autos, but many changes in quality are hard to measure. Accordingly, if over time the quality of products and services tends to improve rather than deteriorate, then the CPI probably overstates inflation.

- Supplement 2-10 "The Billion Prices Project:

A panel of economists recently studied the problem and concluded the CPI overstates inflation by about 1.1 percentage points per year. The BLS has since made further changes in the way the CPI is calculated so that the bias is now believed to be less than 1 percentage point.

2-3 Measuring Joblessness: The Unemployment Rate

Finally, we consider the measurement of unemployment. Employment and unemployment statistics are among the most watched of all economic data, for a couple of reasons. First, a well-functioning economy will use all its resources. Unemployment may signal wasted resources and, hence, problems in the functioning of the economy. Second, unemployment is often felt to be of concern since its costs are very unevenly distributed across the population.

The Household Survey

The U.S. Bureau of Labor Statistics calculates the unemployment rate and other statistics that economists and policymakers use to gauge the state of the labor market. These statistics are based on results from the Current Population Survey of about 60,000 households that the Bureau performs each month. The survey provides estimates of the number of people in the adult population (16 years and older) who are classified as either employed, unemployed, or not in the labor force:

$$POP = E + U + NL,$$

➢ Figure 2-4

where POP is the population, E is the employed, U is the unemployed, and NL is those not in the labor force. Thus, we have

$$L = E + U,$$

where *L* is the *labor force*. The *labor-force participation rate* is the fraction of the population in the labor force:

$$\text{Labor-Force Participation Rate} = L/POP.$$

The employment rate (*e*) and *unemployment rate* (*u*) are given by

➢ Supplement 2-11, "Alternative Measures of Unemployment"

$$e = E/L$$
$$u = U/L = 1 - e.$$

Case Study: Trends in Labor-Force Participation

➢ Supplement 8-6, "Labor Force Participation"

Over the period 1950 to 2013, labor-force participation among women rose sharply, from 34 percent to 57 percent, while among men it has declined from 86 percent to 70 percent. Many factors have contributed to the increase in women's participation, including new technologies such as clothes-washing machines, dishwashers, refrigerators, etc., which reduced the time needed for household chores; fewer children per family; and changing social and political attitudes toward women in the work force. For men, the decline has been due to earlier and longer periods of retirement, more time spent in school (and out of the labor force) for younger men, and greater prevalence of stay-at-home fathers.

➢ Figure 2-5

For the most recent decade, the labor-force participation rate has declined for both men and women. Part of this is due to the beginning of retirement for the baby-boom generation and part is due to the slow economic recovery following the financial crisis of 2008 to 2009. Some economists predict that the labor-force participation rate will decline further over coming decades as the elderly share of the population continues to rise.

The Establishment Survey

In addition to asking households about their employment status, the Bureau of Labor Statistics also separately asks business establishments about the number of workers on their payroll each month. This establishment survey covers 160,000 businesses that employ over 40 million workers. The survey collects data on employment, hours worked, and wages, and provides breakdowns by industry and job categories. Employment as measured by the establishment survey differs from employment as measured by the household survey for several reasons. First, a self-employed person is reported as working in the household survey but does not show up on the payroll of a business establishment and so is not counted in the establishment survey. Second, the household survey does not count separate jobs but only reports if a person is working, whereas the establishment survey counts every job. Third, both surveys use statistical methods to extrapolate from the sample to the population. For the establishment survey, estimates about the number of workers at new start-up firms that are not yet in the sample may be imperfect. For the household survey, incorrect estimates about the overall size of the population—due, for example, to difficulty measuring changes in immigration— may lead to incorrect estimates of overall employment. An especially large divergence between the two surveys occurred in the early 2000s when the economy was recovering from the recession of 2001. Over the period November 2001 to August 2003, the household survey showed an increase in employment of 1.4 million while the establishment survey showed a decline of 1.0 million.

2-4 Conclusion: From Economic Statistics to Economic Models

➢ Supplement 2-12, "Improving the National Accounts

This chapter has explained the measurement of real GDP, price indexes, and unemployment. These are important economic statistics, since they provide an indication of the overall health of the economy. The task of macroeconomics, however, is not just to describe the data and measure economic performance but also to explain the behavior of the economy. This is the subject of our subsequent analyses.

LECTURE SUPPLEMENT

2-1 Measuring Output

As discussed in the text, we can measure the value of national output either by adding up all of the spending on the economy's output of goods and services or by adding up all of the incomes generated in producing output. This basic equivalence between output and income allows us to develop the national income accounting identities relating saving, investment, and net exports that are presented in Chapters 3 and 6.

Although the text uses the term Gross Domestic Product (GDP) to refer to both the spending measure and the income measure of total output, the national income accounts in fact provide two separate measures of total output. In the national income accounts, GDP is measured by adding up spending on domestically produced goods and services. A separate quantity, known as Gross Domestic Income (GDI), is measured by adding up income generated producing domestic output. In theory, these measures should be the same. In practice, however, a measurement error—known as the statistical discrepancy—means that GDP and GDI usually differ by a small amount. Typically, the discrepancy averages close to zero over longer periods of time and tends to become smaller as the data are revised.

During the mid- to late 1990s, however, the statistical discrepancy became unusually persistent, even after revisions to historical data. Over the period 1993–1998, the economy grew 4.5 percent per year when measured using real GDI compared with 3.8 percent per year when measured using real GDP. Figure 1 shows annual average growth rates over successive five-year periods since 1960. As the figure illustrates, the difference in growth rates from the two measures has typically averaged close to zero.

Which Measure Is More Accurate for the Mid- to Late 1990s?

Both the spending and income sides of the national accounts are measured with error because significant portions of the data are estimates based on extrapolations from other indicators and trends.[1] As more complete data become available, the Bureau of Economic Analysis revises its estimates of GDP and GDI. Generally, these annual and multiyear revisions replace more of the spending-side estimates with detailed source data than the income-side estimates, which often continue to be based on incomplete data. When tax returns and census data become available, usually with a lag of many years, income estimates would be expected to improve. But because these data for income remain far from complete, GDP would still be the more accurate measure, although the discrepancy between the two probably would shrink. The persistence of the difference for the late 1990s, despite several major revisions, has continued to be puzzling.

Another way of gauging the accuracy of GDP compared with GDI is to consider which measure fits better with well-known economic relationships that have typically held in the past. One such relationship is Okun's law, a rule of thumb discussed in Chapter 10 that relates the growth rate of output to the change in the unemployment rate.[2] In particular, Okun's law states that a rise in the unemployment rate of 1 percentage point sustained for a year is associated with a decline in economic growth below its long-run potential rate by about 2 percentage points. The opposite holds for a fall in the unemployment rate, which is associated with a rise in economic growth above potential.

Over the period from 1993–1998, the unemployment rate declined by 2.4 percentage points, from 6.9 percent to 4.5 percent. The decline on average was about 0.5 percentage point per year over this five-year period. Using the equation for Okun's law given in Chapter 9, we find that output growth per year would have been predicted to be

[1] For additional discussion, see *The Economic Report of the President, 1997,* U.S. Government Printing Office, Washington, pp. 72–74. The *Report* argues that from its vantage point back in 1997, Okun's law seemed to fit better using GDI growth rather than GDP growth. Subsequent revisions and more data seem to have reversed this finding, as documented below.

[2] Arthur M. Okun, "Potential GNP: Its Measurement and Significance," in *Proceedings of the Business and Economics Statistics Section,* American Statistical Association (Washington, DC: American Statistical Association, 1962), pp. 98–103; reprinted in Arthur M. Okun, *Economics for Policymaking* (Cambridge, MA: MIT Press, 1983), pp. 145–158.

Percentage Change in Output = 3.0 – 2 × Change in Unemployment Rate

= 3.0 – 2 × (–0.5)

= 4.0 percent,

just above the 3.8 percent growth rate of GDP. But, if we adjust Okun's law for a (conservative) 0.5 percentage point step-up in long-run productivity growth during the mid- to late 1990s (productivity growth is discussed in Chapter 9), then we obtain

Percentage Change in Output = 3.5 – 2 × (-0.5) = 4.5 percent,

and Okun's law would exactly match GDI growth rate of 4.5 percent.

Regardless of whether it is GDP or GDI that in the end turns out to provide a more accurate view of growth during the late 1990s, our understanding of the qualitative picture is the same. The economy expanded at a rapid pace in the late 1990s—a topic to which we will return in later chapters.

Figure 1 Comparing Measures of Economic Growth

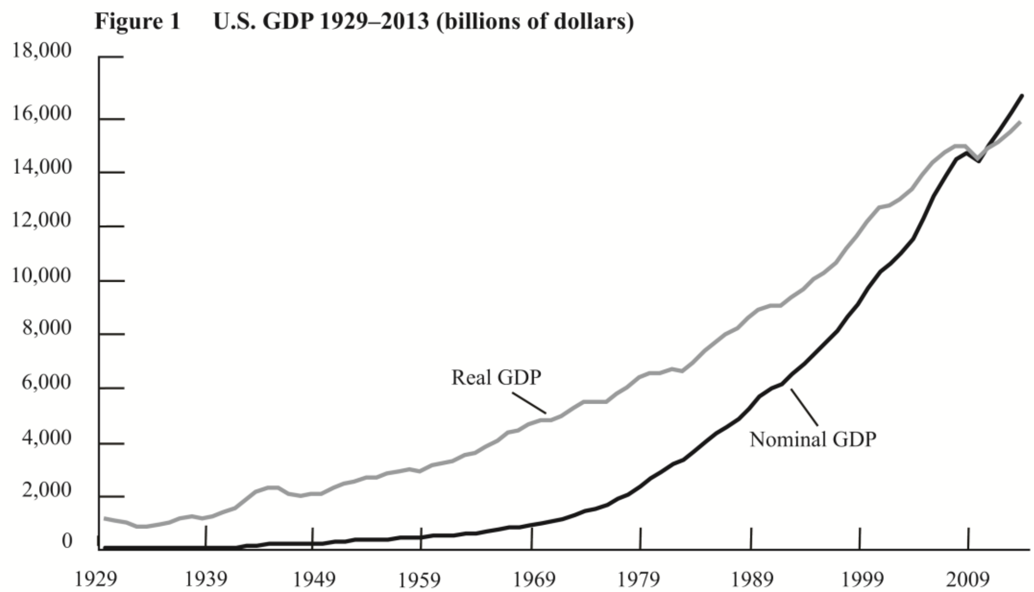
Source: Department of Commerce, Bureau of Economic Analysis.

LECTURE SUPPLEMENT

2-2 Nominal and Real GDP Since 1929

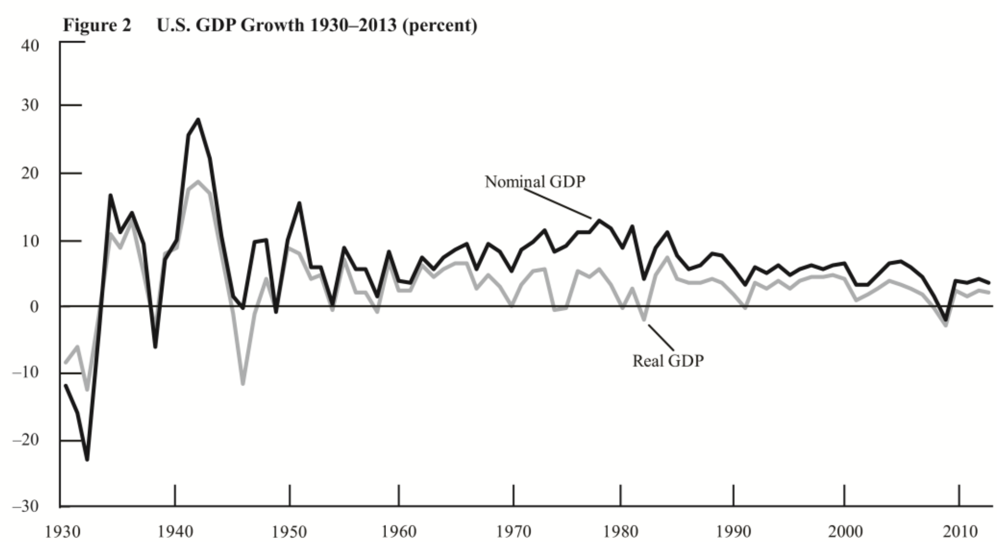
Figure 1 shows real GDP and nominal GDP between 1929 and 2013. Because real GDP is measured in chained 2009 dollars, the two series intersect in 2009. Figure 2 examines the annual percentage change in nominal and real GDP. Table 1 provides annual data for GDP and the GDP price index over the 1929–2013 period.

Figure 1 U.S. GDP 1929–2013 (billions of dollars and billions of chained 2009 dollars)



Source: *U.S. Department of Commerce, Bureau of Economic Analysis.*

Figure 2 U.S. GDP Growth 1930–2013 (percent)



Source: U.S. Department of Commerce, *Bureau of Economic Analysis*.

Table 1 United States GDP: 1929–2013

	Levels			Growth Rates		
Year	Nominal GDP (billions of current dollars)	Real GDP (billions of chained 2009 dollars)	GDP Price Index (2009 = 100)	Nominal GDP (percent)	Real GDP (percent)	GDP Price Index (percent)
1929	104.6	1056.6	9.9			
1930	92.2	966.7	9.5	-11.9	-8.5	-3.8
1931	77.4	904.8	8.6	-16.1	-6.4	-9.9
1932	59.5	788.2	7.6	-23.1	-12.9	-11.4
1933	57.2	778.3	7.4	-3.9	-1.3	-2.7
1934	66.8	862.2	7.8	16.8	10.8	4.9
1935	74.3	939.0	7.9	11.2	8.9	2.0
1936	84.9	1060.5	8.0	14.3	12.9	1.2
1937	93.0	1114.6	8.3	9.5	5.1	3.7
1938	87.4	1077.7	8.2	-6.0	-3.3	-1.8
1939	93.5	1163.6	8.0	7.0	8.0	-1.3
1940	102.9	1266.1	8.1	10.1	8.8	0.9
1941	129.4	1490.3	8.7	25.8	17.7	6.6
1942	166.0	1771.8	9.4	28.3	18.9	8.3
1943	203.1	2073.7	9.8	22.3	17.0	4.8
1944	224.6	2239.4	10.1	10.6	8.0	2.4
1945	228.2	2217.8	10.3	1.6	-1.0	2.5
1946	227.8	1960.9	11.6	-0.2	-11.6	12.6
1947	249.9	1939.4	12.9	9.7	-1.1	11.2
1948	274.8	2020.0	13.6	10.0	4.2	5.6
1949	272.8	2008.9	13.6	-0.7	-0.5	-0.1
1950	300.2	2184.0	13.7	10.0	8.7	0.9
1951	347.3	2360.0	14.7	15.7	8.1	6.8
1952	367.7	2456.1	15.0	5.9	4.1	2.2
1953	389.7	2571.4	15.2	6.0	4.7	1.3
1954	391.1	2556.9	15.3	0.4	-0.6	1.0
1955	426.2	2739.0	15.6	9.0	7.1	1.4
1956	450.1	2797.4	16.1	5.6	2.1	3.4
1957	474.9	2856.3	16.7	5.5	2.1	3.5
1958	482.0	2835.3	17.1	1.5	-0.7	2.3
1959	522.5	3031.0	17.3	8.4	6.9	1.3
1960	543.3	3108.7	17.5	4.0	2.6	1.4
1961	563.3	3188.1	17.7	3.7	2.6	1.1
1962	605.1	3383.1	17.9	7.4	6.1	1.2
1963	638.6	3530.4	18.1	5.5	4.4	1.1
1964	685.8	3734.0	18.4	7.4	5.8	1.5
1965	743.7	3976.7	18.7	8.4	6.5	1.8
1966	815.0	4238.9	19.3	9.6	6.6	2.8
1967	861.7	4355.2	19.8	5.7	2.7	2.9
1968	942.5	4569.0	20.7	9.4	4.9	4.3

(Continued on next page)

Year	Levels: Nominal GDP (billions of current dollars)	Real GDP (billions of chained 2005 dollars)	GDP Chain-type Price Index (2005 = 100)	Growth Rates: Nominal GDP (percent)	Real GDP (percent)	GDP Chain-type Price Index (Percent)
1974	1548.8	5396.0	28.8	8.4	-0.5	9.0
1975	1688.9	5385.4	31.4	9.0	-0.2	9.3
1976	1877.6	5675.4	33.2	11.2	5.4	5.5
1977	2086.0	5937.0	35.2	11.1	4.6	6.2
1978	2356.6	6267.2	37.7	13.0	5.6	7.0
1979	2632.1	6466.2	40.8	11.7	3.2	8.3
1980	2862.5	6450.4	44.5	8.8	-0.2	9.0
1981	3211.0	6617.7	48.7	12.2	2.6	9.4
1982	3345.0	6491.3	51.6	4.2	-1.9	6.1
1983	3638.1	6792.0	53.7	8.8	4.6	3.9
1984	4040.7	7285.0	55.6	11.1	7.3	3.6
1985	4346.7	7593.8	57.3	7.6	4.2	3.2
1986	4590.2	7860.5	58.5	5.6	3.5	2.0
1987	4870.2	8132.6	59.9	6.1	3.5	2.4
1988	5252.6	8474.5	62.0	7.9	4.2	3.5
1989	5657.7	8786.4	64.4	7.7	3.7	3.9
1990	5979.6	8955.0	66.8	5.7	1.9	3.7
1991	6174.0	8948.4	69.1	3.3	-0.1	3.3
1992	6539.3	9266.6	70.6	5.9	3.6	2.3
1993	6878.7	9521.0	72.3	5.2	2.7	2.4
1994	7308.8	9905.4	73.9	6.3	4.0	2.1
1995	7664.1	10174.8	75.4	4.9	2.7	2.1
1996	8100.2	10561.0	76.8	5.7	3.8	1.8
1997	8608.5	11034.9	78.1	6.3	4.5	1.7
1998	9089.2	11525.9	78.9	5.6	4.4	1.1
1999	9660.6	12065.9	80.1	6.3	4.7	1.4
2000	10284.8	12559.7	81.9	6.5	4.1	2.3
2001	10621.8	12682.2	83.8	3.3	1.0	2.3
2002	10977.5	12908.8	85.0	3.3	1.8	1.5
2003	11510.7	13271.1	86.7	4.9	2.8	2.0
2004	12274.9	13773.5	89.1	6.6	3.8	2.7
2005	13093.7	14234.2	92.0	6.7	3.3	3.2
2006	13855.9	14613.8	94.8	5.8	2.7	3.1
2007	14477.6	14873.7	97.3	4.5	1.8	2.7
2008	14718.6	14830.4	99.2	1.7	-0.3	1.9
2009	14418.7	14418.7	100.0	-2.0	-2.8	0.8
2010	14964.4	14783.8	101.2	3.8	2.5	1.2
2011	15517.9	15020.6	103.3	3.7	1.6	2.1
2012	16163.2	15369.2	105.2	4.2	2.3	1.8
2013	16768.1	15710.3	106.7	3.7	2.2	1.5

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

LECTURE SUPPLEMENT

2-3 Chain-Weighted Real GDP

For nearly 50 years, the U.S. Bureau of Economic Analysis calculated real GDP and hence the growth rate of the economy by valuing goods and services at the prices prevailing in a fixed year, known as the base year. Most recently, 1987 was used as the base year. Thus, real GDP in 1995 was calculated by valuing all goods and services produced in 1995 at the prices they sold for in 1987. Similarly, real GDP in 1950 was calculated by valuing all goods and services produced in 1950 using the prices they sold for in 1987. This method of calculating real GDP is known as a fixed-weight measure.

Two major problems are associated with fixed-weight measures of real GDP. First, economic growth may be mismeasured due to substitution bias. Second, attempts to reduce this bias for recent years by periodically updating the base year lead to revisions of historical growth rates.

Substitution bias occurs because the prices of goods and services for which output grows rapidly tend to decline relative to the prices of goods and services for which output grows slowly. By using fixed-price weights from a base year in the past, we overweight rapidly growing sectors with prices that are too high compared to current prices and underweight slowly growing sectors with prices that are too low. Overall, this leads to an upward bias in the rate of GDP growth that becomes progressively worse over time. Likewise, moving back in time over years prior to the base year, GDP growth is understated because those goods and services with rapid output growth are underweighted compared to current prices and those goods and services with slow output growth are overweighted.

The most widely cited example of substitution bias is computers. The price of computers (holding quality fixed) has declined rapidly and the quantity produced has risen sharply. For example, the Bureau of Economic Analysis estimates that the price of a small mainframe computer was $800,000 in 1977. The same computer cost $80,000 in 1987 and $30,000 in 1995.[1] If each computer sold in 1995 were valued at its 1987 price, real GDP would be biased upward. Likewise, if each computer sold in 1977 were valued at its 1987 price, real GDP in 1977 would be biased downward.

Substitution bias not only produces a mismeasurement of real output, but it also can result in a mismeasurement of the relative importance of the components of output: consumption, investment, government expenditures, and net exports. Computers are primarily counted as an investment good in the national accounts. Thus, the rapid increase in the output of computers over the past two decades would lead to an overstatement of the contribution of investment to GDP growth in the years after the base year and an understatement of the contribution of investment to growth in the years prior to the base year.

To reduce the extent of mismeasurement for recent years, the base year was updated every five years. In 1991 the base year was changed from 1982 to 1987. Changing the base year, however, affects the measurement of economic growth in all years. While moving the base year forward provides a more accurate measurement of current growth, it worsens the underestimation of growth in early years.

In 1996, rather than updating the base year to 1992, the Bureau of Economic Analysis switched the method it used to calculate economic growth because of the substitution bias and rewriting of history that occurred with a fixed-weight measure. Real GDP growth in any year, t, is now calculated using prices from year t and $t - 1$. This method minimizes the substitution bias because recent prices are used and eliminates the historical revisions that occurred when the base year was updated.[2]

To understand the difference between fixed-weight growth rates and chain-weight growth rates, consider the following example using the apple and orange economy. Table 1 shows the quantities and prices of apples and oranges from 2008 to 2012. Over this period the price of apples is rising while the price of oranges is falling and the consumption of oranges relative to apples rises.

[1] J. Steven Landefeld and Robert P. Parker, "Preview of the Comprehensive Revision of the National Income and Product Accounts: BEA's New Featured Measures of Output and Prices," *Survey of Current Business*, July 1995.

[2] Historical revisions to the GDP data, however, may still occur because new sources of information often become available only after initial estimates of GDP are constructed (sometimes after several years) and because new statistical methods for measuring and estimating the components of GDP may be developed.

Table 1 Output and Prices of Apples and Oranges

	Apples		Oranges	
Year	**Quantity**	**Price**	**Quantity**	**Price**
2008	100	$0.25	50	$0.50
2009	102	0.28	55	0.48
2010	103	0.32	60	0.45
2011	104	0.34	65	0.44
2012	105	0.36	70	0.42

Table 2 calculates the growth rates of real GDP on a year-to-year basis from 2008 to 2012. Using a fixed-weight measure, the percentage growth rate of real GDP from year t – 1 to year t is given by the formula

$$\left(\frac{P_B^A Q_t^A + P_B^O Q_t^O}{P_B^A Q_{t-1}^A + P_B^O Q_{t-1}^O} - 1\right) + 100,$$

where the superscript A refers to apples, the superscript O refers to oranges and the subscript B is the base year. Columns 2–6 indicate how the year-to-year growth rates vary as the base year changes. For example, the growth of real GDP between 2008 and 2009 varies from 4.9 percent to 6.0 percent depending on which year is used as the base for prices. Note that the farther away from the base, the greater the difference in growth rates. This explains why using 2008 prices or 2012 prices for the weights provides the extremes for the growth rates.

The chain-weight method of calculating the percentage real growth rate between any two years t – 1 and t is given by the formula:

$$\left(\sqrt{\left(\frac{P_t^A Q_t^A + P_t^O Q_t^O}{P_t^A Q_{t-1}^A + P_t^O Q_{t-1}^O} \times \frac{P_{t-1}^A Q_t^A + P_{t-1}^O Q_t^O}{P_{t-1}^A Q_{t-1}^A + P_{t-1}^O Q_{t-1}^O}\right)} - 1\right) \times 100 .$$

This method produces a growth rate that is the geometric average of the growth rates using year t – 1 and year t. The growth rate of real GDP between 2011 and 2012 was 4.0 percent using prices in 2011 for the weights and 3.8 percent using prices in 2012 for the weights. The geometric average of these two growth rates is 3.9 percent, the growth rate given by the chain-weight method.

Table 2 Growth Rate of Real Output Using Fixed-Weight or Chain-Weight Method

	2008 Base	**2009 Base**	**2010 Base**	**2011 Base**	**2012 Base**	**Chain-Weight**
2008–09	6.0%	5.7%	5.3%	5.1%	4.9%	5.8%
2009–10	5.2	4.9	4.5	4.3	4.1	4.7
2010–11	4.9	4.6	4.3	4.1	3.9	4.2
2011–12	4.7	4.4	4.1	4.0	3.8	3.9

Using the chain-weight method, real GDP is calculated as

$$\text{RGDP}_t = (1 + \text{Growth}_t) \times \text{RGDP}_{t-1}$$

where growth$_t$ is the growth rate from year t – 1 to year t. Some year must be chosen for which real GDP is set equal to nominal GDP (for U.S. GDP, the BEA currently uses 2009).

Calculating the chain-weight price index is similar to the process for calculating real GDP. The percentage growth rate of prices in the apple and orange economy is given by:

$$\left(\sqrt{\left(\frac{P_t^A Q_t^A + P_t^O Q_t^O}{P_{t-1}^A Q_t^A + P_{t-1}^O Q_t^O} \times \frac{P_t^A Q_{t-1}^A + P_t^O Q_{t-1}^O}{P_{t-1}^A Q_{t-1}^A + P_{t-1}^O Q_{t-1}^O}\right)} - 1\right) \times 100$$

The equation used to calculate the price index itself is:

$$\text{Price Index}_t = (1 + \text{Inflation Rate}_t) \times \text{Price Index}_{t-1}$$

where the inflation rate is the rate of change in prices from year t – 1 to year t.

The chain-weighted measures of real GDP and the price index also have the property that 1 plus the growth of nominal GDP divided by 1 plus the growth of real GDP will equal 1 plus the inflation rate:

$$(1 + \text{Inflation Rate}_t) = (1 + \text{Growth Nominal GDP}_t)/(1 + \text{Growth}_t).$$

And, if one chooses a year in which to set real and nominal GDP equal, the chain-weighted price index will equal the ratio of nominal GDP to chain-weighted GDP—just as it did for the fixed-weight measures of output and prices:

$$\text{Price Index}_t = \text{Nominal GDP}_t/\text{Chain-Weighted GDP}_t.$$

Accordingly, the “arithmetic tricks” discussed in the text for approximating the percentage change in nominal GDP will also work for chain-weighted measures of GDP and prices.

CASE STUDY EXTENSION

2-4 The Components of GDP

Table 1 and Figure 1 show the principal components of GDP between 1929 and 2013.

Table 1 U.S. Nominal GDP and the Components of Expenditure: 1929–2013 (billions of dollars)

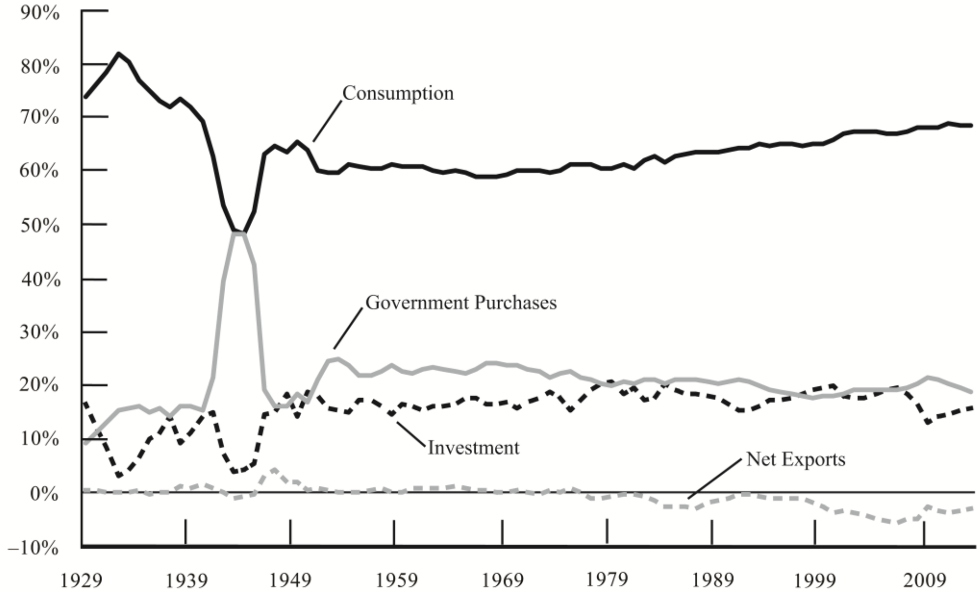
Year	GDP	Consumption	Investment	Government Purchases	Net Exports
1929	104.6	77.4	17.2	9.6	0.4
1930	92.2	70.1	11.4	10.3	0.3
1931	77.4	60.7	6.5	10.2	0.0
1932	59.5	48.7	1.8	9.0	0.0
1933	57.2	45.9	2.3	8.9	0.1
1934	66.8	51.5	4.3	10.7	0.3
1935	74.3	55.9	7.4	11.2	-0.2
1936	84.9	62.2	9.4	13.4	-0.1
1937	93.0	66.8	13.0	13.1	0.1
1938	87.4	64.3	7.9	14.2	1.0
1939	93.5	67.2	10.2	15.2	0.8
1940	102.9	71.3	14.6	15.6	1.5
1941	129.4	81.1	19.4	27.9	1.0
1942	166.0	89.0	11.8	65.5	-0.3
1943	203.1	99.9	7.4	98.1	-2.2
1944	224.6	108.6	9.2	108.7	-2.0
1945	228.2	120.0	12.4	96.6	-0.8
1946	227.8	144.3	33.1	43.2	7.2
1947	249.9	162.0	37.1	40.0	10.8
1948	274.8	175.0	50.3	44.0	5.5
1949	272.8	178.5	39.1	50.0	5.2
1950	300.2	192.2	56.5	50.7	0.7
1951	347.3	208.5	62.8	73.5	2.5
1952	367.7	219.5	57.3	89.8	1.2
1953	389.7	233.0	60.4	97.0	-0.7
1954	391.1	239.9	58.1	92.8	0.4
1955	426.2	258.7	73.8	93.3	0.5
1956	450.1	271.6	77.7	98.5	2.4
1957	474.9	286.7	76.5	107.5	4.1
1958	482.0	296.0	70.9	114.5	0.5
1959	522.5	317.5	85.7	118.9	0.4
1960	543.3	331.6	86.5	121.0	4.2
1961	563.3	342.0	86.6	129.8	4.9
1962	605.1	363.1	97.0	140.9	4.1
1963	638.6	382.5	103.3	147.9	4.9
1964	685.8	411.2	112.2	155.5	6.9
1965	743.7	443.6	129.6	164.9	5.6
1966	815.0	480.6	144.2	186.4	3.9
1967	861.7	507.4	142.7	208.1	3.6
1968	942.5	557.4	156.9	226.8	1.4
1969	1019.9	604.5	173.6	240.4	1.4
1970	1075.9	647.7	170.1	254.2	4.0
1971	1167.8	701.0	196.8	169.3	0.6

Table 1 U.S. Nominal GDP and the Components of Expenditure: 1929–2010 (billions of dollars) (*continued*)

Year	GDP	Consumption	Investment	Government Purchases	Net Exports
1972	1282.4	769.4	228.1	288.2	-3.4
1973	1428.5	851.1	266.9	306.4	4.1
1974	1548.8	932.0	274.5	343.1	-0.8
1975	1688.9	1032.8	257.3	382.9	16.0
1976	1877.6	1150.2	323.2	405.8	-1.6
1977	2086.0	1276.7	396.6	435.8	-23.1
1978	2356.6	1426.2	478.4	477.4	-25.4
1979	2632.1	1589.5	539.7	525.5	-22.5
1980	2862.5	1754.6	530.1	590.8	-13.1
1981	3211.0	1937.5	631.2	654.7	-12.5
1982	3345.0	2073.9	581.0	710.0	-20.0
1983	3638.1	2286.5	637.5	765.7	-51.6
1984	4040.7	2498.2	820.1	825.2	-102.7
1985	4346.7	2722.7	829.6	908.4	-114
1986	4590.2	2898.4	849.1	974.5	-131.9
1987	4870.2	3092.1	892.2	1030.8	-144.8
1988	5252.6	3346.9	937.0	1078.2	-109.4
1989	5657.7	3592.8	999.7	1151.9	-86.7
1990	5979.6	3825.6	993.5	1238.4	-77.9
1991	6174.0	3960.2	944.3	1298.2	-28.6
1992	6539.3	4215.7	1013.0	1345.4	-34.7
1993	6878.7	4471.0	1106.8	1366.1	-65.2
1994	7308.8	4741.0	1256.5	1403.7	-92.5
1995	7664.1	4984.2	1317.5	1452.2	-89.8
1996	8100.2	5268.1	1432.1	1496.4	-96.4
1997	8608.5	5560.7	1595.6	1554.2	-102.0
1998	9089.2	5903.0	1735.3	1613.5	-162.7
1999	9660.6	6307.0	1884.2	1726.0	-256.6
2000	10284.8	6792.4	2033.8	1834.4	-375.8
2001	10621.8	7103.1	1928.6	1958.8	-368.7
2002	10977.5	7384.1	1925.0	2094.9	-426.5
2003	11510.7	7765.5	2027.9	2220.8	-503.7
2004	12274.9	8260.0	2276.7	2357.4	-619.2
2005	13093.7	8794.1	2527.1	2493.7	-721.2
2006	13855.9	9304.0	2680.6	2642.2	-770.9
2007	14477.6	9750.5	2643.7	2801.9	-718.5
2008	14718.6	10013.6	2424.8	3003.2	-723.1
2009	14418.7	9847.0	1878.1	3089.1	-395.4
2010	14964.4	10202.2	2100.8	3174.0	-512.7
2011	15517.9	10689.3	2239.9	3168.7	-580.0
2012	16163.2	11083.1	2479.2	3169.2	-568.3
2013	16768.1	11484.3	2648.0	3143.9	-508.2

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 1 Expenditure Components of U.S. GDP, 1929–2013 (percent of GDP)



Source: U.S. Department of Commerce, Bureau of Economic Analysis. Data are expressed as a percentage of GDP.

As Figure 1 illustrates, the GDP shares of consumption expenditure, private investment expenditure, and government purchases have been relatively constant over the past 60 years. Earlier in the twentieth century, however, the story was much different as expenditure shares shifted sharply. During the Great Depression of the early 1930s, the collapse of investment spending led to a decline in its share of GDP while the share of consumption expenditure increased. During World War II, the federal government's expansion pushed government purchases to nearly 50 percent of GDP, while the shares of private investment and consumption plummeted.

As shown in Table 1, the sum of consumption, investment, government purchases, and net exports must always equal GDP when measured in current dollars. Under the old fixed-weight method of calculating real GDP, it was also true that real GDP was equal to the sum of its spending components provided they were measured in real terms using the same base year. Under the new chain-weight system, however, the components of real spending no longer sum to real GDP, and so a residual equaling the difference between real GDP and the sum of its components is included in Table 2, which reports real GDP and its components since 1980.

Table 2 **U.S. Real GDP and the Components of Expenditure: 1980–2013 (billions of chained 2009 dollars)**

Year	GDP	Consumption	Investment	Government Purchases	Net Exports	Residual
1980	6450.4	3991.5	881.2	1612.5	6.5	-41.3
1981	6617.7	4050.8	958.7	1628.0	1.3	-21.1
1982	6491.3	4108.4	833.7	1658.0	-23.0	-85.8
1983	6792.0	4342.6	911.5	1721.6	-79.2	-104.5
1984	7285	4571.6	1160.3	1783.2	-154.0	-76.1
1985	7593.8	4811.9	1159.5	1904.0	-175.6	-106.0
1986	7860.5	5014.0	1161.3	2007.7	-193.9	-128.6
1987	8132.6	5183.6	1194.4	2066.9	-184.9	-127.4
1988	8474.5	5400.5	1223.8	2094.8	-136.0	-108.6
1989	8786.4	5558.1	1273.4	2155.1	-103.9	-96.3
1990	8955.0	5672.6	1240.6	2224.3	-76.5	-106.0
1991	8948.4	5685.6	1158.8	2250.9	-32.8	-114.1
1992	9266.6	5896.5	1243.7	2262.1	-35.7	-100.0
1993	9521.0	6101.4	1343.1	2243.3	-78.2	-88.6
1994	9905.4	6338.0	1502.3	2245.5	-111.0	-69.4
1995	10174.8	6527.6	1550.8	2257.5	-101.0	-60.1
1996	10561.0	6755.6	1686.7	2279.2	-114.6	-45.9
1997	11034.9	7009.9	1879.0	2322.0	-145.3	-30.7
1998	11525.9	7384.7	2058.3	2370.5	-265.5	-22.1
1999	12065.9	7775.9	2231.4	2451.7	-377.1	-112.4
2000	12559.7	8170.7	2375.5	2498.2	-477.8	-83.6
2001	12682.2	8382.6	2231.4	2592.4	-502.1	-90.9
2002	12908.8	8598.8	2218.2	2705.8	-584.3	-70.5
2003	13271.1	8867.6	2308.7	2764.3	-641.9	-45.5
2004	13773.5	9208.2	2511.3	2808.2	-734.7	-19.6
2005	14234.2	9531.8	2672.6	2826.2	-782.3	-2.2
2006	14613.8	9821.7	2730.0	2869.3	-794.2	-3.8
2007	14873.7	10041.6	2644.1	2914.4	-712.6	-9.7
2008	14830.4	10007.2	2396	2994.8	-557.8	-13.6
2009	14418.7	9847.0	1878.1	3089.1	-395.5	0.2
2010	14783.8	10036.3	2120.4	3091.4	-458.8	-1.1
2011	15020.6	10263.5	2230.4	2997.4	-459.4	-10.8
2012	15369.2	10449.7	2435.9	2953.9	-452.5	-17.3
2013	15710.3	10699.7	2556.2	2894.5	-420.5	-22.5

Source: U.S. Department of Commerce, Bureau of Economic Analysis.

To understand why a chain-weight method violates the identity $Y = C + I + G + NX$, consider the following simple example. Consumption consists of two goods: apples and oranges. Investment consists of buildings and equipment. There are no government expenditures, exports, or imports. The quantity and price of each good in years 1 and 2 and nominal expenditures are given in Table 3. Nominal GDP was \$2.6 million in year 1 and \$2.8 million in year 2. In each year, nominal GDP equaled consumption plus investment expenditures.

Table 3 Calculating GDP and Its Components

	Year 1			Year 2		
	Quantity	**Price**	**Expenditures**	**Quantity**	**Price**	**Expenditures**
Apples	4,000,000	$.25	$1,000,000	3,500,000	$.28	$980,000
Oranges	1,000,000	$.5	$500,000	2,000,000	$.4	$800,000
Consumption			**$1,500,000**			**$1,780,000**
Buildings	5	$200,000	$1,000,000	4	$225,000	$900,000
Equipment	10	$5,000	$50,000	15	$4,750	$71,250
Investment			**$1,050,000**			**$971,250**
GDP			**$2,550,000**			**$2,751,250**

Calculating real GDP under the fixed-weight method in this economy is easy. Suppose year 1 is the base year. Then real consumption and investment are $1.5 million and $1.1 million, respectively, in year 1, and real GDP is $2.6 million. In year 2, real consumption is calculated by valuing the quantity of apples and the quantity of oranges at their year 1 prices. Thus,

$$\begin{aligned} C^2 &= P^1_{\text{apples}} Q^2_{\text{apples}} + P^1_{\text{oranges}} Q^2_{\text{oranges}} \\ &= \$1{,}875{,}000. \end{aligned}$$

Real investment in year 2 is calculated by valuing the quantity of buildings and the quantity of equipment at their year 1 prices. Thus,

$$\begin{aligned} I^2 &= P^1_{\text{buildings}} Q^2_{\text{buildings}} + P^1_{\text{equipment}} Q^2_{\text{equipment}} \\ &= \$875{,}000. \end{aligned}$$

Real GDP in year 2 is calculated by valuing the quantity of each good produced at its price in year 1. Thus,

$$\begin{aligned} \text{Real GDP}^2 &= P^1_{\text{apples}} Q^2_{\text{apples}} + P^1_{\text{oranges}} Q^2_{\text{oranges}} + P^1_{\text{buildings}} Q^2_{\text{buildings}} + P^1_{\text{equipment}} Q^2_{\text{equipment}} \\ &= C^2 + I^2 \\ &= \$1{,}875{,}000 + \$875{,}000 \\ &= \$2{,}750{,}000. \end{aligned}$$

From the above formula it is clear that the sum of real consumption and real investment will always equal real GDP.

The chain-weight method of calculating real GDP is not so simple and the components do not necessarily add up to total GDP. We calculate the components of GDP using the same approach shown in Supplement 2-4 for calculating chain-weighted GDP. For example, to compute real consumption, we begin by setting it equal to its nominal value in year 1. Real consumption in year 2 then equals consumption in year 1 multiplied by the geometric average of the growth rates of consumption measured using prices from year 1 and using prices from year 2:

$$
\begin{aligned}
C^2 &= \sqrt{\left(\frac{P^1_{\text{apples}}Q^2_{\text{apples}} + P^1_{\text{oranges}}Q^2_{\text{oranges}}}{P^1_{\text{apples}}Q^1_{\text{apples}} + P^1_{\text{oranges}}Q^1_{\text{oranges}}}\right)\left(\frac{P^2_{\text{apples}}Q^2_{\text{apples}} + P^2_{\text{oranges}}Q^2_{\text{oranges}}}{P^2_{\text{apples}}Q^1_{\text{apples}} + P^2_{\text{oranges}}Q^1_{\text{oranges}}}\right)} \times C^1 \\
&= 1.2099 \times \$1{,}500{,}000 \\
&= \$1{,}814{,}850.
\end{aligned}
$$

Similarly, real investment in year 2 is equal to real investment in year 1 multiplied by the geometric average of the growth rates of investment measured using prices from year 1 and using prices from year 2:

$$
\begin{aligned}
I^2 &= \sqrt{\left(\frac{P^1_{\text{buildings}}Q^2_{\text{buildings}} + P^1_{\text{equipment}}Q^2_{\text{equipment}}}{P^1_{\text{buildings}}Q^1_{\text{buildings}} + P^1_{\text{equipment}}Q^1_{\text{equipment}}}\right)\left(\frac{P^2_{\text{buildings}}Q^2_{\text{buildings}} + P^2_{\text{equipment}}Q^2_{\text{equipment}}}{P^2_{\text{buildings}}Q^1_{\text{buildings}} + P^2_{\text{equipment}}Q^1_{\text{equipment}}}\right)} \times I^1 \\
&= 0.8308 \times \$1{,}050{,}000 \\
&= \$872{,}340.
\end{aligned}
$$

The formula used to calculate real GDP under the chain-weight method is not the sum of the formulas used to calculate the components (as is the case under a fixed-weight calculation). Therefore, the components do not sum to GDP. The formula for real GDP in year 2 is:

$$
\begin{aligned}
GDP^2 &= \sqrt{\left(\frac{P^1_{\text{a}}Q^2_{\text{a}} + P^1_{\text{O}}Q^2_{\text{O}} + P^1_{\text{b}}Q^2_{\text{b}} + P^1_{\text{e}}Q^2_{\text{e}}}{P^1_{\text{a}}Q^1_{\text{a}} + P^1_{\text{O}}Q^1_{\text{O}} + P^1_{\text{b}}Q^1_{\text{b}} + P^1_{\text{e}}Q^1_{\text{e}}}\right)\left(\frac{P^2_{\text{a}}Q^2_{\text{a}} + P^2_{\text{O}}Q^2_{\text{O}} + P^2_{\text{b}}Q^2_{\text{b}} + P^2_{\text{e}}Q^2_{\text{e}}}{P^2_{\text{a}}Q^1_{\text{a}} + P^2_{\text{O}}Q^1_{\text{O}} + P^2_{\text{b}}Q^1_{\text{b}} + P^2_{\text{e}}Q^1_{\text{e}}}\right)} \times \text{GDP}^1 \\
&= 1.0498 \times \$2{,}550{,}000 \\
&= \$2{,}676{,}990.
\end{aligned}
$$

The residual is

$$
\begin{aligned}
\text{GDP}^2 - \left(C^2 + I^2\right) &= \$2{,}676{,}990 - \left(\$1{,}814{,}850 + \$872{,}340\right) \\
&= \$2{,}676{,}990 - \left(\$2{,}687{,}190\right) \\
&= -\$10{,}220.
\end{aligned}
$$

In Table 2, the residual is larger in earlier years and also exhibits sharper swings between years. Because the residual tends to grow in size and variability as one moves away in time from the year in which the nominal and real series are linked, the chained-dollar GDP and its components are not very useful for comparing the relative shares of different real spending components in years distant from the link date. In gauging the comparative size of spending components, the nominal shares shown in Figure 1 are much more appropriate measures.

CASE STUDY EXTENSION

2-5 Defining National Income

A case study in Chapter 2 of the text describes the 2013 comprehensive revision of the National Income and Product Accounts by the Bureau of Economic Analysis at the U.S. Department of Commerce. These periodic revisions employ additional source data, improved estimation methods, and changes in definitions and classifications. An important change made with the revision released during 2013 is to classify expenditure on intellectual property and creative works as capital investment rather than spending on intermediate goods. The Bureau had also released one of these comprehensive revisions in December 2003. With that revision, the Bureau adopted the definition of national income recommended by the *System of National Accounts 1993* [1], the principal international guidelines for national accounts data. [2]

Since 1993, the Bureau gradually has adopted most of the major changes recommended by these international guidelines, including the move in 1996 to chain-weight indexes for measuring changes in real GDP and prices (see Supplement 2-4). As the Bureau noted in announcing its 2003 revision, “integration of the world’s monetary, fiscal, and trade policies has led to a growing need for international harmonization of economic statistics. Many of the definitional changes presented in this year’s revision will improve consistency with the principle international guidelines for national accounts.” [33]

National income was redefined to equal gross national product minus consumption of fixed capital. Thus, national income now includes *all net incomes*, not only factor incomes accruing to labor and owners of capital. These nonfactor charges—primarily indirect business taxes—are now included in the official definition of national income. This change, however, does not affect personal income or saving because these nonfactor charges are subtracted from national income to obtain personal income. As with most definitional changes, the Bureau has implemented the new measure of national income back to 1929, so macroeconomists working with historical data will have a consistent data series for their research.

[1] See Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, and the World Bank, *System of National Accounts 1993* (Brussels/Luxembourg, New York, Paris, and Washington, DC, 1993).

[2] See “New International Guidelines in Economic Accounting,” *Survey of Current Business* 73 (February 1993).

[3] “Preview of the 2003 Comprehensive Revision of the National Income and Product Accounts,” *Survey of Current Business* 83 (June 2003), p. 18.

LECTURE SUPPLEMENT

2-6 Seasonal Adjustment and the Seasonal Cycle

Economists use various techniques to describe economic data. One set of techniques involves decomposing data series into constituent subseries that can be added together to give the total series. As an example, economists often separate GDP into a long-run, or *trend*, component and a short-run, or *business cycle,* component.[1] Another decomposition involves removing the seasonal component from economic data. Sophisticated statistical techniques (known as *spectral analysis*) are used to carry out these decompositions. We can thus take a data series (say, for GDP), detrend it, and then divide it into a seasonal series and a *seasonally adjuste*d cyclical series. The overall series for GDP would then be the sum of a long-run trend, a shorter-run cyclical component, and a very short-run seasonal component.[2] Most investigations of business cycles carry out just such a decomposition and focus on the seasonally adjusted cyclical component of different economic data series. The fact that these data series exhibit certain regularities is the primary motivation for the study of business cycles in Part IV of the textbook.

Robert Barsky and Jeffrey Miron decided instead to look at the seasonal component of the data.[3] Interestingly, they found that the same sort of regularities that are observed in business cycle data also show up in seasonal data. Moreover, they found that seasonal fluctuations are significant in the sense that they account for much of the variation in detrended data. Seasonal fluctuations were found in all major components of GDP.

All major components of GDP with the exception of fixed investment display the same seasonal pattern: a large decline in the first quarter, small declines in the second and third quarters, and a large increase in the fourth quarter. Fixed investment shows declines in the first and fourth quarters and increases in the second and third quarters. An obvious explanation of seasonal variation is weather but, with the exception of the fixed investment series, it is difficult to reconcile seasonal patterns with this explanation. Other key findings are that, just as in business cycle data, money is *procyclical* (that is, money and output movements are positively correlated), as is labor productivity. Similarly, prices exhibit much less variation than quantities in seasonal data, as they do in business cycle data. Sales and production are also correlated at a seasonal as well as a cyclical level.

Barsky and Miron argue that the similarity of seasonal and business cycles suggests that we should look for similar explanations of the two phenomena. Moreover, since many of the forces behind seasonal fluctuations can clearly be anticipated (there is a spending shock as a result of Christmas shopping at the same time every year), the distinction between anticipated and unanticipated shocks may not be as important for the business cycle as some theories suggest.[4] Whereas seasonal and business cycles may be initially generated by different shocks, they may be driven by similar *propagation mechanisms*.[5]

The finding that money is procyclical in seasonal data indicates that the causal relationship runs from output to money, and not vice versa (since monetary expansions presumably do not cause Christmas). The view that money may be endogenous at the *cyclical* level is important to real-business-cycle theory. Finally, the seasonal correlation between production and sales raises questions for the *production-smoothing* model of inventories discussed in Chapter 17 of the textbook.

[1] There are, in turn, a number of different ways to detrend data. See Supplement 10-2, "Understanding Business Cycles I: The Stylized Facts," for related discussion.

[2] In the terminology of spectral analysis, these are referred to as different frequencies. Roughly speaking, short-run fluctuations occur at high frequencies, and long-run fluctuations occur at low frequencies.

[3] R. Barsky and J. Miron, "The Seasonal Cycle and the Business Cycle," *Journal of Political Economy* 97 (June 1989): 503–34.

[4] See, in particular, the models of aggregate supply in Chapter 14 and Supplement 14-4, "Anticipated and Unanticipated Money."

[5] See Supplement 10-7, "Understanding Business Cycles II: Modeling Cycles."

ADDITIONAL CASE STUDY

2-7 Measuring the Price of Light

According to William Nordhaus, unmeasured changes in quality dramatically overestimate the true rise in the cost of living, as measured by the consumer price index (CPI).[1] Nordhaus uses a simple example of estimating the price of light to illustrate the importance of quality changes and the effect that not accounting for these changes can have on the measurement of inflation. Nordhaus traces the use of artificial light from fire to fat burning lamps to candles to kerosene lamps to the electric light bulb.

There are two ways to measure the price of light. The first, which Nordhaus refers to as the traditional way, is to measure the price of the good that provides light. Whether that light was provided by a kerosene lamp as in the 1800s or a fluorescent bulb of today is irrelevant. The second method is to measure the price of the service that the light provides. The service provided by light is illumination, which is measured by lumen hours per thousand Btus. As Figure 1 indicates, the traditional price of light has risen sharply between 1800 and today but at a lower rate than overall consumer prices. The price of light has tripled in the last 190 years, while consumer prices have risen tenfold. If, rather than measuring the price of a good that produces light, one measures the price of a lumen hour of light, the results are very different. This "true price" of light has declined precipitously since 1800. The nominal price of 1000 lumen hours of light has declined from $0.40 in 1800 to $0.03 in 1900 to nearly $0.001 in 1992, as shown in Table 1. The real price has fallen even more, from $4.30 in 1800 to $0.43 in 1900 to nearly $0.001 in 1992. Comparing the real price of light as measured by the traditional and true price indexes, Nordhaus states that the traditional price of light overestimates the true price by a factor of 900 over the period 1800–1992, or 3.6 percent per year.

If the overestimation of the price of light is indicative of the overestimation of the prices of other goods that have experienced quality improvements, then the consumer price index is clearly biased upward. Furthermore, if such a bias exists, then our estimates of real wages are also biased. Based on the CPI, real wages of a worker today are 13 times higher than those of a worker in 1800. However, using a quality adjusted measure of inflation, real wages are anywhere from 58 to 970 times higher today than in 1800. Such estimates, according to Nordhaus, indicate that we have "greatly underestimated quality improvements and real-income growth while overestimating inflation and the growth in prices."

[1] William D. Nordhaus, "Do Real Output and Real Wage Measures Capture Reality? The History of Lighting Suggests Not," *Cowles Foundation Discussion Paper no. 1078* (September 1994).

Figure 1

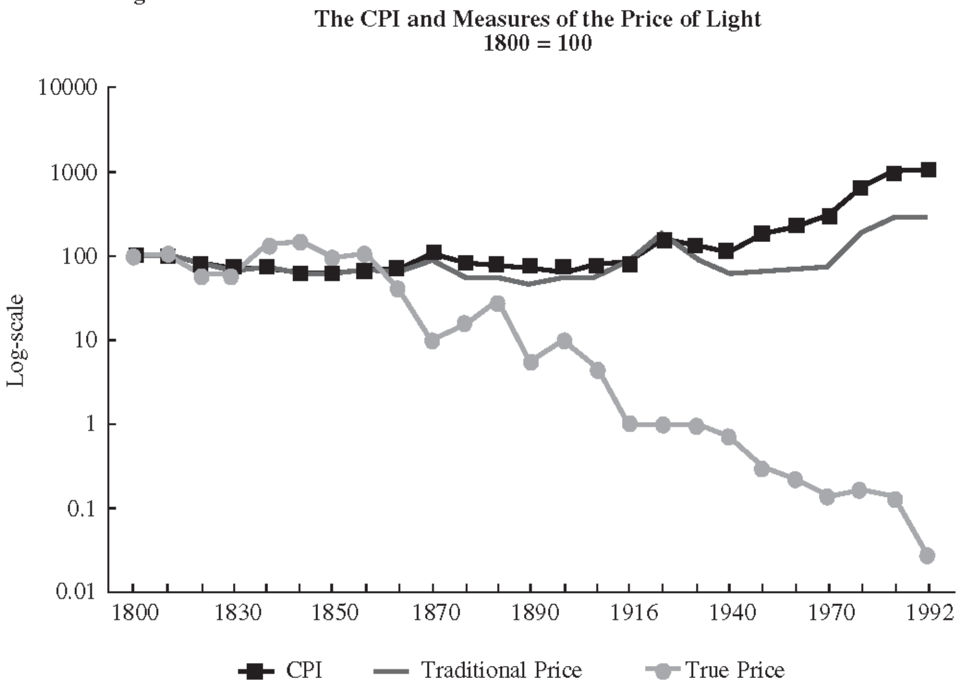


Table 1 The True Price of Light (price per 1000 lumen hours)

Year	Current Price (cents)	Real (1992) Price (cents)
1800	40.29	429.63
1818	40.87	430.12
1827	18.63	249.99
1830	18.32	265.66
1835	40.39	596.09
1840	36.94	626.77
1850	23.20	397.36
1855	29.78	460.98
1860	10.96	176.51
1870	4.04	41.39
1880	5.04	65.99
1883	9.23	127.79
1890	1.57	23.24
1900	2.69	42.90
1910	1.38	19.55
1916	0.85	4.28
1920	0.63	4.23
1930	0.51	4.10
1940	0.32	3.09
1950	0.24	1.35
1960	0.21	0.94
1970	0.18	0.61
1980	0.45	0.73
1990	0.60	0.63
1992	0.12	0.12

LECTURE SUPPLEMENT

2-8 Improving the CPI

The Bureau of Labor Statistics (BLS) has made changes to the consumer price index in an effort to measure inflation more accurately. Some of these changes address the measurement problems discussed in Chapter 2 of the text and are part of an ongoing program at the BLS to improve the CPI.[1] These changes involve problems associated with substitution bias, introduction of new goods, and quality improvements.

Substitution Bias

The BLS has taken two major steps to reduce the substitution bias inherent in a fixed-weight index. First, it instituted a new formula for the CPI in 1998 that allows for substitution as prices change among items *within* some categories but maintains zero substitution *across* categories. For example, consumers are permitted to substitute among items within the category of apples—Delicious apples for Macintosh apples when the relative price of Macintosh rises—but they are not allowed to substitute between the overall category of ice cream products and the overall category of apples when the relative price of apples rises compared to ice cream. The categories allowing substitution among items represent about 60 percent of the expenditure by consumers, while the categories allowing no substitution amount to 40 percent. The latter include medical care, utility charges, and housing.

Second, the BLS adopted a new policy of updating the market basket more frequently starting in January 2002. The weights in the market basket are now updated on a two-year schedule, rather than the roughly ten-year schedule of the past. Because of production lags in the collection of data, the weights for the January 2010 update come from the average expenditure pattern of 2007–2008. These weights will be updated again starting with the January 2012 index using the spending patterns from 2009–2010, and similarly every two years in the future. More frequent updating avoids situations like that at the end of 1997 when the weights were nearly 15 years old, reflecting spending patterns from 1982–1984!

In August 2002, the BLS began publishing a supplemental "Chained Consumer Price Index" that uses a more advanced index formula to correct for upper-level substitution bias, allowing some substitution among items across categories. The formula is similar to the method for computing the GDP price index and uses the average of weights from adjacent periods of time. Expenditure data required for calculating the weights are available only with a time lag, so monthly estimates of the Chained CPI are preliminary and subject to two subsequent revisions. Because the official CPI is used for indexation and other purposes, it must be final when first released and cannot be revised. Accordingly, the Chained CPI, which is subject to revision, cannot be adopted as the "official" measure.

New Goods

The BLS in 1999 incorporated improved procedures to update its sample of stores and items more rapidly, helping ensure that new brands of products and new stores are included in the index more quickly than in the past. Likewise, the shorter two-year time lag in updating the market basket itself will ensure that completely new products are more rapidly introduced into the index. As the text points out, a greater variety of products may improve a consumer's welfare—something that the CPI as currently computed does not fully account for. But, in addition to this effect from increased variety, new products often experience a rapid decline in price in the years immediately following their introduction to the marketplace. Because new products traditionally have taken many years to be included in the CPI market basket, this sharp decline in price often was not factored into overall inflation. For example, VCRs, microwave ovens, and personal computers were not included in the index for more than a decade after they first appeared in U.S. stores, during which time their prices had fallen by over 80 percent.[2] As a result, inflation likely has been overstated in the past because of the delay in including new goods in the index.

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[1] For further detail on the changes discussed in this supplement, see, J.S. Greenlees and C.C. Mason, "Overview of the 1998 Revision of the Consumer Price Index," *Monthly Labor Review,* December 1996; and K.V. Dalton, J.S. Greenlees, and K.J. Stewart, "Incorporating a Geometric Mean Formula into the CPI," *Monthly Labor Review,* October 1998.

[2] See M.J. Boskin, E.R. Dulberger, R.J. Gordon, Z. Grilliches, and D.W. Jorgenson, "Consumer Prices, the Consumer Price Index, and the Cost of Living," *Journal of Economic Perspectives,* 12(1), Winter 1998

Quality Improvements

The BLS has introduced quality adjustments to the prices of an expanding array of products over the years, recently adding adjustments for apparel (1991), personal computers (1998), and televisions (1999). Some economists believe that mismeasurement of improvements in quality is the single largest source of upward bias in the CPI. But others point out that deterioration in quality may have occurred for some products. The quality of air travel, for example, is generally thought to have declined in recent years as competition among airlines on ticket prices has led to cost-cutting measures, such as fewer airline meals and less comfortable seating. And, in testimony to the difficulty of deciding exactly what represents an improvement in quality, the BLS recently changed the way it adjusts the prices of new automobiles. Quality adjustment for new autos was introduced in 1967 and incorporated the costs of mandated pollution-reduction systems. In 1999, the BLS decided to no longer treat the cost of pollution reduction as a "quality improvement." This shift reflected the uncertainty of whether pollution reduction, while clearly a public good, was appropriately viewed as a quality improvement for the individual consumer.[3] The BLS continues to treat mandated safety features, such as airbags, as quality improvements because individual consumers directly benefit from these devices.

[3] "The Treatment of Mandated Pollution Control Measures in the CPI," Bureau of Labor Statistics, October 2001.

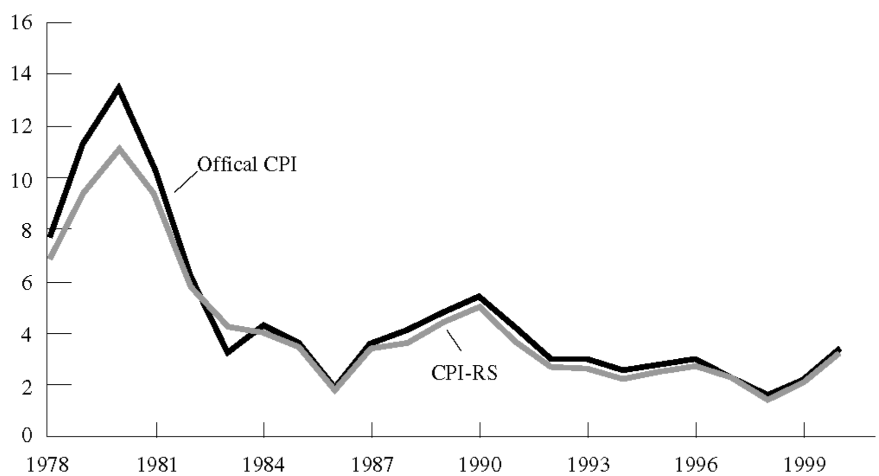
ADDITIONAL CASE STUDY

2-9 CPI Improvements and the Decline in Inflation During the 1990s

An important feature of the official CPI is that the series is never revised and so recent improvements in the index are not introduced into the historical data.[1] As a consequence, some of the decline in inflation over the 1990s was probably due to methodological changes in the index—such as improvements in the treatment of generic drugs starting in 1995 and various improvements in adjustments for quality change—that did not represent a true decline in inflation. In other words, the bias in the index may have been reduced as these changes were implemented, leading to a lower (and more accurate) picture of inflation. To help assess this issue, the BLS has computed an index for researchers, known as the CPI-RS, that incorporates most of the recent changes in CPI methodology back to 1978.[2]

Figure 1 plots annual inflation as measured by the official CPI and as measured by the CPI-RS from 1978 to 2000. For the period as a whole, the official CPI increased an average of roughly 0.5 percentage point per year faster than the CPI-RS. The largest gap between these measures occurs in the late 1970s and early 1980s and reflects differences in methods used to gauge housing costs. Starting in 1983, the BLS instituted an improved method for imputing the cost of owner-occupied housing that lowered the measured rate of inflation for housing. Although there is some year-to-year variation, this is the main reason for much of the gap between these series in the period before 1983. As new methods were introduced during the 1990s, the gap continued to shrink. For 2000, the methodologies are the same and so there is no difference between inflation as measured by the two indexes. For the 1990s, the CPI-RS rose about 0.25 percentage point per year less than the official CPI and thus can account for only about one-eighth of the 2-percentage-point decline in official CPI inflation between 1990 and 2000.

Figure 1 Comparing the Official CPI and CPI-RS (annual percentage change)



Source: U.S. Department of Labor, Bureau of Labor Statistics. Data are annual percent cha

[1] Well, almost never, excepting revisions for computational errors, such as occurred in the fall of 2000, when a correction was made to the CPI. The reason for not revising the data is that many business and labor contracts, as well as social security and the tax code, are indexed to the CPI and would require retroactive adjustments if the CPI were revised. In the fall of 2000, when the computational error was corrected, social security recipients subsequently received a small increase in their benefit payments to compensate for the slightly higher rate of inflation over the previous year.

[2] For details, see K.J. Stewart and S.B. Reed, "Consumer Price Index Research Series Using Current Methods, 1978–98," *Monthly Labor Review,* June 1999.

ADDITIONAL CASE STUDY

2-10 The Billion Prices Project

The CPI is based on thousands of prices for individual goods and services that are collected each month by workers for the Bureau of Labor Statistics who visit retail stores. Two researchers recently proposed another way to gather price data. MIT economists Alberto Cavallo and Roberto Rigobon use the Internet to track prices charged by 300 online retailers for about five million items sold in 70 different countries. They then use these data to compute overall price indices for the 70 countries.[1]

One problem with this approach is that it only includes goods and not services. One benefit is that the data collection is done automatically and quickly by computer and thus can be performed daily, unlike the CPI, which is produced only monthly. The researchers find that the daily price index for the United States tracks the CPI relatively closely, but this is not the case for all countries. For example, in Argentina the new data have shown inflation to be considerably higher than the official statistics. Some have argued this is evidence that the Argentine government manipulates inflation statistics so it will pay less on inflation-indexed government bonds.

[1] See http://bpp.mit.edu for more details.

LECTURE SUPPLEMENT

2-11 Alternative Measures of Unemployment

The text defines unemployment as the percentage of the labor force unemployed at a particular time. The labor force consists of individuals 16 and over who currently have a job (the employed) or do not have a job but are actively seeking work (the unemployed). An individual who does not have a job and is not looking for work is not considered part of the labor force.

While this is the most widely used measure of the unemployment rate, it is not the only one. The Bureau of Labor Statistics, the U.S. government agency responsible for the collection and dissemination of unemployment data, publishes six different measures of labor underutilization:[1]

U1: Persons unemployed 15 weeks or longer, as a percentage of the civilian labor force.

U2: Persons who have lost their job or have completed temporary assignments and are currently without a job, as a percentage of the civilian labor force.

U3: All unemployed persons, as a percentage of the civilian labor force.

U4: All unemployed persons plus discouraged workers, as a percentage of the civilian labor force plus discouraged workers.

U5: All unemployed persons plus all marginally attached workers, as a percentage of the civilian labor force plus all marginally attached workers.

U6: All unemployed persons plus all marginally attached workers, plus all persons employed part time for economic reasons, as a percentage of the civilian labor force plus all marginally attached workers.

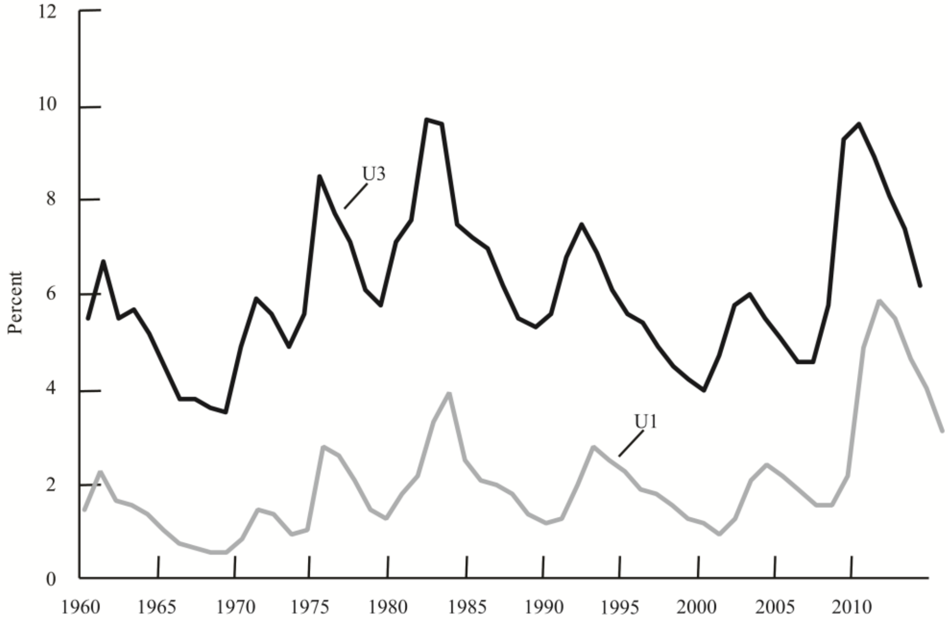
U3 is known as the official unemployment rate and corresponds to the definition of the unemployment rate given in the text. U1 and U2 examine a subset of the unemployed as a percentage of the civilian labor force. U1 provides a measure of the long-term unemployed, while U2 concentrates on those who previously held jobs but now are unemployed. U3, in contrast, includes both those who have previously held jobs and those who have never held a job but are looking for work. Figure 1 shows the unemployment rate as measured by U1 and U3 over the period 1960–2014.

The remaining three measures of labor underutilization expand the concept of unemployment and the labor force to include those who are not currently searching for work or who are working fewer hours than desired. Discouraged workers are those who want to work and are available for work but have given up searching because they don’t believe they can find a job. Marginally attached workers, a category that includes discouraged workers, are individuals who want to work and are available for work but are not searching for a job. The reasons a marginally attached worker might not be searching include discouragement, transportation problems, and child-care problems. U4 and U5 thus measure the extent to which the economy is not utilizing potential labor resources. U6 measures the extent to which both potential (the marginally attached workers) and existing (part-time workers who would like to work full time) labor resources are not utilized.

As shown in Figure 2, these three measures follow the cyclical pattern of the official unemployment rate (U3), falling during the expansion of the 1990s and rising during the recessions of 2001 and 2007–2009. In addition, Figure 2 also shows some widening in the gap between the broadest measure, U6, and the official measure, U3, during the recent recessions. Unfortunately, these broad measures of unemployment are only available since 1994, and so it is not possible to determine whether this gap has also widened during previous recessions.

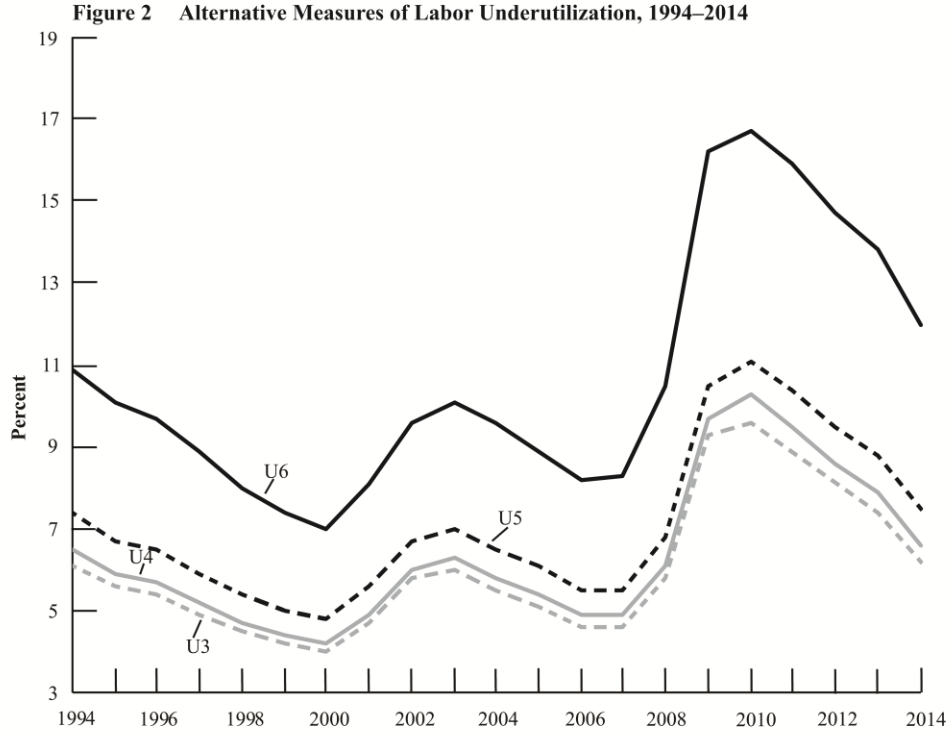
[1] For more information, see J.E. Bregger and S.E. Haugen, “BLS Introduces New Range of Alternative Unemployment Measures,” *Monthly Labor Review* (October 1995): 19–26. See also the discussion in Chapter 6 of the text.

Figure 1 Alternative Measures of Labor Underutilization, 1960–2014



Source: U.S. Department of Labor, Bureau of Labor Statistics

Figure 2 Alternative Measures of Labor Underutilization, 1994–2014



Source: U.S. Department of Labor, Bureau of Labor Statistics.

ADDITIONAL CASE STUDY

2-12 Improving the National Accounts

Economists have long been aware that the statistics in the national accounts are imperfect. Some of these imperfections simply have to do with the difficulties of precisely defining and/or measuring the variables that economists care about. Some critics charge, however, that there are *fundamental* problems with the system of national accounts. One set of arguments challenges the presumption that measures of income, such as Gross Domestic Product, tell us anything useful about individuals' welfare or overall well-being. Another set of arguments holds that the national accounts are dangerously misleading because they fail to take account of the depletion of natural resources and other environmental concerns.

In the late 1960s and early 1970s, a number of commentators questioned the desirability of economic growth—that is, increasing GDP—because they felt that increases in GDP did not reflect increases in welfare.[1] The economists William Nordhaus and James Tobin acknowledged this possibility and, in a paper written in 1972, attempted to construct a *measure of economic welfare* (MEW) that adjusted for some of the differences between GDP and welfare.[2] Their aim was to construct "a comprehensive measure of the annual real consumption of households" where consumption "is intended to include all goods and services, marketed or not … and allowance is to be made for negative externalities, such as those due to environmental damage."[3]

This ambitious new measure thus focused on consumption. It added some components of government expenditures, such as recreation outlays, to private consumption, but not others, such as national defense (termed a "regrettable"). It reclassified some elements of private consumption (such as education and health expenditures and consumption of durables) as investment and subtracted other components, such as personal business expenses. Nordhaus and Tobin also added in an *imputed value* for leisure and other nonmarket uses of time.

The two most important of the many adjustments Nordhaus and Tobin made were the exclusion of regrettables (which they found to be an increasing fraction of GDP) and the imputations for leisure and nonmarket work. The latter correction proved to be sensitive to different assumptions about the effects of technical progress (technical progress allows us to produce more goods per hour; does it also increase our enjoyment of an hour of leisure time?). As a result, Nordhaus and Tobin could not come to a definitive conclusion about whether conventional measures of economic growth understated or overstated growth in welfare. Nevertheless, they were able to conclude that the picture of long-run economic growth conveyed by the national accounts is reasonably accurate; their corrected measures of welfare all indicated long-run growth in economic well-being.

The appropriate treatment in national income accounting of natural resources and other environmental concerns was also addressed by Nordhaus and Tobin and has received increased attention in recent years. The basic idea is that the national accounts should adjust for environmental degradation and for changes in the stocks of natural resources.

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[1] See, for example, T. Scitovsky, *The Joyless Economy* (Oxford: Oxford University Press, 1976) and E. Mishan, *The Costs of Economic Growth* (Harmondsworth: Penguin, 1969). A recent observation along these lines, concerning the economic reforms in the Soviet Union, is the following: "Remember, even though it won't show up positively on the national statistics, a 10 percent reduction in tanks accompanied by a 5 percent increase in making goods that people want is a real gain for society." (Editorial, *Manchester Guardian Weekly*, July 21, 1991).

[2] W. Nordhaus and J. Tobin, "Is Growth Obsolete?" *Economic Growth: Fiftieth Anniversary Colloquium V*, National Bureau of Economic Research (New York: Columbia University Press, 1972), reprinted in J. Tobin, *Essays in Economics: Theory and Policy* (Cambridge, MA: MIT Press, 1985), 360–439.

[3] Ibid., 383.