CHAPTER 2

National Income Accounting

CHAPTER HIGHLIGHTS

- Gross domestic product is the value of the goods and services produced within the country. In equilibrium, the amount of output produced equals the amount demanded.
- The production of output generates income for those who produce. The bulk of that income is received by labor and the owners of capital.
- Output is demanded for private consumption and investment, for government expenditure, and for international trade.
- The dollar value of gross domestic product depends on both physical production and the price level. Inflation is the change over time in the price level.

Good accounting turns data into information. We study national income accounting for two reasons. First, the national income accounts provide the formal *structure* for our macrotheory models. We divide output in two ways. On the production side, output is paid out to labor in the form of wages and to capital in the form of interest and dividends. On the demand side, output is consumed or invested for the future. The division of output into factor payments (wages, etc.) on the production side provides a framework for our study of growth and aggregate supply. The division of income into consumption, investment, and so on, on the demand side provides the framework for studying aggregate demand. The input and output, or demand and production, accountings are necessarily equal in equilibrium. In addition to looking at real output, the national income accounts include measures of the overall price level. This provides a basis for our discussions of inflation.

The second reason for studying national income accounts is to learn a few ballpark numbers that help characterize the economy. If we spread annual U.S. output equally across the population, would each person control $4,000, $40,000, or $400,000? Is a dollar today worth a 1947 penny, dime, or dollar? Is income paid mostly to labor or mostly to capital? While memorizing exact statistics is a waste of time, knowing rough magnitudes is vital for linking theory to the real world. And macroeconomics is very much about the world we live in.

We begin our study with the basic measure of output—*gross domestic product,* or *GDP*. **GDP is the value of all final goods and services produced in the country within a given period.** It includes the value of goods produced, such as houses and CDs, and the value of services, such as airplane rides and economists' lectures. The output of each of these is valued at its market price, and the values are added together to get GDP. In 2002 the value of GDP in the U.S. economy was about $10,400 billion, or something over $10 trillion. Since the U.S. population was about 287 million, *per capita GDP* (GDP per person) was roughly $36,000 per year (= $10,400 billion/287 million).

2-1 THE PRODUCTION OF OUTPUT AND PAYMENTS TO FACTORS OF PRODUCTION

The production side of the economy transforms inputs, such as labor and capital, into output, GDP. Inputs such as labor and capital are called *factors of production,* and the payments made to factors, such as wages and interest payments, are called *factor payments*. Imagine a student pie-baking economy with you as the entrepreneur. You hire several friends to roll dough, and you rent a kitchen from another friend. Your factor inputs are friends (labor) and kitchens (capital). Output is measured as the number of pies. With some experience, you could predict the number of pies that can be produced with a given number of friends and so many kitchens. You could express the relation as a mathematical formula called a *production function,* which is written in this case as

$$\text{Pies} = f(\text{friends, kitchens}) \qquad (1)$$

We will, of course, be interested in a somewhat more general production function relating all the economy's production, GDP (Y) to inputs of labor (N) and capital (K), which we write as $Y = f(N,K)$. The production function will be a focal point for our study of growth in Chapters 3 and 4, where we will also elaborate on the role of technology and on the use of inputs other than labor and capital.

Once the pies are baked, it's time to make factor payments. Some of the pies you give to your friends as payment for their labor. These pies are wage income to your friends. You also need to set aside one slice from each pie (about 8 percent of the pie in the United States) to send to the government as a contribution for social security. This slice is also considered a payment to labor, since the payment is made on behalf of the worker. You should also take a pie for yourself as a fair return for your management skills. This pie, too, is a payment to labor. A few pies you leave for the kitchen owner. These are payments to capital. Any remaining pies are true profit.

All the factor payments, including profit, if any, add up to the total number of pies produced. We can express this as an equation:

$$\text{Pies} = \text{labor payments} + \text{capital payments} + \text{profit} \qquad (2)$$

More generally, we might write that labor payments equal the wage rate (w) times the amount of labor used and that capital payments (the rent for the kitchen) equal the rental rate (r) times the amount of capital rented and write $Y = (w \times N) + (r \times K) + \text{profit}$.

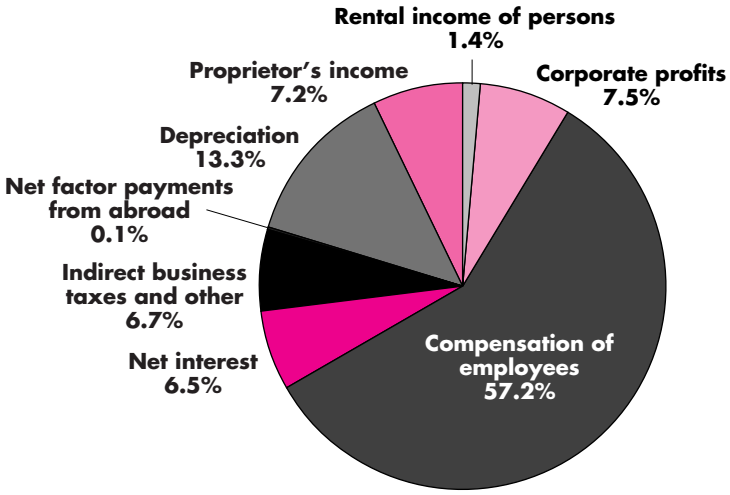
Figure 2-1*a* shows the GDP pie broken down into factor payments plus a few complicating items.

GDP AND GNP

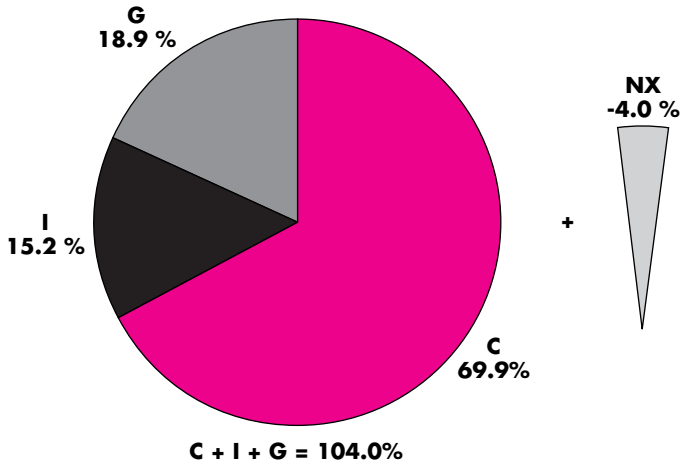
The first complication is that factor payments include receipts from abroad made as factor payments to domestically owned factors of production. Adding these payments to GDP gives *gross national product,* or *GNP*. For instance, part of U.S. GDP corresponds to the profits earned by Honda from its U.S. manufacturing operations. These profits are part of Japan's GNP, because they are the income of Japanese-owned capital. In the United States the difference between GDP and GNP is only about 1 percent and can be ignored for our purposes, but the difference can be more important in some other countries. For example, in the year 2000, in Ireland GDP was almost 15 percent higher than GNP, while in Switzerland GNP was about 6 percent higher than GDP.

GDP AND NDP

The second complication is quite important but also quite straightforward. Capital wears out, or *depreciates,* while it is being used to produce output. ***Net domestic product (NDP)* is equal to GDP minus depreciation.** NDP thus comes closer to measuring the net amount of goods produced in the country in a given period: It is the total value of production minus the value of the amount of capital used up in producing that output. *Depreciation* is typically about 11 percent of GDP, so NDP is usually about 89 percent of GDP.



(*a*) Payments of factors of production



(*b*) Components of demand for output

FIGURE 2-1 COMPOSITION OF U.S. GDP IN 2002.
(Source: Bureau of Economic Analysis.)

NATIONAL INCOME

The third complication is that businesses pay indirect taxes (i.e., taxes on sales, property, and production) that must be subtracted from NDP before making factor payments. These payments are large, amounting to nearly 10 percent of NDP, so we need to mention them here. (Having done so, we won't mention them again.) What's left for making factor payments is *national income,* equaling about 80 percent of GDP.

You should remember that about three-fourths of factor payments are payments to labor. Most of the remainder goes to pay capital. Only a small amount goes for other factors of production or true profits. The same allocation is very roughly the case in most industrialized countries. (There are a small number of resource-extraction economies based on oil, copper, or guano where natural resources are a dominant factor of production.)

RECAP

From this section you should remember:

- GDP is the value of all final goods and services produced in the country within a given period.
- In the United States, per capita GDP is around $36,000 per year.
- GDP is the sum of all factor payments.
- Labor is the dominant factor of production.

2-2 OUTLAYS AND COMPONENTS OF DEMAND

In this section we look at the demand for output, and we discuss the *components* of the aggregate demand for domestically produced goods and services, the different purposes for which GDP is demanded.

Total demand for domestic output is made up of four components: (1) consumption spending by households (C), (2) investment spending by businesses and households (I), (3) government (federal, state, and local) purchases of goods and services (G), and (4) foreign demand for our net exports (NX). These four categories account, definitionally, for all spending. **The fundamental *national income accounting identity* is**

$$Y \equiv C + I + G + NX \tag{3}$$

MEMORIZE THIS IDENTITY. You will use it repeatedly in this course and in organizing your thinking about the macroeconomy.

We now look more closely at each of the four components.

CONSUMPTION

Table 2-1 presents a breakdown of the demand for goods and services by components of demand. The table shows that the chief component of demand is *consumption spending* by the household sector. This includes spending on anything from food to golf lessons, but it also involves, as we shall see in discussing investment, consumer spending on durable goods such as automobiles—spending that might be regarded as investment rather than consumption.

TABLE 2-1 GDP and Components of Demand

	2002	
	$ BILLIONS	PERCENT
Personal consumption expenditures	7,301	69.9
Gross private domestic investment	1,586	15.2
Government purchases of goods and services	1,973	18.9
Net exports of goods and services	−418	−4.0
Gross domestic product	10,442	100.0

Source: Bureau of Economic Analysis.

Figure 2-2 shows the percentage of GDP accounted for by consumption in both Japan and the United States. Note that the consumption share is not constant by any means. Observe, too, that Japan consumes a far smaller share of its GDP than is the case in the United States. Given the share of government spending, higher consumption (or lower saving), as we will see in a moment, means either less investment or larger trade deficits.

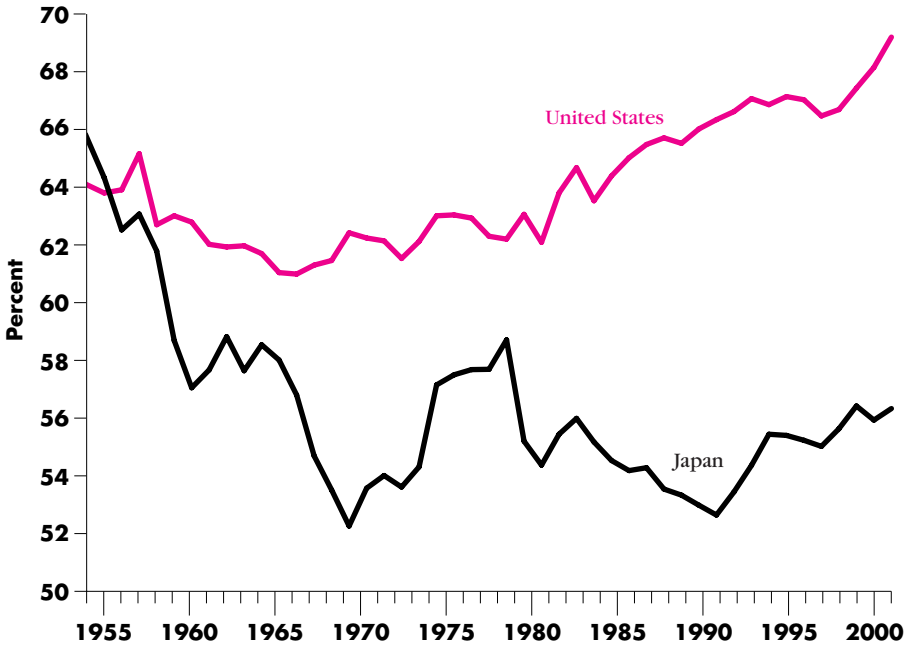


FIGURE 2-2 CONSUMPTION AS A SHARE OF GDP: UNITED STATES AND JAPAN, 1955–2001.
(Source: International Financial Statistics CD-ROM, IMF.)

GOVERNMENT

Next in size we have *government purchases* of goods and services. This component of GDP includes such items as national defense expenditures, costs of road paving by state and local governments, and salaries of government employees.

We draw attention to the use of certain words in connection with government spending. We refer to government spending on goods and services as *purchases* of goods and services. In addition, the government makes *transfer payments,* payments that are made to people without their providing a current service in exchange. Typical transfer payments are social security benefits and unemployment benefits. **Transfer payments are *not* counted as part of GDP because transfers are not part of current production.** We speak of *transfers plus purchases* as *government expenditure*. The federal government budget, on the order of $2,000 billion ($2.0 trillion), refers to federal government expenditure. Less than one-third of that sum is spent on federal government purchases of goods and services; most of it is used for transfers.

Total government spending, both items that are counted in GDP and items that are not, plays a large role in determining how the economy is split between the public sector and the private sector. In the United States federal, state, and local spending account for a little over a third of the economy, as can be seen in Figure 2-3.

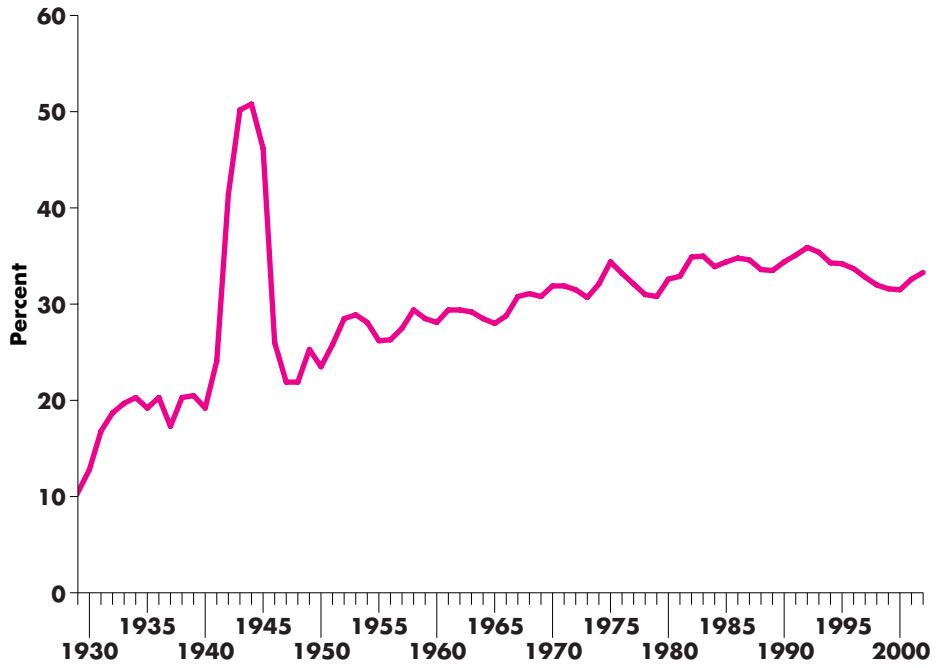


FIGURE 2-3 GOVERNMENT PURCHASES AND TRANSFER PAYMENTS AS A SHARE OF GDP.
(Source: Bureau of Economic Analysis.)

INVESTMENT

Gross private domestic investment requires some definitions. First, throughout this book, the term *investment* means additions to the physical stock of capital. As we use the term, investment does *not* include buying a bond or purchasing stock in General Motors. Investment includes housing construction, building of machinery, construction of factories and offices, and additions to a firm's inventories of goods.

If we think of investment more generally as any current activity that increases the economy's ability to produce output in the future, we would include not only physical investment but also what is known as investment in human capital. *Human capital* is the knowledge and ability to produce that is embodied in the labor force. Investment in education can be regarded as investment in human capital, but the official accounts treat personal educational expenditures as consumption and public educational expenditures as government spending.[1]

The classification of spending as consumption or investment is to a significant extent a matter of convention. From the economic point of view, there is little difference between a household's building up an inventory of peanut butter and a grocery store's doing the same. Nevertheless, in the national income accounts, the individual's purchase is treated as a personal consumption expenditure, whereas the store's purchase is treated as inventory investment. Although these borderline cases clearly exist, we can apply a simple rule of thumb: Investment is associated with the business sector's adding to the physical stock of capital, including inventories.[2] Officially, however, all household expenditures (except new housing construction) are counted as consumption spending. This is not quite so bad as it might seem, since the accounts do separate households' purchases of *durable goods* like cars and refrigerators from their other purchases.

In passing, we note that in Table 2-1 investment is listed as "gross." It is *gross investment* in the sense that depreciation is not deducted. *Net investment* is gross investment minus depreciation.

NET EXPORTS

The item "Net exports" appears in Table 2-1 to account for domestic spending on foreign goods and foreign spending on domestic goods. When foreigners purchase goods we produce, their spending adds to the demand for domestically produced goods. Correspondingly, that part of our spending that purchases foreign goods has to be subtracted from the demand for domestically produced goods. Accordingly, the difference between

[1]In the total incomes system of accounts (TISA), referred to in footnote 8 on page 36, the definition of investment is broadened to include investment in human capital, which means that total investment in that system is more than one-third of GDP. But in this book and in the official national income accounts, investment counts only additions to the physical capital stock.

[2]The GDP accounts record as investment *business sector* additions to the stock of capital. Some government spending, for instance, for roads or schools, also adds to the capital stock. Estimates of the capital stock owned by government are available in *Fixed Reproducible Tangible Wealth in the United States, 1925–97* (Washington, DC: U.S. Bureau of Economic Analysis, National Income and Wealth Division, 1999). For the most recent statistics, go to www.bea.doc.gov/bea/dn/faweb.

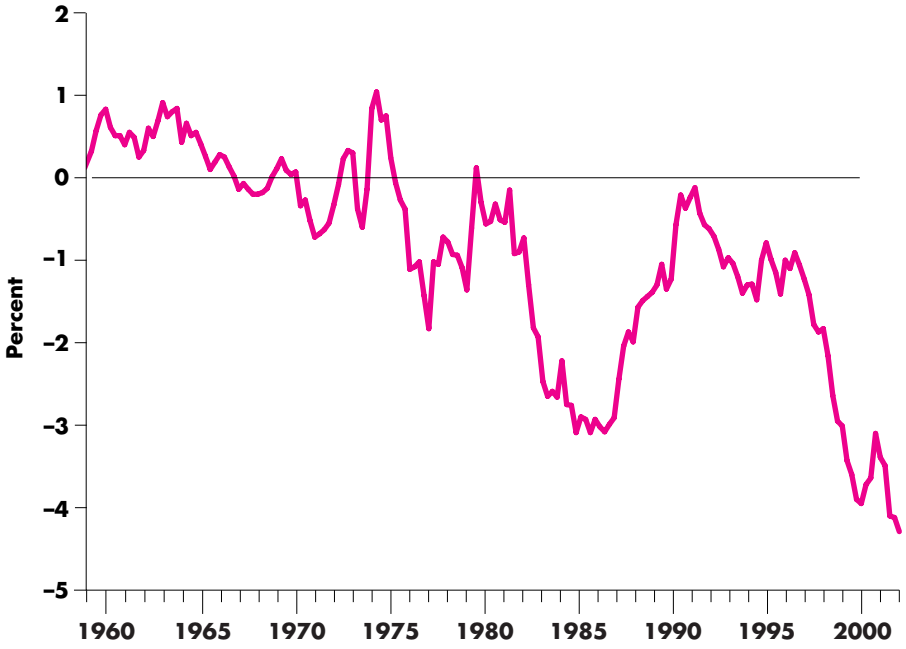


FIGURE 2-4 U.S. NET EXPORTS, 1960–2002.
(Source: Bureau of Economic Analysis.)

exports and imports, called *net exports,* is a component of the total demand for our goods. U.S. net exports have been negative since the 1980s, as shown in Figure 2-4, reflecting a high level of imports and a lower level of exports; note, though, that net exports have been close to zero in some years (trade has been nearly balanced) and very negative in others (the United States has had a large balance-of-trade deficit).

The role of net exports in accounting for GDP can be illustrated with an example. Assume that personal sector spending was higher by $2 billion. How much higher would GDP be? If we assume that government and investment spending remained unchanged, we might be tempted to say that GDP would have been $2 billion higher. That is correct if all the additional spending had fallen on domestic goods (e.g., cars built in Detroit). The other extreme, however, is that all the additional spending had fallen on imports (e.g., Jaguars imported from the U.K.). In that event, consumption would have been up $2 billion *and* net exports would have been down $2 billion, with *no* net effect on GDP.

RECAP

From this section you should remember:

- Demand for GDP is split into four components: consumption, investment, government, and net exports, according to the identity of the purchaser.
- $Y \equiv C + I + G + NX$.

- The relative sizes of the demand sectors vary across countries and across time, but rough numbers to remember for the United States are consumption, 70 percent; investment, 15 percent; government purchases of goods and services, 19 percent; and net exports, negative.

2-3 SOME IMPORTANT IDENTITIES

In this section we summarize the discussion of the preceding sections by presenting a set of national income relationships that we use extensively in the rest of the book. We introduce here some notation and conventions that we follow throughout the book.

For analytical work in the following chapters, we simplify our analysis by making assumptions that ensure that national income is equal to GDP. For the most part, we disregard depreciation and thus the difference between GDP and NDP as well as the difference between gross investment and net investment. We refer simply to investment spending. We also disregard indirect taxes and business transfer payments. With these conventions in mind, **we refer to national income and GDP interchangeably as income or output.** These simplifications have no serious consequences and are made only for convenience. Finally, just in the next subsection, we omit both the government and foreign sector.

A SIMPLE ECONOMY

We denote the value of output in our simple economy, which has neither a government nor foreign trade, by Y. Consumption is denoted by C and investment spending by I. The first key identity is that output produced equals output sold. What happens to unsold output? *We count the accumulation of inventories as part of investment* (as if the firms sold the goods to themselves to add to their inventories), and therefore all output is either consumed or invested. Output sold can be expressed in terms of the components of demand as the sum of consumption and investment spending. Accordingly, we can write

$$Y \equiv C + I \tag{4}$$

The next step is to establish a relation among *saving,* consumption, and GDP. How will income be allocated? Part will be spent on consumption, and part will be saved.[3] Thus we can write

$$Y \equiv S + C \tag{5}$$

[3]Decisions about saving are made by businesses as well as directly by consumers. It is convenient to ignore the existence of corporations and consolidate, or add together, the entire private sector.

where S denotes private sector saving. Identity (5) tells us that the whole of income is allocated to either consumption or saving. Next, identities (4) and (5) can be combined to read

$$C + I \equiv Y \equiv C + S \tag{6}$$

The left-hand side of identity (6) shows the components of demand, and the right-hand side shows the allocation of income. The identity emphasizes that output produced is equal to output sold. The value of output produced is equal to income received, and income received, in turn, is spent on goods or saved.

Identity (6) can be slightly reformulated to show the relation between saving and investment. Subtracting consumption from each part of identity (6), we have

$$I \equiv Y - C \equiv S \tag{7}$$

Identity (7) shows that in this simple economy *investment is identically equal to saving*.

One can think of what lies behind this relationship in a variety of ways. In a very simple economy, the only way the individual can save is by undertaking an act of physical investment—for example, by storing grain or building an irrigation channel. In a slightly more sophisticated economy, one could think of investors financing their investing by borrowing from individuals who save.

REINTRODUCING THE GOVERNMENT AND FOREIGN TRADE

We now reintroduce the government sector and the external sector.[4] We denote government purchases of goods and services by G and all taxes by TA. Transfers to the private sector (including interest on the public debt) are denoted by TR. Net exports (exports minus imports) are denoted by NX.

We return to the identity between output produced and sold, taking account now of all components of demand, including G and NX. Accordingly, we restate the fundamental identity:

$$Y \equiv C + I + G + NX \tag{8}$$

Next we turn to the derivation of the very important relation between output and disposable income. Now we have to recognize that part of income is spent on taxes and that the private sector receives net transfers (TR) in addition to national income. Disposable income (YD) is thus equal to income plus transfers less taxes:

$$YD \equiv Y + TR - TA \tag{9}$$

Disposable income, in turn, is allocated to consumption and saving:

$$YD \equiv C + S \tag{10}$$

[4]"Government" here means the federal government plus state and local governments.

Rearranging identity (9) and inserting for Y in identity (8), we have

$$YD - TR + TA \equiv C + I + G + NX \tag{11}$$

Putting identity (10) into identity (11) yields

$$C + S - TR + TA \equiv C + I + G + NX \tag{12}$$

With some rearrangement, we obtain

$$S - I \equiv (G + TR - TA) + NX \tag{13}$$

SAVING, INVESTMENT, THE GOVERNMENT BUDGET, AND TRADE

Identity (13) cannot be overemphasized. The first set of terms on the right-hand side ($G + TR - TA$) is the *government budget deficit (BD)*. $G + TR$ is equal to total government expenditure, consisting of government purchases of goods and services (G) plus government transfer payments (TR). TA is the amount of taxes received by the government. The difference ($G + TR - TA$) is the excess of the government's spending over its receipts, or its budget deficit. (The budget deficit is a negative budget surplus, $BS = TA - (G + TR)$.) The second term on the right-hand side is the excess of exports over imports, or the *net exports of goods and services,* or net exports for short. NX is also called the *trade surplus.* When net exports are negative, we have a *trade deficit*.

Thus, identity (13) states that the excess of saving over investment ($S - I$) in the private sector is equal to the government budget deficit plus the trade surplus. The identity suggests, correctly, that there are important relations among the excess of private saving over investment ($S - I$), the government budget (BD), and the external sector (NX). For instance, if, for the private sector, saving is equal to investment, then the government's budget deficit (surplus) is reflected in an equal external deficit (surplus).

Table 2-2 shows the significance of identity (13). To fix ideas, suppose that private sector saving S is equal to $1,000 billion. In the first two rows we assume that exports are equal to imports, so the trade surplus is zero. In row 1, we assume the government budget is balanced. Investment accordingly has to equal $1,000 billion. In the next row we assume the government budget deficit is $150 billion. *Given the level of saving* of $1,000 billion and a zero trade balance, it has to be true that investment is now lower by $150 billion. Row 3 shows how this relationship is affected when there is a trade surplus.

TABLE 2-2 The Budget Deficit, Trade, Saving, and Investment
(Billions of Dollars)

SAVING (S)	INVESTMENT (I)	BUDGET DEFICIT (BD)	NET EXPORTS (NX)
1,000	1,000	0	0
1,000	850	150	0
1,000	900	0	100
1,000	950	150	−100

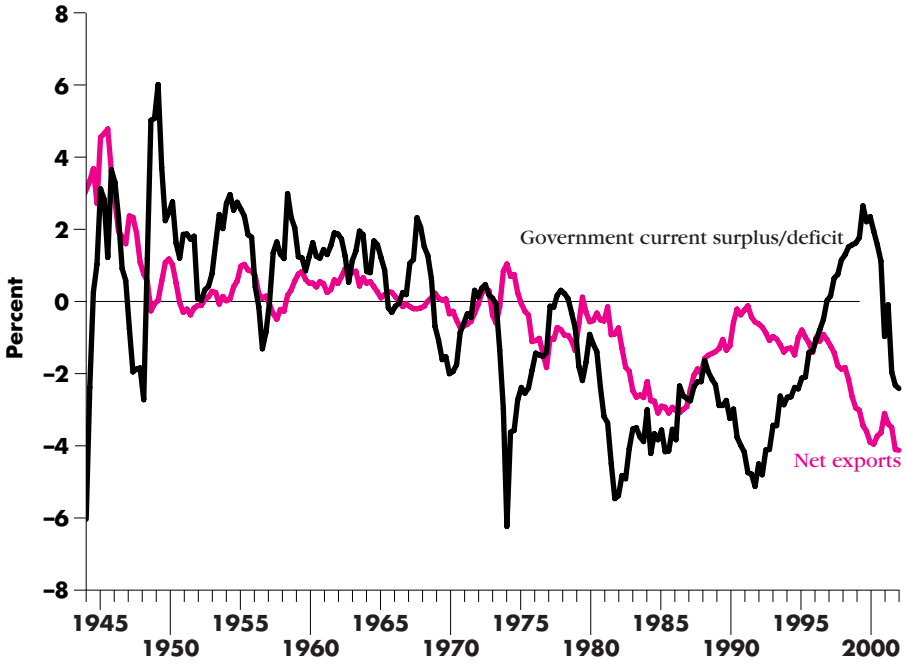


FIGURE 2-5 BUDGET AND TRADE SURPLUSES AS A PERCENTAGE OF GDP.
(Source: Bureau of Economic Analysis.)

Any sector that spends more than it receives in income has to borrow to pay for the excess spending. The private sector has three ways of disposing of its saving. It can make loans to the government, which thereby pays for the excess of its spending over the income it receives from taxes. Or the private sector can lend to foreigners, who are buying more from us than we are buying from them. They therefore are earning less from us than they need in order to pay for the goods they buy from us, and we have to lend to cover the difference. Or the private sector can lend to business firms, which use the funds for investment. In all three cases, households will be paid back later, receiving interest or dividends in addition to the amount they lent.

In the 1950s and 1960s, the U.S. budget balance and trade balance were usually in surplus, as Figure 2-5 shows. The story of the late 1970s through the mid-1990s was one of persistent government budget deficits and trade deficits. At the turn of the millennium, the budget had moved into surplus for the first time in many years, but the trade balance continued to be in deficit. By 2003 the budget balance appeared to be heading back toward significant deficit.

Figure 2-6 shows the federal debt, which is the accumulation of past deficits. Most federal debt has been the result of wars, but a considerable amount was added in the 1980s even though the United States was at peace.

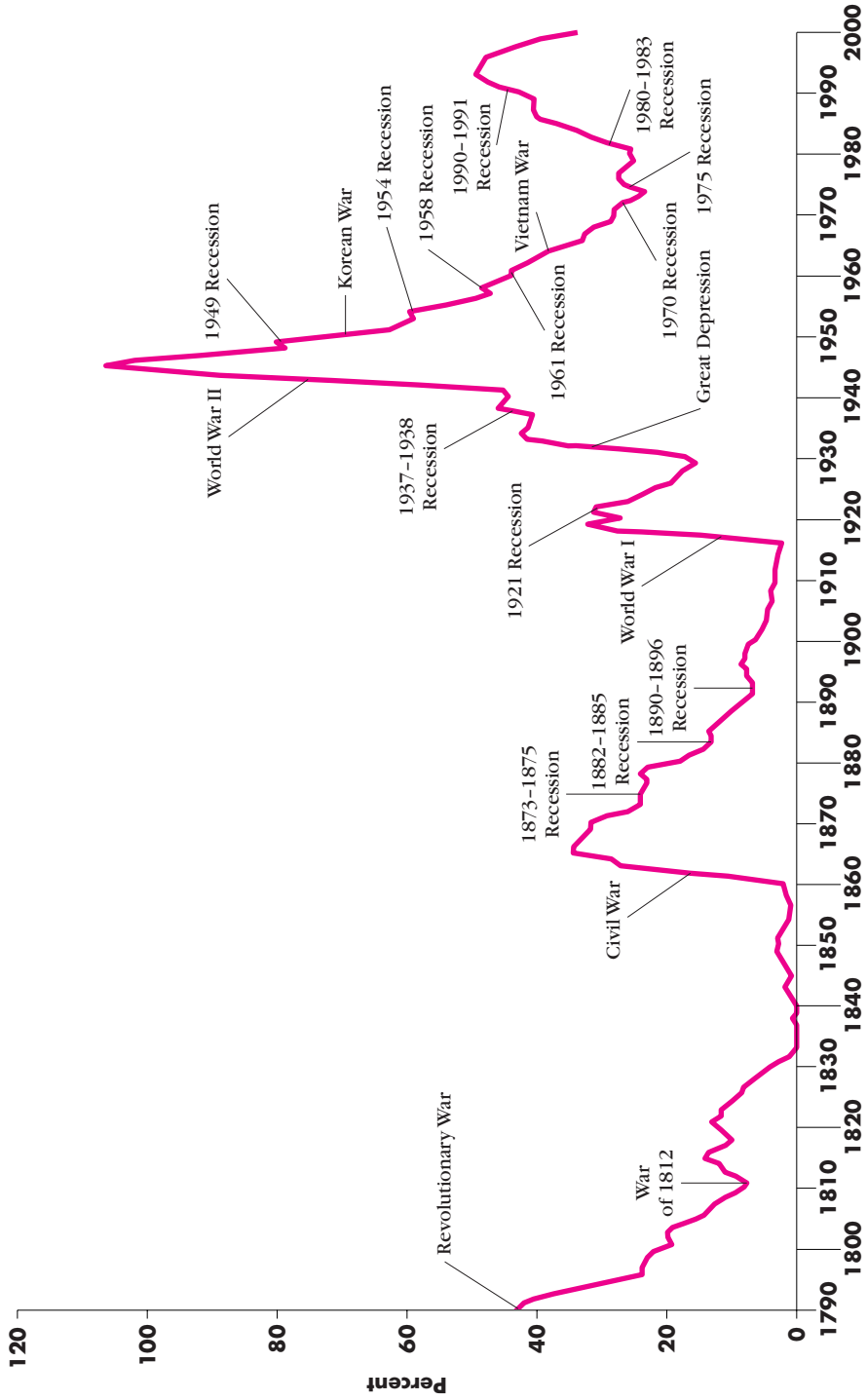


FIGURE 2-6 FEDERAL DEBT HELD BY THE PUBLIC AS A PERCENTAGE OF GROSS NATIONAL PRODUCT, 1790–2000.
(Source: Congressional Budget Office.)

2-4 MEASURING GROSS DOMESTIC PRODUCT

There are a number of subtleties in the calculation of GDP. There are also a number of nonsubtle problems. We start with the straightforward points.

FINAL GOODS AND VALUE ADDED

GDP is the value of *final goods and services* produced. The insistence on final goods and services is simply to make sure that we do not double-count. For example, we would not want to include the full price of an automobile in GDP and then also include as part of GDP the value of the tires that were bought by the automobile producer for use on the car. The components of the car that are bought by the manufacturers are called *intermediate goods,* and their value is not included in GDP. Similarly, the wheat that goes into a pie is an intermediate good. We count only the value of the pie as part of GDP; we do not count the value of the wheat sold to the miller and the value of the flour sold to the baker.

In practice, double counting is avoided by working with *value added*. At each stage of the manufacture of a good, only the value added to the good at that stage is counted as part of GDP. The value of the wheat produced by the farmer is counted as part of GDP. Then the value of the flour sold by the miller minus the cost of the wheat is the miller's value added. If we follow this process along, we will see that the sum of the value added at each stage of processing is equal to the final value of the bread sold.

CURRENT OUTPUT

GDP consists of the value of output *currently produced*. It thus excludes transactions in existing commodities, such as old masters or existing houses. We count the construction of new houses as part of GDP, but we do not add trade in existing houses. We do, however, count the value of realtors' fees in the sale of existing houses as part of GDP. The realtor provides a current service in bringing buyer and seller together, and that is appropriately part of current output.

PROBLEMS OF GDP MEASUREMENT

GDP data are, in practice, used not only as a measure of how much is being produced but also as a measure of the welfare of the residents of a country. Economists and politicians talk as if an increase in GDP means that people are better off. But GDP data are

far from perfect measures of either economic output or welfare.[5] There are, specifically, three major problems:

- Some outputs are poorly measured because they are not traded in the market. If you bake homemade pie, the value of your labor isn't counted in official GDP statistics. If you buy a (no doubt inferior) pie, the baker's labor is counted. This means that the vastly increased participation of women in the labor force has increased official GDP numbers with no offsetting reduction for decreased production at home. (We officially measure the value of commercial day care, but taking care of your own kids is valued at zero.)

  Note, too, that government services aren't directly priced by the market. The official statistics assume that a dollar spent by the government is worth a dollar of value.[6] GDP is mismeasured to the extent that a dollar spent by the government produces output valued by the public at more or less than a dollar.
- Some activities measured as adding to GDP in fact represent the use of resources to avoid or contain "bads" such as crime or risks to national security. Similarly, the accounts do not subtract anything for environmental pollution and degradation. This issue is particularly important in developing countries. For instance, one study of Indonesia claims that properly accounting for environmental degradation would reduce the measured growth rate of the economy by 3 percent.[7]
- It is difficult to account correctly for improvements in the quality of goods. This has been the case particularly with computers, whose quality has improved dramatically while their price has fallen sharply. But it applies to almost all goods, such as cars, whose quality changes over time. The national income accountants attempt to adjust for improvements in quality, but the task is not easy, especially when new products and new models are being invented.

Attempts have been made to construct an *adjusted GNP* series that takes account of some of these difficulties, moving closer to a measure of welfare. The most comprehensive of these studies, by the late Robert Eisner of Northwestern University, estimates an adjusted GNP series in which the level of real GNP is about 50 percent higher than the official estimates.[8]

[5]See the articles by M. J. Boskin, B. R. Moulton, and W. D. Nordhaus under the heading "Getting the 21st Century GDP Right" in *American Economic Review,* May 2000.

[6]You probably have the immediate reaction that a dollar spent by the government on higher education is worth far more than a dollar spent on soft drinks—we hope.

[7]R. Repetto, W. Magrath, M. Wells, C. Beer, and F. Rossini, *Wasting Assets: Natural Resources in the National Income Accounts* (Washington, DC: World Resources Institute, June 1989). For a sophisticated look at accounting for the environment and natural resources, see William D. Nordhaus and Edward C. Kokkelenberg (eds.), *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment* (Washington, DC: National Academy Press, 1999). You can read this book online at http://books.nap.edu/catalog/6374.html.

[8]Eisner presents his data in his book, *The Total Incomes System of Accounts* (Chicago: University of Chicago Press, 1989). In Appendix E, he reviews a variety of other attempts to adjust the standard accounts for major inadequacies. Eisner estimated an adjusted GNP rather than GDP series mainly because he did his work at the time when GNP was used as the basic measure of output.

BOX 2-1 Light and Truth

To shed light on just how much quality change can matter, William Nordhaus, of Yale University, has calculated how much better room lighting is now than in the past, based on estimates of energy requirements per lumen. The improvements—very few of which show up in the official statistics—are enormous. Today's electric light is about 25 times as efficient as Edison's first electric light was in 1883.

Unmeasured quality improvements are not new. Nordhaus calculates that 5 liters of sesame oil cost a Babylonian worker about 1/2 shekel (roughly 2 weeks' wages). Light equivalent to 2 candles burning for an hour cost a Babylonian about an hour's wages.*

*For other serious, but fun, comparisons, see William D. Nordhaus, "Do Real Output and Real Wage Measures Capture Reality? The History of Lighting Suggests Not," in Robert J. Gordon and Timothy F. Bresnahan (eds.), *The Economics of New Goods* (Chicago: University of Chicago Press, 1997), pp. 29–66.

2-5 INFLATION AND PRICE INDEXES

GDP would be easy to measure if all we consumed was pie. One year GDP would be 1,000 pies; the next year 1,005. Unfortunately, life is beer and skittles. You can't add a pint of beer to a game of skittles, but if the price of a pint is a dollar and a game of skittles costs 50 cents, you can say that a pint and a game adds $1.50 to GDP. Now suppose that next year all prices double: a pint and a game add $3 to GDP, but clearly nothing *real* has changed. While the dollar value of GDP has doubled, the amount of goods produced—which is what we care about—is unchanged.

Real GDP* measures changes in physical output in the economy between different time periods by valuing all goods produced in the two periods at the same prices, or in *constant dollars. Real GDP is now measured in the national income accounts at the prices of 1996.[9] This means that, in calculating real GDP, today's physical output is multiplied by the prices that prevailed in 1996 to obtain a measure of what today's output would have been worth had it been sold at the prices of 1996.

Nominal GDP* measures the value of output in a given period in the prices of that period, or, as it is sometimes put, in *current dollars. [10] Thus, 2004 nominal GDP

[9]The Bureau of Economic Analysis now produces "chain-weighted" estimates of real GDP. These estimates use 1996 prices but each year shift the weights given to various goods in measuring real GDP. See *Survey of Current Business,* January–February 1996.

[10]National income account data are regularly reported in the *Survey of Current Business (SCB)*. Historical data are available in the September issue of *SCB;* in the Commerce Department's *Business Statistics,* a biennial publication; and in the annual *Economic Report of the President*.

TABLE 2-3 Real and Nominal GDP, an Illustration

	1996 NOMINAL GDP	2004 NOMINAL GDP	2004 REAL GDP*
Beer	1 at \$1.00 \$1.00	2 at \$2.00 \$4.00	2 at \$1.00 \$2.00
Skittles	1 at \$0.50 0.50	3 at \$0.75 2.25	3 at \$0.50 1.50
	\$1.50	\$6.25	\$3.50

*Measured in 1996 prices.

measures the value of the goods produced in 2004 at the market prices prevailing in 2004, and 1929 nominal GDP measures the value of goods produced in 1929 at the market prices that prevailed in 1929. Nominal GDP changes from year to year for two reasons. First, the physical output of goods changes, and, second, market prices change. Changes in nominal GDP that result from price changes do not tell us anything about the performance of the economy in producing goods and services. That is why we use real rather than nominal GDP as the basic measure for comparing output in different years.

If all prices change in fixed proportion, say, every price doubles, then any reasonable price index will also change in that proportion. When some prices rise more than others, different price indexes will differ modestly according to how the different prices are weighted. Such differences are generally inconsequential for understanding macrotheory.

In Table 2-3 we present a simple example that illustrates the calculation of nominal and real GDP. The hypothetical outputs and prices of beer and skittles in 1996 and 2004 are shown in the first two columns of the table. Nominal GDP in 1996 was \$1.50 and in 2004 was \$6.25. However, much of the increase in nominal GDP is purely the result of the increase in prices and does not reflect an increase in physical output. When we calculate real GDP in 2004 by valuing 2004 output at the prices of 1996, we find that real GDP is \$3.50. Since beer consumption doubled and skittle consumption tripled, we know that real GDP more than doubled and less than tripled. The fourfold increase in nominal GDP does not measure real value.

INFLATION AND PRICES

***Inflation* is the rate of change in prices, and the price level is the cumulation of past inflations.** If P_{t-1} represents the price level last year and P_t represents today's price level, then the inflation rate over the past year can be written as

$$\pi \equiv \frac{P_t - P_{t-1}}{P_{t-1}} \tag{14}$$

where π stands for the inflation rate. Correspondingly, today's price level equals last year's price level adjusted for inflation:

$$P_t = P_{t-1} + (\pi \times P_{t-1}) \tag{15}$$

In the United States in the late nineties and early twenty-first century, the inflation rate was relatively low, around 2 or 3 percent per year, even though prices were much higher than they were 20 years earlier. High inflation rates in the 1970s had pushed up the price level. Once raised, the price level doesn't fall unless the inflation rate is negative—in other words, unless there is a *deflation*.

PRICE INDEXES

No single price index is perfect. The three main price indexes are the GDP deflator, the consumer price index, and the producer price index. Figure 2-7 shows the historical behavior of the GDP deflator, p, as well as the purchasing power of the dollar, $1/p$.

The GDP Deflator

The calculation of real GDP gives us a useful measure of inflation known as the *GDP deflator*. **The GDP deflator is the ratio of nominal GDP in a given year to real GDP of that year.** Since the GDP deflator is based on a calculation involving all the goods produced in the economy, it is a widely based price index that is frequently used to measure inflation. The deflator measures the change in prices that has occurred between the base year and the current year. Using the fictional example in Table 2-3, we

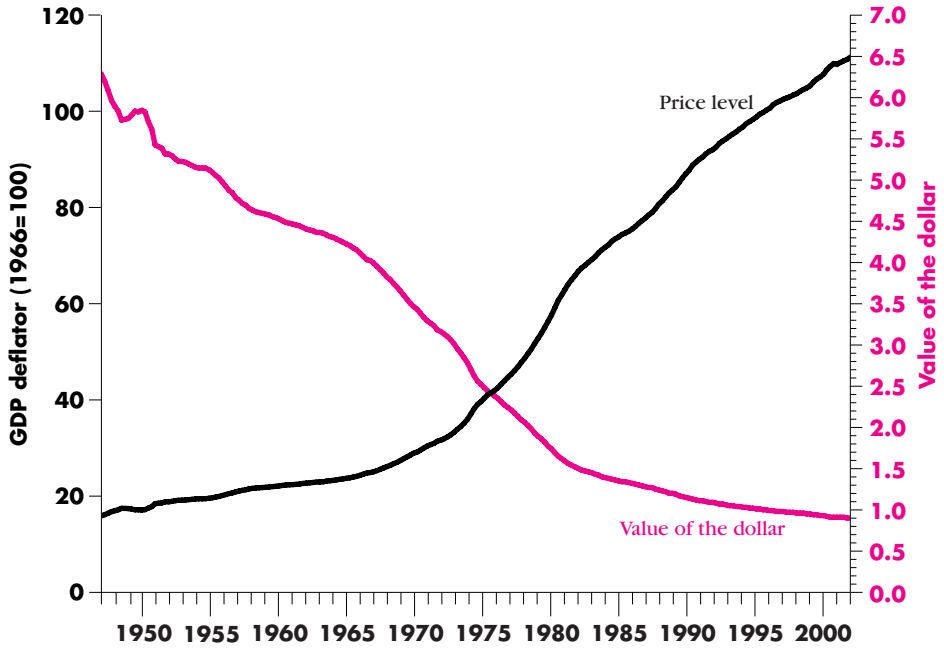


FIGURE 2-7 THE GDP DEFLATOR AND THE VALUE OF THE DOLLAR.
(Source: Bureau of Economic Analysis.)

BOX 2-2 Measuring Inflation: An "Academic" Exercise?

Price indexes are imperfect, in part because market baskets change and in part because quality changes are very hard to quantify. The resulting errors, on the order of a percent or so a year, have mostly been of interest to the economists who create and study price indexes. Recently, "correcting" price indexes has become a hot political topic. Many payments are "indexed to inflation," meaning that the nominal payment is adjusted for inflation to keep the real value constant. In the United States, social security is one such payment.

Because the U.S. social security system is in long-run financial danger, many politicians would like to reduce its costs. But the same politicians are loath to reduce benefits. Well, here's a clever solution: Suppose we announce that the official price index overstates inflation and legislate a "correction" of 1 percent per year. Then we can claim to be paying the same real benefits while spending 1 percent less the first year, 2 percent less the second year, and so forth.

Current price indexes probably overstate inflation. But as you can imagine, the economists who study price indexes would like to find a scientifically based correction rather than one based on current political trends. One careful study of the bias in the CPI, by Matthew Shapiro and David Wilcox, gives a range of estimates for how much the official CPI overstates inflation. The estimates center around 1 percent per year but could be as low as .6 or as high as 1.5 percent per year.* More recent work by Mark Bils and Peter Klenow suggests that because of failures to completely control for

can get a measure of inflation between 1996 and 2004 by comparing the value of 2004 GDP in 2004 prices and 1996 prices. The ratio of nominal to real GDP in 2004 is 1.79 (= 6.25/3.50). We would ascribe the 79 percent increase to price increases, or inflation, over the 1996–2004 period. (In the nonfictional world in which we live, U.S. prices rose about 20 percent between 1996 and 2004.)

The Consumer and Producer Price Indexes

The *consumer price index (CPI)* measures the cost of buying a fixed basket of goods and services representative of the purchases of urban consumers. The CPI differs in three main ways from the GDP deflator. First, the deflator measures the prices of a much wider group of goods than the CPI does. Second, the CPI measures the cost of a given basket of goods which is the same from year to year. The basket of goods included in the GDP deflator, however, differs from year to year, depending on what is produced in the economy in each year. When corn crops are large, corn receives a relatively large weight in the computation of the GDP deflator. By contrast, the CPI

quality improvements, measured inflation may have been overstated by as much as 2.2 percent per year between 1980 and 1996.**

The discussion of inflation mismeasurement is an example of how scientific work in economics has an immediate policy impact. To reduce the kind of criticism about political decision making hinted at above, in 1996 the Senate appointed a panel of blue-ribbon economists to review measurements of the CPI.† The panel reported that current CPI measurements overstate inflation by about 1.1 percent a year. As a dramatic example of how CPI measurement affects spending, the panel estimated that a 1 percent overestimate of cost-of-living increases would, between 1996 and 2008, increase the national debt by $1 trillion through overindexing of tax and benefit programs.

A 1 percent mismeasurement of the price level would matter less if the errors didn't build up year after year. Cumulative mismeasurement at the 1 percent annual level makes a very large difference. Leonard Nakamura gives a good example in terms of real wages.‡ According to official statistics, between 1970 and 1995 the average real (measured in 1982 dollars) wage in the economy declined from about $8 an hour to just under $7.50. Correcting for a 1 percent annual bias in inflation would change this picture from a drop to an increase, from $8 to about $9.50 an hour.

*Matthew D. Shapiro and David W. Wilcox, "Mismeasurement in the Consumer Price Index: An Evaluation," NBER working paper, no. W5590, 1996.

**Mark Bils and Peter Klenow, "Quantifying Quality Growth," NBER working paper no. W7695, May 2000.

†Advisory Commission to Study the Consumer Price Index, "Final Report to the Senate Finance Committee," December 5, 1996. See also "Symposia: Measuring the CPI," *Journal of Economic Perspectives,* Winter 1998; Robert J. Gordon, "The Boskin Commission Report and Its Aftermath," NBER working paper no. W7759, June 2000; and, David E. Lebow and Jeremy B. Rudd, "Measurement Error in the Consumer Price Index: Where Do We Stand?" Board of Governors FEDS working paper no. 2001-61, December 2001.

‡Leonard Nakamura, "Measuring Inflation in a High-Tech Age," Federal Reserve Bank of Philadelphia *Business Review*, November–December 1995. See also, by the same author, "Is U.S. Economic Performance Really That Bad?" Federal Reserve Bank of Philadelphia working paper, April 1996.

measures the cost of a fixed basket of goods that does not vary over time. Third, the CPI directly includes prices of imports, whereas the deflator includes only prices of goods *produced* in the United States.[11]

The GDP deflator and the CPI differ in behavior from time to time. For example, at times when the price of imported oil rises rapidly, the CPI is likely to rise faster than the deflator. However, over long periods the two produce quite similar measures of inflation.

The *producer price index (PPI)* is the third price index that is widely used. Like the CPI, the PPI is a measure of the cost of a given basket of goods. However, it differs from the CPI in its coverage; the PPI includes, for example, raw materials and semi-finished goods. It differs, too, in that it is designed to measure prices at an early stage of the distribution system. Whereas the CPI measures prices where urban households

[11]Detailed discussion of the various price indexes can be found in the Bureau of Labor Statistics' *Handbook of Methods* and in the Commerce Department's biennial *Business Statistics*.

actually do their spending—that is, at the retail level—the PPI is constructed from prices at the level of the first significant commercial transaction.

This makes the PPI a relatively flexible price index and one that frequently signals changes in the general price level, or the CPI, some time before they actually materialize. For this reason, the PPI and, more particularly, some of its subindexes, such as the index of "sensitive materials," serve as one of the business cycle indicators that are closely watched by policymakers. To return to the question posed at the beginning of the chapter, a dollar today buys—measured by the CPI—a bit more than what a dime would have bought in 1947.

2-6 UNEMPLOYMENT

The *unemployment rate* measures the fraction of the workforce that is out of work and looking for a job or expecting a recall from a layoff. Figure 2-8 shows unemployment rates for the United States and France. In the United States, 4 percent unemployment is very low and 9 percent is extremely high. Over the last half century, unemployment in France—and much of Europe—went from being well below U.S. unemployment to notably higher.

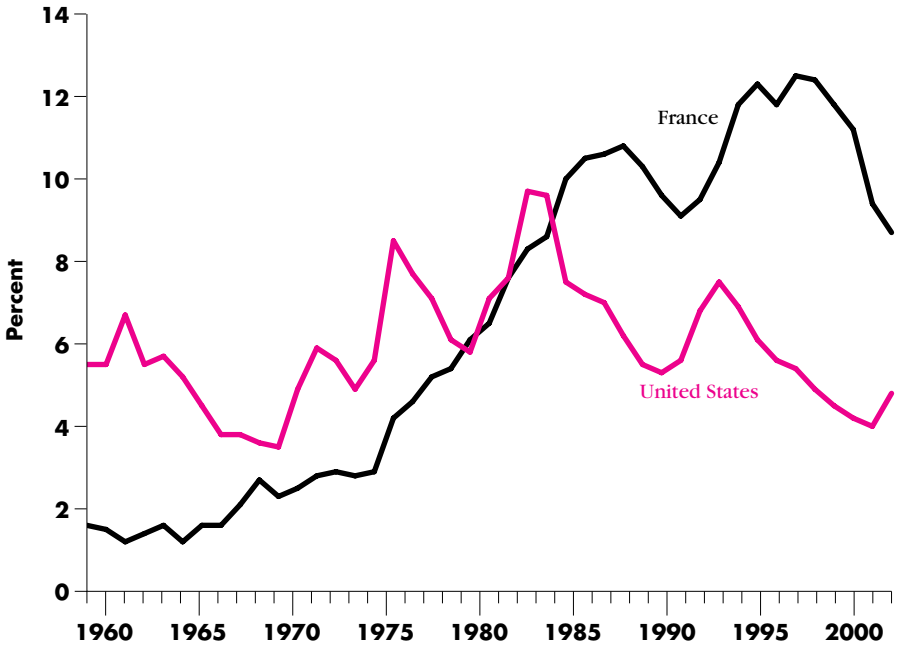


FIGURE 2-8 UNEMPLOYMENT RATES—UNITED STATES AND FRANCE.
(Source: Bureau of Labor Statistics.)

Because life is difficult for people without a job, and because it is more difficult to find a job when the unemployment rate is high, the unemployment rate is an important indicator of how well the economy is performing. Later in the book we will examine unemployment and its consequences in detail.

2-7

INTEREST RATES AND REAL INTEREST RATES

The interest rate states the rate of payment on a loan or other investment, over and above principal repayment, in terms of an annual percentage. If you have $1,000 in the bank and the bank pays you $50 in interest at the end of each year, then the annual interest rate is 5 percent. One of the simplifications we make in studying macroeconomics is to speak of "the" interest rate, when there are, of course, many interest rates. These rates differ according to the creditworthiness of the borrower, the length of the loan, and many other aspects of agreement between borrower and lender. (Some of the elements are discussed in Chapter 17.) Short-term U.S. Treasury bills are among the most heavily traded assets in the world. Figure 2-9 shows interest rates on 3-month Treasury bills.

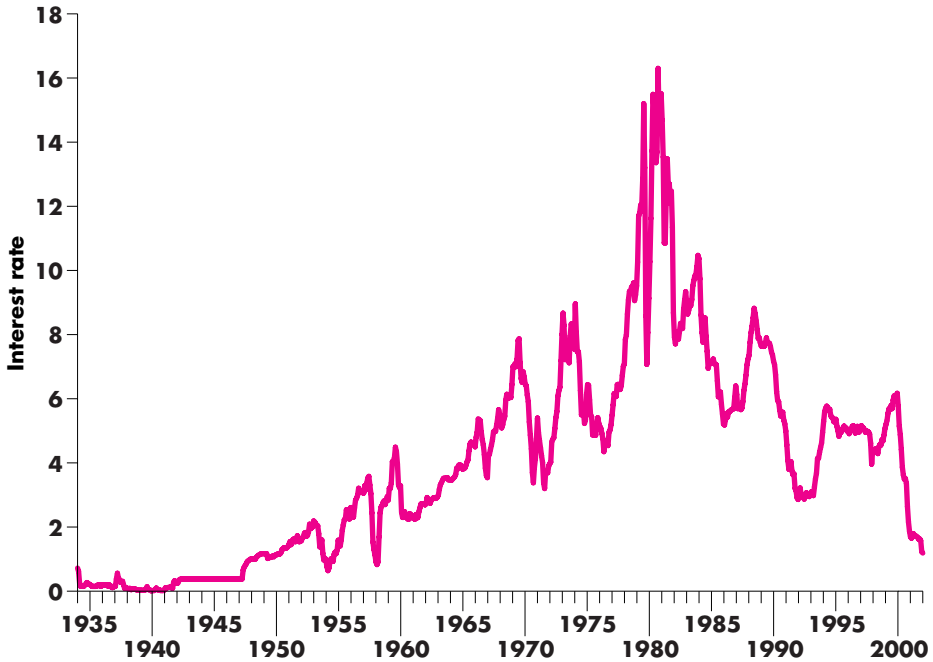


FIGURE 2-9 THREE-MONTH TREASURY BILL, SECONDARY MARKET.
(Source: www.economagic.com.)

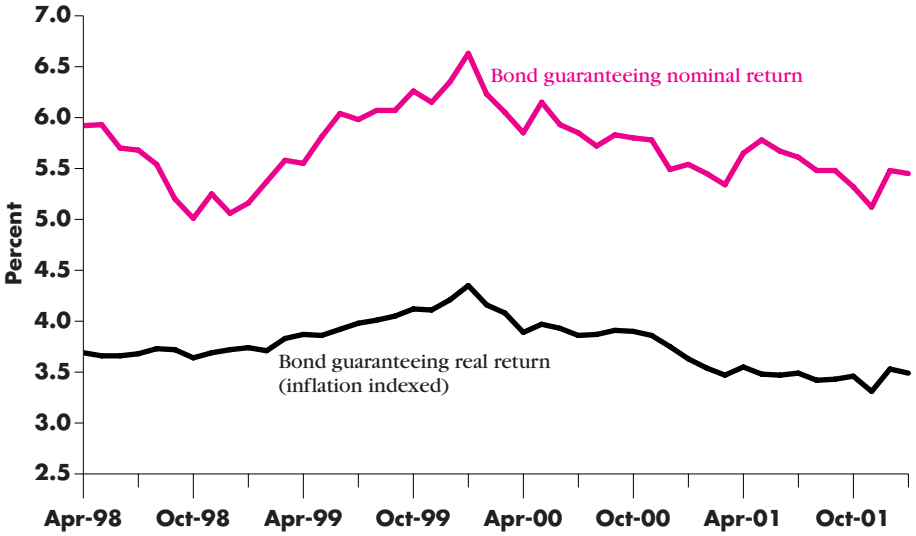


FIGURE 2-10 NOMINAL AND REAL INTEREST RATES FOR 30-YEAR TREASURY BONDS.
(Source: Federal Reserve Economic Data (FRED II), http://research.stlouisfed.org/fred2.)

The interest rates reported in the press, and displayed in Figure 2-9, state a nominal return. If you earn 5 percent on your bank account while the overall level of prices also rises 5 percent, you've really just broken even. The *nominal interest rates* that we see in the newspaper state returns in dollars. *Real interest rates* subtract inflation to give a return in terms of dollars of constant value. Somewhat surprisingly, there are relatively few financial instruments that guarantee real rather than nominal returns. The United States began issuing bonds guaranteeing a real return only recently.[12] Figure 2-10 shows data for two long-term (30-year) U.S. Treasury bonds, one that guarantees a nominal return and one that guarantees a real return. (The latter, "inflation indexed" bonds, are called Treasury inflation protected securities, or TIPS.)

To illustrate the difference between real and nominal returns, in December 2001 the nominal-rate 30-year bond paid an annual interest rate of 5.48 percent while the real-rate 30-year bond paid 3.53 percent *plus an inflation adjustment*. If inflation ran higher than 1.95 percent (at an annual rate) the real-rate bonds would pay more than the nominal-rate bonds. Because the real-rate bonds guarantee your purchasing power, they are a safer investment than nominal-rate bonds.

[12]See Jeffrey M. Wrase, "Inflation-Indexed Bonds: How Do They Work?" Federal Reserve Bank of Philadelphia *Business Review,* July–August 1997. Professor Huston McCulloch of Ohio State University maintains an up-to-date website on real and nominal interest rates at http://economics.sbs.ohio-state.edu/jhm/jhm.html.

BOX 2-3 Understanding Nominal versus Real Interest Rates in "Real Life"

When you invest money in bonds or an interest-bearing bank deposit, part of the return you receive (the *nominal* interest rate) is a real return (the *real* interest rate) and the remainder is an inflation adjustment to compensate for the fact that dollars will be worth less in the future. For example, if at the time of your birth your parents had deposited $1,927 in an account paying 5 percent interest, then in 18 years the account would have $4,636—which coincidentally is the cost of one year's in-state tuition at the University of Washington in 2003.

One never wants to discourage generous parents—but when you understand real versus nominal interest rates you know that the account isn't "really" paying 5 percent a year; part of the payment is just to offset inflation. If inflation is expected to average 3 percent, then the account is paying 2 percent a year after inflation is accounted for. Another way to say this is that if tuition costs rise at the rate of inflation, then while the account will have grown to $4,636, tuition will have risen to $7,892.

2-8 EXCHANGE RATES

In the United States, things monetary are measured in U.S. dollars. Canada uses Canadian dollars. Much of Europe uses the euro. The *exchange rate* is the price of foreign currency. For example, the exchange rate with the Japanese yen is about eight-tenths of a U.S. cent. The British pound is worth about US$1.56. Some countries allow their exchange rates to *float,* meaning the price is determined by supply and demand. Both Japan and Britain follow this policy, so their exchange rates fluctuate over time. Other countries *fix* the value of their exchange rate by offering to exchange their currency for dollars at a fixed rate. For example, the Bermuda dollar is always worth exactly one U.S. dollar and the Hong Kong dollar is set at US$0.13. In practice, many countries intervene to control their exchange rates at some times but not at others, so their exchange rates are neither purely fixed nor purely floating.

Whether a particular currency is worth more or less than a dollar has nothing to do with whether goods are more expensive in that country, as every tourist quickly learns. The Bermuda dollar is worth exactly one U.S. dollar, but even Bermuda onions are more expensive in Bermuda than in the United States. In contrast, there are about

10 Mexican pesos to the dollar, but for many goods you can buy more for 10 pesos in Mexico than you can for one dollar in the United States.

In later chapters we take a careful look at how exchange rates affect the economy and at how the economy helps determine exchange rates.

2-9 WHERE TO GRAB A LOOK AT THE DATA

One of the pleasures of the Internet is the ease with which you can find economic data. We repeat our earlier suggestion that to start looking for almost everything, the best site is "Resources for Economists on the Internet," www.aeaweb.org/RFE/EconFAQ.html. An excellent site for U.S. macroeconomic data, www.economagic.com has links to over 100,000 series and will plot data for you as well as provide easy downloads. The official source for U.S. national income accounts is the Bureau of Economic Analysis at www.bea.doc.gov. You can also find the *Survey of Current Business* online at this site. The *Economic Report of the President,* including data tables and past issues, is available at w3.access.gpo.gov/eop. The White House releases topical data at www.whitehouse.gov/fsbr/esbr.html.

Statistics Canada is the right place to look for Canadian data, www.statcan.ca/start.html (ou pour Statistique Canada, www.statcan.ca/start/_f.html). The Statistical Office of the European Union, http://europa.eu.int/comm/eurostat, is a good source for European data. American (North and South) data are provided by the Inter-American Development Bank at http://database.iadb.org. The World Bank is an excellent source of data on developing countries; see www.worldbank.org/data. The NBER provides a set of pre-World War II data for several countries at www.nber.org/databases/macrohistory/contents/index.html.

SUMMARY

1. GDP is the value of all final goods and services produced in the country within a given period.
2. On the production side, output is paid out as factor payments to labor and capital. On the demand side, output is consumed or invested by the private sector, used by the government, or exported.
3. $Y \equiv C + I + G + NX$.
4. $C + G + I + NX \equiv Y \equiv YD + (TA - TR) \equiv C + S + (TA - TR)$.
5. The excess of the private sector's saving over investment is equal to the sum of the budget deficit and net exports.
6. Nominal GDP measures the value of output in a given period in the prices of that period, that is, in current dollars.
7. Inflation is the rate of change in prices, and the price level is the cumulation of past inflations.
8. Nominal interest rates give the return on loans in current dollars. Real interest rates give the return in dollars of constant value.

9. The unemployment rate measures the fraction of the labor force that is out of work and looking for a job.
10. The exchange rate is the price of one country's currency in terms of another's.

KEY TERMS

adjusted GNP
consumer price index (CPI)
consumption spending
deflation
depreciation
durable goods
exchange rate
factor payments
factors of production
final goods and services
GDP deflator
government budget deficit
government expenditure
government purchases
gross domestic product (GDP)
gross investment
gross national product (GNP)
gross private domestic investment
human capital
inflation
intermediate goods
investment
national income
national income account identity
net domestic product (NDP)
net exports
net investment
nominal GDP
nominal interest rate
producer price index (PPI)
production function
real GDP
real interest rate
saving
transfer payments
unemployment rate
value added

PROBLEMS

Conceptual

1. What would happen to GDP if the government hired unemployed workers, who had been receiving amount $*TR* in unemployment benefits, as government employees and now paid them $*TR* to do nothing? Explain.
2. In the national income accounts, what is the difference between
   a. A firm's buying an auto for an executive and the firm's paying the executive additional income to buy the automobile herself?
   b. Your hiring your spouse (who takes care of the house) rather than having him or her do the work without pay?
   c. Your deciding to buy an American car rather than a German car?
3. What is the difference between GDP and GNP? Is one a better measure of income/output than the other? Why?
4. What is NDP? Is it a better or worse measure of output than GDP? Explain.
5. Increases in real GDP are often interpreted as increases in welfare. What are some problems with this interpretation? Which do you think is the biggest problem with it, and why?
6. The CPI and PPI are both measures of the price level. How are they different, and when might you prefer one of these measures over the other?
7. What is the GDP deflator, and how does it differ from the consumer and producer price indexes? Under what circumstances might it be a more useful measure of price than the CPI and PPI?
8. If you woke up in the morning and found that nominal GDP had doubled overnight, what statistic would you need to check before you began to celebrate? Why?

9. Suppose you make a loan of $100 that will be repaid to you in 1 year. If the loan is denominated in terms of a nominal interest rate, are you happy or sad if inflation is higher than expected during the year? What if the loan instead had been denominated in terms of a real return?

Technical

1. In the text, we calculated the change in real GDP in the hypothetical economy of Table 2-3, using the prices of 1996. Calculate the change in real GDP between 1996 and 2004 using the same data but *the prices of 2004*. Your answer should demonstrate that the prices that are used to calculate real GDP do affect the calculated growth rate, but typically not by very much.

2. Show from national income accounting that
- **a.** An increase in taxes (while transfers remain constant) must imply a change in net exports, government purchases, or the saving-investment balance.
- **b.** An increase in disposable personal income must imply an increase in consumption or an increase in saving.
- **c.** An increase in both consumption and saving must imply an increase in disposable income.

[For both (**b**) and (**c**) assume there are no interest payments by households or transfer payments to foreigners.]

3. The following is information from the national income accounts for a hypothetical country:

GDP	$6,000
Gross investment	800
Net investment	200
Consumption	4,000
Government purchases of goods and services	1,100
Government budget surplus	30

What is
- **a.** NDP?
- **b.** Net exports?
- **c.** Government taxes minus transfers?
- **d.** Disposable personal income?
- **e.** Personal saving?

4. Assume that GDP is $6,000, personal disposable income is $5,100, and the government budget deficit is $200. Consumption is $3,800, and the trade deficit is $100.
- **a.** How large is saving (S)?
- **b.** How large is investment (I)?
- **c.** How large is government spending (G)?

5. If a country's labor is paid a total of $6 billion, its capital is paid a total of $2 billion, and profits are zero, what is the level of output? (*Hint:* see equation 2.)

6. Consider an economy that consists only of those who bake bread and those who produce its ingredients. Suppose that this economy's production is as follows: 1 million loaves of bread (sold at $2 each); 1.2 million pounds of flour (sold at $1 per pound); and 100,000 pounds each of yeast, sugar, and salt (all sold at $1 per pound). The flour, yeast, sugar, and salt are sold only to bakers, who use them exclusively for the purpose of making bread.
- **a.** What is the value of output in this economy (i.e., nominal GDP)?
- **b.** How much value is added to the flour, yeast, sugar, and salt when the bakers turn them into bread?

7. Suppose a country's CPI increased from 2.1 to 2.3 in the course of 1 year. Use this fact to compute the rate of inflation for that year. Why might the CPI overstate the rate of inflation?
8. Suppose you buy a $100 government bond that is due next year. How much nominal interest will you receive if inflation is 4 percent over the year and the bond promises a *real* return of 3 percent?

Empirical

1. Section 2.1 in this chapter deals with the relationship between the different components included in the National Income and Product Accounts (NIPA for short). Go to www.economagic.com. Under the heading "Browse by Source," choose the link to the Department of Commerce, BEA: National Accounts. Select the Current Annual option, and choose the data heading "Relation of Gross Domestic Product, Gross National Product, Net National Product, National Income, and Personal Income."

   Use the information provided there to fill in columns 1, 2, 3, and 5 in the following table, and calculate GNP and NNP based on the formulas given in the second row of the table. Do the values you found correspond to the numbers reported at www.economagic.com?

	GDP	INCOME RECEIPTS FROM ROW	INCOME PAYMENTS TO ROW	GNP	DEPRECIATION (CONSUMPTION OF FIXED CAPITAL)	NNP
	1	2	3	4 = 1 + 2 − 3	5	6 = 4 − 5
2000						
2001						
2002						

2. Check out the "Most Requested Series" website at www.economagic.com. How much was U.S. real GDP growth in the year 2002? What about the growth rate of U.S. population? Using these two pieces of information, what can you infer about the evolution of U.S. per capita real GDP in 2002?