TALKING WITH Raj Chetty*

RAJ CHETTY is the William Henry Bloomberg Professor of Economics, at Harvard University, where he was also an undergraduate, earning his BA summa cum laude in 2000, and graduate student, completing his PhD in 2003.

Professor Chetty is also Director of Harvard's Lab for Economic Applications and Policy, Co-Director of the Public Economics Program or the National Bureau of Economic Research, a member of the Congressional Budget Office Panel of Economic Advisers, and editor of the Journal of Public Economics.

His list of honors is extraordinarily long and includes the 2013 John Bates Clark Medal of the American Economic Association, awarded to the best economist under 40 years of age, the National Tax Association Best Dissertation Prize in 2003, and the Harris, Hoopes, and Williams Prizes for the best thesis and undergraduate in economics at Harvard, in 2000.

He has published more than 20 papers in leading journals on a wide range of policy issues and come up with interesting answers, some of which he describes here.

Michael Parkin talked with Raj Chetty about his research and what we learn from it about how to design more effective government economic policies.

Every economics student learns that tax incidence and deadweight loss depend on the elasticities of supply and demand, and that one of the most crucial elasticities is that of the supply of labor. What does your work tell us about this elasticity? Is labor supply elastic or inelastic?

It is true that the labor supply elasticity is a key determinant of the deadweight loss from income taxation. If people are very responsive in how much they work, that is, if labor supply is very elastic with respect to tax rates, then having high tax rates will generate a lot of inefficiency.

My work has shown that the picture is actually quite a bit more complicated than that because there are many other factors that affect how people respond to tax changes beyond what we have in standard economic models.

... labor supply might be somewhat elastic in the long run ... [but in the short run] may not be very elastic.

To take one example, we usually assume that people perfectly understand and pay attention to the complicated income tax system that we face in the United States today. But we have a number of studies showing that in fact many people aren't aware of tax rates they face, don't really pay attention to tax changes, and may not, at least in the short run, respond by changing the amount they work when the tax code is changed in complicated ways.

The bottom line is that labor supply might be somewhat elastic in the long run if you've got very high tax rates, say, as in European economies for 50 years consistently. People might start to think "Oh, I don't get to keep so much of my paycheck, maybe it doesn't pay to work." With a short-run tax increase of 5 or 10 percent, our growing sense is that people may not respond as much, and labor supply may not be very elastic.

*Read the full interview with Raj Chetty in MyEconLab.

PART SEVEN MONITORING MACROECONOMIC PERFORMANCE

21 MEASURING GDP AND ECONOMIC GROWTH

After studying this chapter, you will be able to:

- Define GDP and explain why GDP equals aggregate expenditure and aggregate income
- Explain how the Bureau of Economic Analysis measures U.S. GDP and real GDP
- Explain the uses and limitations of real GDP as a measure of economic well-being

Will our economy start to expand more rapidly in 2015 or will growth remain slow? Or worse, will the economy slip into recession? U.S. businesses, both small and large, want to know the answers to these questions. To assess the state of the economy and to make big decisions about business expansion, firms such as Google and Amazon use forecasts of GDP. What is GDP and what does it tell us about the state of the economy?

In this chapter, you will find out how economic statisticians at the Bureau of Economic Analysis measure GDP and its rate of growth. You will also learn about the uses and the limitations of these measures. In *Economics in the News* at the end of the chapter, you can see what GDP tells us about the state of the U.S. economy today.

Gross Domestic Product

What exactly is GDP, how is it calculated, what does it mean, and why do we care about it? You are going to discover the answers to these questions in this chapter. First, what *is* GDP?

GDP Defined

GDP, or **gross domestic product**, is the market value of the final goods and services produced within a country in a given time period. This definition has four parts:

- Market value
- Final goods and services
- Produced within a country
- In a given time period

We'll examine each in turn.

Market Value To measure total production, we must add together the production of apples and oranges, computers and popcorn. Just counting the items doesn't get us very far. For example, which is the greater total production: 100 apples and 50 oranges or 50 apples and 100 oranges?

GDP answers this question by valuing items at their *market values*—the prices at which items are traded in markets. If the price of an apple is 10 cents, then the market value of 50 apples is $5. If the price of an orange is 20 cents, then the market value of 100 oranges is $20. By using market prices to value production, we can add the apples and oranges together. The market value of 50 apples and 100 oranges is $5 plus $20, or $25.

Final Goods and Services To calculate GDP, we value the *final goods and services* produced. A **final good** (or service) is an item that is bought by its final user during a specified time period. It contrasts with an **intermediate good** (or service), which is an item that is produced by one firm, bought by another firm, and used as a component of a final good or service.

For example, a Ford truck is a final good, but a Firestone tire on the truck is an intermediate good. An iPad is a final good, but an Apple A5X chip inside it is an intermediate good.

If we were to add the value of intermediate goods and services produced to the value of final goods and services, we would count the same thing many times—a problem called *double counting*. The value of a truck already includes the value of the tires, and the value of an iPad already includes the value of the chip inside it.

Some goods can be an intermediate good in some situations and a final good in other situations. For example, the ice cream that you buy on a hot summer day is a final good, but the ice cream that a restaurant buys and uses to make sundaes is an intermediate good. The sundae is the final good. So whether a good is an intermediate good or a final good depends on what it is used for, not what it is.

The purchase of a secondhand good—for example, a used car or existing home—isn't part of GDP. It was part of GDP in the year in which it was produced.

Produced Within a Country Only goods and services that are produced *within a country* count as part of that country's GDP. Nike Corporation, a U.S. firm, produces sneakers in Vietnam, and the market value of those shoes is part of Vietnam's GDP, not part of U.S. GDP. Toyota, a Japanese firm, produces automobiles in Georgetown, Kentucky, and the value of this production is part of U.S. GDP, not part of Japan's GDP.

In a Given Time Period GDP measures the value of production *in a given time period*—normally either a quarter of a year—called the quarterly GDP data—or a year—called the annual GDP data.

GDP and the Circular Flow of Expenditure and Income

GDP is a measure of the value of total production. We can measure this value either by the total income earned producing GDP or the total expenditure on GDP. The equality between the value of total production and total income is important because it shows the direct link between productivity and living standards. Our standard of living rises when our incomes rise and we can afford to buy more goods and services. But we must produce more goods and services if we are to be able to buy more goods and services.

Rising incomes and a rising value of production go together. They are two aspects of the same phenomenon. You're now going to see why.

The Circular Flow Model Figure 21.1 illustrates the circular flow model. The economy consists of households, firms, governments, and the rest of the world (the rectangles), which trade in factor markets and goods (and services) markets. We focus first on households and firms.

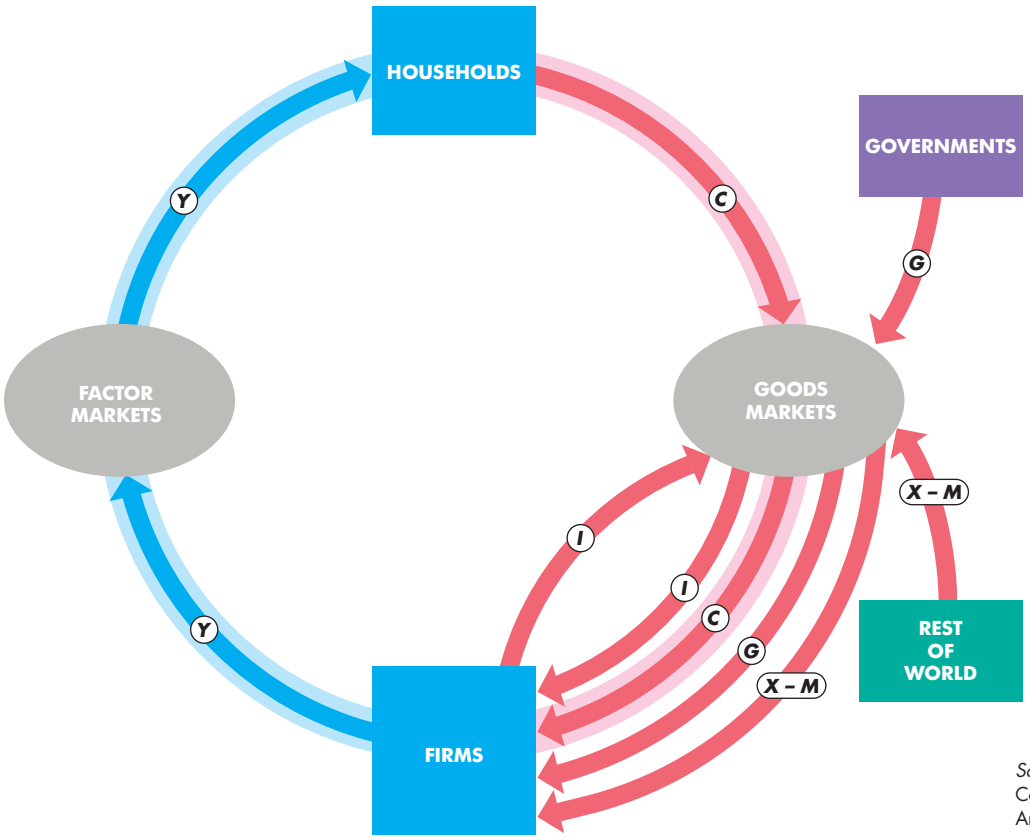
Households and Firms Households sell and firms buy the services of labor, capital, and land in factor markets. For these factor services, firms pay income to households: wages for labor services, interest for the use of capital, and rent for the use of land. A fourth factor of production, entrepreneurship, receives profit.

Firms' retained earnings—profits that are not distributed to households—are part of the household sector's income. You can think of retained earnings as being income that households save and lend back to firms. Figure 21.1 shows the total income—*aggregate income*—received by households, including retained earnings, as the blue flow labeled *Y*.

Firms sell and households buy consumer goods and services in goods markets. The total payment for these goods and services is **consumption expenditure**, shown by the red flow labeled *C*.

Firms buy and sell new capital equipment—such as computer systems, airplanes, trucks, and assembly line equipment—in goods markets. Some of what firms produce is not sold but is added to inventory. For example, if GM produces 1,000 cars and sells 950 of them, the other 50 cars remain in GM's inventory of unsold cars, which increases by 50 cars. When a firm adds unsold output to inventory, we can think of the firm as buying goods from itself. The purchase of new plant, equipment, and buildings and the additions to inventories are **investment**, shown by the red flow labeled *I*.

FIGURE 21.1 The Circular Flow of Expenditure and Income



Households make consumption expenditures (*C*); firms make investments (*I*); governments buy goods and services (*G*); and the rest of the world buys net exports (*X* − *M*). Firms pay incomes (*Y*) to households. Aggregate income equals aggregate expenditure.

Billions of dollars in 2014	
C =	11,729
I =	2,714
G =	3,139
X − *M* =	−538
Y =	17,044

Source of data: U.S. Department of Commerce, Bureau of Economic Analysis. (The data are for the first quarter of 2014 annual rate.)

MyEconLab Animation and Draw Graph

Governments Governments buy goods and services from firms—**government expenditure.** In Fig. 21.1, government expenditure is shown as the red flow *G*.

Governments finance their expenditure with taxes and make financial transfers to households, such as Social Security benefits and unemployment benefits, and pay subsidies to firms. But taxes and financial transfers are not part of the circular flow of expenditure and income.

Rest of the World Firms in the United States sell goods and services to the rest of the world—**exports**—and buy goods and services from the rest of the world—**imports.** The value of exports (X) minus the value of imports (M) is called **net exports**, the red flow $X - M$ in Fig 21.1. If net exports are positive, the net flow is from U.S. firms to the rest of the world. If net exports are negative, the net flow is from the rest of the world to U.S. firms.

GDP Equals Expenditure Equals Income Gross domestic product can be measured in two ways: By the total expenditure on goods and services or by the total income earned producing goods and services.

The total expenditure—*aggregate expenditure*—is the sum of the red flows in Fig. 21.1. Aggregate expenditure equals consumption expenditure plus investment plus government expenditure plus net exports.

Aggregate income is equal to the total amount paid for the services of the factors of production used to produce final goods and services—wages, interest, rent, and profit. The blue flow in Fig. 21.1 shows aggregate income. Because firms pay out as incomes (including retained profits) everything they receive from the sale of their output, aggregate income (the blue flow) equals aggregate expenditure (the sum of the red flows). That is,

$$Y = C + I + G + X - M.$$

The table in Fig. 21.1 shows the value of each expenditure in 2014 and that their sum is $17,044 billion, which also equals aggregate income.

Because aggregate expenditure equals aggregate income, the two methods of measuring GDP give the same answer. So

> GDP equals aggregate expenditure and equals aggregate income.

The circular flow model is the foundation on which the national economic accounts are built.

Why "Domestic" and Why "Gross"?

What do the words "domestic" and "gross" mean in the term gross domestic product?

Domestic *Domestic* product is production *within a country*. It contrasts with a related concept, *national* product, which is the value of goods and services produced anywhere in the world by the residents of a nation. For example, Nike's income from shoe factories that it owns in Vietnam is part of U.S. national product. But it is part of Vietnam's domestic product. Gross national product, GNP, equals GDP plus net income from factors of production owned in other countries.

Gross *Gross* means before subtracting the depreciation of capital. The opposite of gross is *net*, which means after subtracting the depreciation of capital.

Depreciation is the decrease in the value of a firm's capital that results from wear and tear and obsolescence. The total amount spent both buying new capital and replacing depreciated capital is called **gross investment.** The amount by which the value of capital increases is called **net investment.** Net investment equals gross investment minus depreciation.

Gross investment is one of the expenditures included in the expenditure approach to measuring GDP. So the resulting value of total product is a gross measure.

Gross profit, which is a firm's profit before subtracting depreciation, is one of the incomes included in the income approach to measuring GDP. So again, the resulting value of total product is a gross measure.

REVIEW QUIZ

1. Define GDP and distinguish between a final good and an intermediate good. Provide examples.
2. Why does GDP equal aggregate income and also equal aggregate expenditure?
3. What are the distinctions between domestic and national, and gross and net?

Work these questions in Study Plan 21.1 and get instant feedback. Do a Key Terms Quiz. MyEconLab

Let's now see how the ideas that you've just studied are used in practice. We'll see how GDP and its components are measured in the United States today.

Measuring U.S. GDP

The Bureau of Economic Analysis (BEA) uses the concepts in the circular flow model to measure GDP and its components in the *National Income and Product Accounts*. Because the value of aggregate production equals aggregate expenditure and aggregate income, there are two approaches available for measuring GDP, and both are used. They are

- The expenditure approach
- The income approach

The Expenditure Approach

The *expenditure approach* measures GDP as the sum of consumption expenditure (C), investment (I), government expenditure on goods and services (G), and net exports of goods and services ($X - M$). These expenditures correspond to the red flows through the goods markets in the circular flow model in Fig. 21.1 and Fig. 21.2. Table 21.1 shows these expenditures and GDP for 2014.

Personal consumption expenditures (the red flow C in Fig. 21.2) are the expenditures by U.S. households on goods and services produced in the United States and in the rest of the world. They include goods such as soda and books and services such as banking and legal advice. They also include the purchase of consumer durable goods such as TVs and microwave ovens.

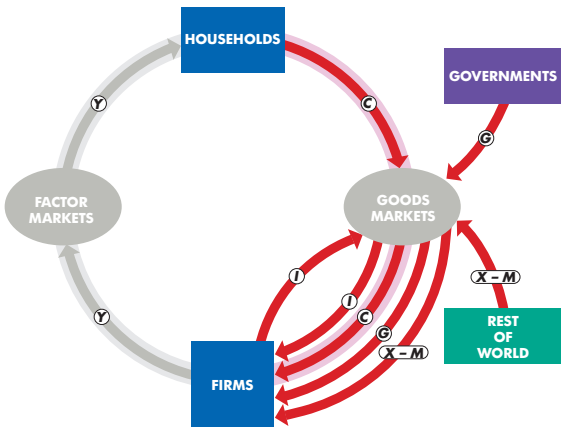
TABLE 21.1 GDP: The Expenditure Approach

Item	Symbol	Amount in 2014 (billions of dollars)	Percentage of GDP
Personal consumption expenditures	C	11,729	68.8
Gross private domestic investment	I	2,714	15.9
Government expenditure on goods and services	G	3,139	18.4
Net exports of goods and services	$X-M$	−538	−3.2
Gross domestic product	**Y**	**17,044**	**100.0**

The expenditure approach measures GDP as the sum of personal consumption expenditures, C, gross private domestic investment, I, government expenditure on goods and services, G, and net exports, $X - M$. In 2014, GDP measured by the expenditure approach was $17,044 billion. Expenditure on personal consumption goods and services is more than two thirds of aggregate expenditure.

Source of data: U.S. Department of Commerce, Bureau of Economic Analysis. The data are for the first quarter of 2014 at an annual rate.

FIGURE 21.2 Aggregate Expenditure



Aggregate expenditure is the sum of the red flows.

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But they do *not* include the purchase of new homes, which the BEA counts as part of investment.

Gross private domestic investment (the red flow I in Fig. 21.2) is expenditure on capital equipment and buildings by firms and the additions to business inventories. It also includes expenditure on new homes by households.

Government expenditure on goods and services (the red flow G in Fig. 21.2) is the expenditure by all levels of government on goods and services such as national defense and garbage collection. It does *not* include *transfer payments*, such as unemployment benefits, because they are not expenditures on goods and services.

Net exports of goods and services (the red flow $X - M$ in Fig. 21.2) are the value of exports minus the value of imports. This item includes the value of airplanes that Boeing sells to British Airways (a U.S. export), and the value of Japanese DVD players that Best Buy purchases from Sony (a U.S. import).

The Income Approach

The *income approach* measures GDP by summing the incomes that firms pay households for the services of the factors of production they hire—wages for labor, interest for capital, rent for land, and profit for entrepreneurship. These incomes correspond to the blue flows through the factor markets in the circular flow model in Fig. 21.1 and Fig. 21.3. Table 21.2 shows these incomes and GDP for 2014.

Compensation of employees (the blue flow *W* in Fig. 21.3) is the payment for labor services. It includes net wages and salaries (called "take-home pay") that workers receive plus taxes withheld on earnings plus fringe benefits such as Social Security and pension fund contributions. This item is more than 50 percent of total income.

Net interest, rental income, corporate profits, and proprietors' income are earned by capital and land. These other factor incomes are in the blue flow *OFI* in Fig. 21.3.

The factor incomes sum to *net domestic income at factor cost*, which is the cost of the factors of production used to produce final goods. The *expenditures* on final goods are valued at *market prices*, which differ from factor cost because of indirect taxes and subsidies.

An *indirect tax* is a tax such as a sales tax or a tax on gasoline. Market price includes indirect taxes, so exceeds factor cost. A *subsidy* is a payment, such as a farm subsidy, by the government to a producer. Subsidies make market price less than factor cost.

TABLE 21.2 GDP: The Income Approach

Item	Amount in 2014 (billions of dollars)	Percentage of GDP
Compensation of employees	9,109	53.4
Net interest	685	4.0
Rental income	623	3.7
Corporate profits	1,514	8.9
Proprietors' income	1,351	7.9
Net domestic income at factor cost	13,282	77.9
Indirect taxes *less* subsidies	1,244	7.3
Net domestic income at market prices	14,526	85.2
Depreciation	2,699	15.8
GDP (income approach)	**17,225**	**101.1**
Statistical discrepancy	–181	–1.1
GDP (expenditure approach)	**17,044**	**100.0**

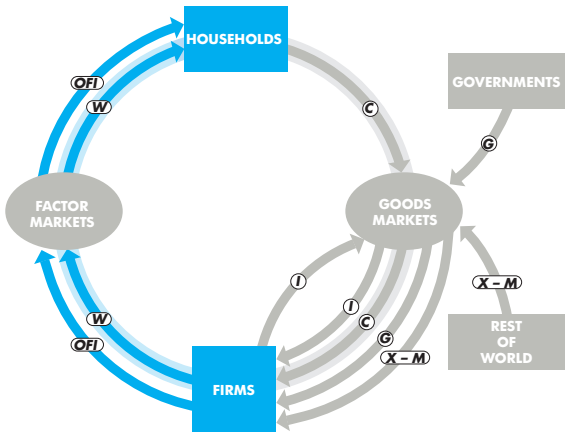
The sum of factor incomes equals *net domestic income at factor cost*. GDP equals net domestic income at factor cost plus indirect taxes minus subsidies plus depreciation.

In 2014, GDP measured by the income approach was $17,225 billion. This amount is $181 billion more than GDP measured by the expenditure approach—a statistical discrepancy of $181 billion or 1.1 percent of GDP.

Compensation of employees—labor income—is by far the largest component of aggregate income.

Source of data: U.S. Department of Commerce, Bureau of Economic Analysis. The data are for the first quarter of 2014 at annual rate.

FIGURE 21.3 Aggregate Income



Aggregate income is the sum of the blue flows.

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To get from factor cost to market price, we add indirect taxes and subtract subsidies and get *net domestic income at market prices*. We still must get from a *net* to a *gross* measure.

Total expenditure is a *gross* number because it includes *gross* investment. Net domestic income at market prices is a net income measure because corporate profits are measured *after deducting depreciation*. They are a *net* income measure. To get from net income to gross income, we must *add depreciation*.

We've now arrived at GDP using the income approach. This number is not exactly the same as GDP using the expenditure approach because all the numbers are estimates. The gap between the two measures of GDP, called the *statistical discrepancy*, is never large. In 2014, it was 1.1 percent of GDP.

Nominal GDP and Real GDP

Often, we want to *compare* GDP in two periods, say 2000 and 2014. In 2000, GDP was $10,285 billion and in 2014, it was $17,044 billion—66 percent higher than in 2000. This increase in GDP is a combination of an increase in production and a rise in prices. To isolate the increase in production from the rise in prices, we distinguish between *real* GDP and *nominal* GDP.

Real GDP is the value of final goods and services produced in a given year when *valued at the prices of a reference base year*. By comparing the value of production in the two years at the same prices, we reveal the change in production.

Currently, the reference base year is 2009 and we describe real GDP as measured in 2009 dollars—in terms of what the dollar would buy in 2009.

Nominal GDP is the value of final goods and services produced in a given year when valued at the prices of that year. Nominal GDP is just a more precise name for GDP.

Economists at the Bureau of Economic Analysis calculate real GDP using the method described in the Mathematical Note on pp. 546–547. Here, we'll explain the basic idea but not the technical details.

Calculating Real GDP

We'll calculate real GDP for an economy that produces one consumption good, one capital good, and one government service. Net exports are zero.

Table 21.3 shows the quantities produced and the prices in 2009 (the base year) and in 2014. In part (a), we calculate nominal GDP in 2009. For each item, we multiply the quantity produced in 2009 by its price in 2009 to find the total expenditure on the item. We sum the expenditures to find nominal GDP, which in 2009 is $100 million. Because 2009 is the base year, both real GDP and nominal GDP equal $100 million.

In Table 21.3(b), we calculate nominal GDP in 2014, which is $300 million. Nominal GDP in 2014 is three times its value in 2009. But by how much has production increased? Real GDP will tell us.

In Table 21.3(c), we calculate real GDP in 2014. The quantities of the goods and services produced are those of 2014, as in part (b). The prices are those in the reference base year—2009, as in part (a).

For each item, we multiply the quantity produced in 2014 by its price in 2009. We then sum these expenditures to find real GDP in 2014, which is $160 million. This number is what total expenditure would have been in 2014 if prices had remained the same as they were in 2009.

Nominal GDP in 2014 is three times its value in 2009, but real GDP in 2014 is only 1.6 times its 2009 value—a 60 percent increase in production.

TABLE 21.3 Calculating Nominal GDP and Real GDP

	Item	Quantity (millions)	Price (dollars)	Expenditure (millions of dollars)
(a) In 2009				
C	T-shirts	10	5	50
I	Computer chips	3	10	30
G	Security services	1	20	20
Y	Real GDP in 2009			100
(b) In 2014				
C	T-shirts	4	5	20
I	Computer chips	2	20	40
G	Security services	6	40	240
Y	Nominal GDP in 2014			300
(c) Quantities of 2014 valued at prices of 2009				
C	T-shirts	4	5	20
I	Computer chips	2	10	20
G	Security services	6	20	120
Y	Real GDP in 2014			160

In 2009, the reference base year, real GDP equals nominal GDP and was $100 million. In 2014, nominal GDP increased to $300 million, but real GDP, which is calculated by using the quantities in 2014 in part (b) and the prices in 2009 in part (a), was only $160 million—a 60 percent increase from 2009.

REVIEW QUIZ

1. What is the expenditure approach to measuring GDP?
2. What is the income approach to measuring GDP?
3. What adjustments must be made to total income to make it equal GDP?
4. What is the distinction between nominal GDP and real GDP?
5. How is real GDP calculated?

Work these questions in Study Plan 21.2 and get instant feedback. Do a Key Terms Quiz. MyEconLab

The Uses and Limitations of Real GDP

Economists use estimates of real GDP for two main purposes:

- To compare the standard of living over time
- To compare the standard of living across countries

The Standard of Living Over Time

One method of comparing the standard of living over time is to calculate real GDP per person in different years. **Real GDP per person** is real GDP divided by the population. Real GDP per person tells us the value of goods and services that the average person can enjoy. By using *real* GDP, we remove any influence that rising prices and a rising cost of living might have had on our comparison.

We're interested in both the long-term trends and the shorter-term cycles in the standard of living.

Long-Term Trend A handy way of comparing real GDP per person over time is to express it as a ratio of some reference year. For example, in 1960, real GDP per person was $17,210 and in 2013, it was $49,658. So real GDP per person in 2013 was almost 3 times its 1960 level ($49,658 ÷ $17,210 = 2.9). To the extent that real GDP per person measures the standard of living, people were 2.9 times as well off in 2013 as their grandparents had been in 1960.

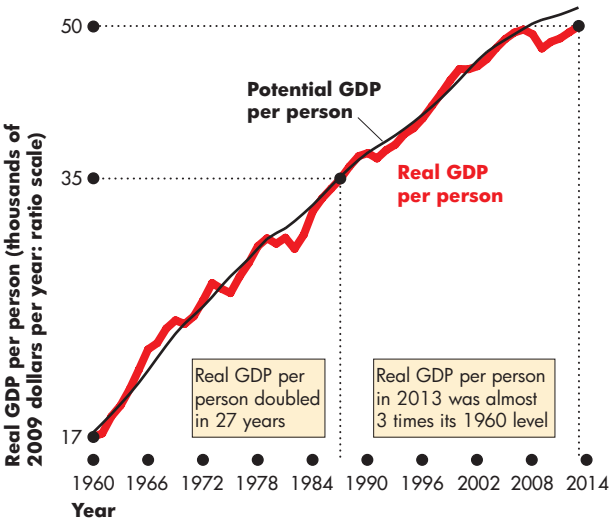
Figure 21.4 shows the path of U.S. real GDP per person for the 53 years from 1960 to 2013 and highlights two features of our expanding living standard:

- The growth of potential GDP per person
- Fluctuations of real GDP per person

The Growth of Potential GDP **Potential GDP** is the maximum level of real GDP that can be produced while avoiding shortages of labor, capital, land, and entrepreneurial ability that would bring rising inflation. Potential GDP per person, the smoother black line in Fig. 21.4, grows at a steady pace because the quantities of the factors of production and their productivities grow at a steady pace.

But potential GDP per person doesn't grow at a *constant* pace. During the 1960s, it grew at 2.8 percent per year but slowed to only 2.3 percent per year during the 1970s. This slowdown might seem small, but it had big consequences, as you'll soon see.

FIGURE 21.4 Rising Standard of Living in the United States



Real GDP per person in the United States doubled between 1960 and 1987 and almost tripled between 1960 and 2013. Real GDP per person, the red line, fluctuates around potential GDP per person, the black line. (The *y*-axis is a ratio scale—see the Appendix, pp. 506–507.)

Sources of data: U.S. Department of Commerce Bureau of Economic Analysis and Congressional Budget Office.

MyEconLab Real-time data

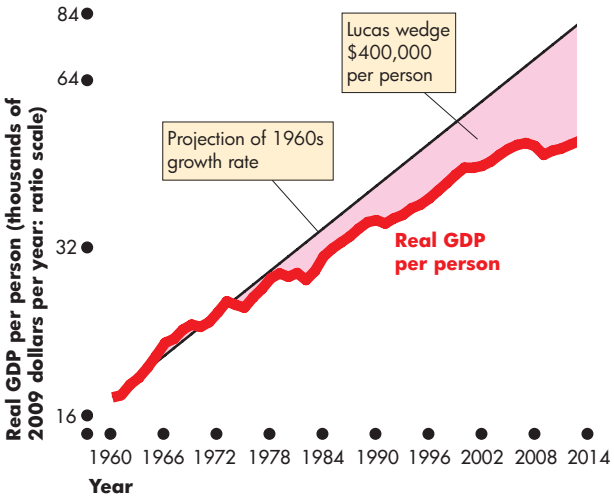
Fluctuations of Real GDP You can see that real GDP shown by the red line in Fig. 21.4 fluctuates around potential GDP, and sometimes real GDP shrinks.

Let's take a closer look at the two features of our expanding living standard that we've just outlined.

Productivity Growth Slowdown How costly was the slowdown in productivity growth after 1970? The answer is provided by the *Lucas wedge*, which is the dollar value of the accumulated gap between what real GDP per person would have been if the 1960s growth rate had persisted and what real GDP per person turned out to be. (Nobel Laureate Robert E. Lucas Jr. drew attention to this gap.)

Figure 21.5 illustrates the Lucas wedge. The wedge started out small during the 1970s, but by 2013 real GDP per person was $31,000 per year lower than it would have been with no growth slowdown, and the accumulated gap was an astonishing $400,000 per person.

FIGURE 21.5 The Cost of Slower Growth: The Lucas Wedge



The black line projects the 1960s growth rate of real GDP per person to 2013. The Lucas wedge arises from the slowdown of productivity growth that began during the 1970s. The cost of the slowdown is $400,000 per person.

Sources of data: U.S. Department of Commerce Bureau of Economic Analysis, Congressional Budget Office, and author's calculations.

MyEconLab Real-time data

Real GDP Fluctuations—The Business Cycle We call the fluctuations in the pace of expansion of real GDP the business cycle. The **business cycle** is a periodic but irregular up-and-down movement of total production and other measures of economic activity. The business cycle isn't a regular predictable cycle like the phases of the moon, but every cycle has two phases:

1. Expansion
2. Recession

and two turning points:

1. Peak
2. Trough

Figure 21.6 shows these features of the most recent U.S. business cycle.

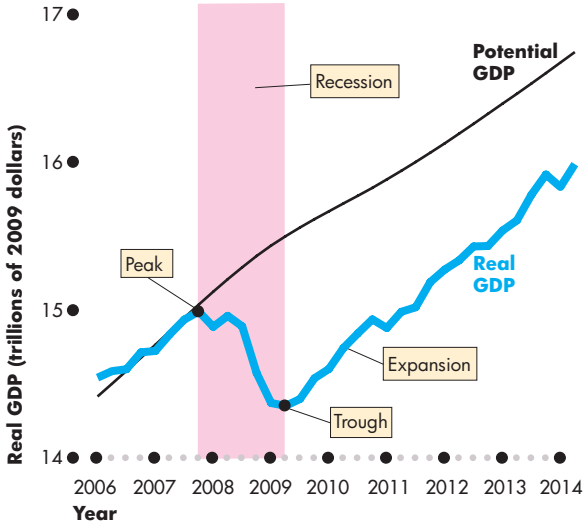
An **expansion** is a period during which real GDP increases. In the early stage of an expansion, real GDP returns to potential GDP; and as the expansion progresses, potential GDP grows and real GDP eventually exceeds potential GDP.

A common definition of **recession** is a period during which real GDP decreases—its growth rate is negative—for at least two successive quarters. The definition used by the National Bureau of Economic Research, which dates the U.S. business cycle phases and turning points, is "a period of significant decline in total output, income, employment, and trade, usually lasting from six months to a year, and marked by contractions in many sectors of the economy."

An expansion ends and recession begins at a business cycle *peak*, which is the highest level that real GDP has attained up to that time. A recession ends at a *trough*, when real GDP reaches a temporary low point and from which the next expansion begins.

In 2008, the U.S. economy went into an unusually severe recession. Starting from a long way below potential GDP, a new expansion began in mid-2009. Estimates of the exact depth of the recession have changed with revisions of the real GDP data.

FIGURE 21.6 The Most Recent U.S. Business Cycle



A recession began at a peak in the fourth quarter of 2007 and ended at a trough in the second quarter of 2009. A slow expansion then began, but real GDP has remained below potential GDP for more than five years.

Sources of data: U.S. Department of Commerce Bureau of Economic Analysis, Congressional Budget Office, and National Bureau of Economic Research.

MyEconLab Real-time data

The Standard of Living Across Countries

Two problems arise in using real GDP to compare living standards across countries. First, the real GDP of one country must be converted into the same currency units as the real GDP of the other country. Second, the goods and services in both countries must be valued at the same prices. Comparing the United States and China provides a striking example of these two problems.

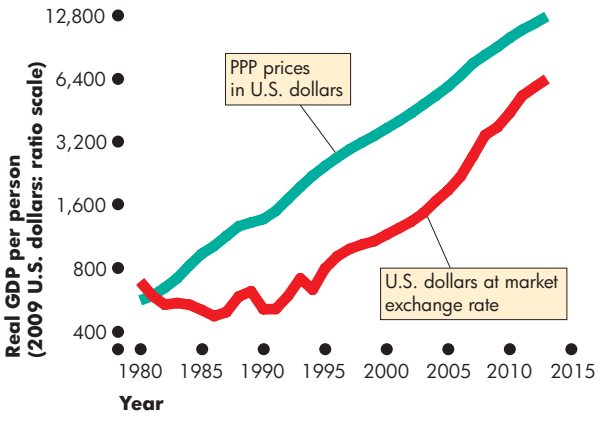
China and the United States in U.S. Dollars In 2013, nominal GDP per person in the United States was $53,000 and in China it was 42,000 yuan. The yuan is the currency of China and the price at which the dollar and the yuan exchanged, the *market exchange rate*, was 6.2 yuan per $1 U.S. Using this exchange rate, 42,000 yuan converts to $6,775. On these numbers, GDP per person in the United States in 2013 was 7.9 times that in China.

The red line in Fig. 21.7 shows *real* GDP per person in China from 1980 to 2013 when the market exchange rate is used to convert yuan to U.S. dollars.

China and the United States at PPP Figure 21.7 shows a second estimate of China's real GDP per person that values China's production on the same terms as U.S. production. It uses *purchasing power parity* or *PPP* prices, which are the *same prices* for both countries.

In July 2014, a Big Mac cost $4.80 in Chicago and 16.93 yuan or $2.73 in Shanghai. To compare real GDP in China and the United States, we must value China's Big Macs at the $4.80 U.S. price—the PPP price.

FIGURE 21.7 Two Views of Real GDP in China



Real GDP per person in China has grown rapidly. But how rapidly it has grown and to what level depends on how real GDP is valued. When GDP in 2013 is valued at the market exchange rate, U.S. income per person is 7.9 times that in China. China looks like a poor developing country. But this comparison is misleading. When GDP is valued at purchasing power parity prices (PPP), U.S. income per person is only 5.4 times that in China.

Source of data: International Monetary Fund, *World Economic Outlook database,* April 2014.

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The prices of some goods are higher in the United States than in China, so these items get a smaller weight in the calculation of China's real GDP than they get in U.S. real GDP. An example is a Big Mac that costs $4.80 in Chicago. In Shanghai, a Big Mac costs 16.93 yuan which is the equivalent of $2.73. So in China's real GDP, a Big Mac gets about half the weight that it gets in U.S. real GDP.

Some prices in China are higher than in the United States but more prices are lower, so Chinese prices put a lower value on China's production than do U.S. prices.

According to the PPP comparisons (same prices in both countries), real GDP per person in the United States in 2013 was 5.4 times that of China, not 7.9 times.

You've seen how real GDP is used to make standard of living comparisons over time and across countries. But real GDP isn't a perfect measure of the standard of living and we'll now examine its limitations.

Limitations of Real GDP

Real GDP measures the value of goods and services that are bought in markets. Some of the factors that influence the standard of living and that are not part of GDP are

- Household production
- Underground economic activity
- Leisure time
- Environmental quality

Household Production Preparing meals, changing a light bulb, cutting grass, and caring for a child are all examples of household production. Because these productive activities are not traded in markets, they are not included in GDP.

The omission of household production from GDP means that GDP *underestimates* total production. But it also means that the growth rate of GDP *overestimates* the growth rate of total production. The reason is that some of the growth rate of market production (included in GDP) is a replacement for home production. So part of the increase in GDP arises from a decrease in home production.

Underground Economic Activity The *underground economy* is the part of the economy that is purposely hidden from the view of the government to avoid taxes and regulations or because the goods and services being produced are illegal. Because underground economic activity is unreported, it is omitted from GDP. The underground economy in the United States ranges between 9 and 30 percent of GDP ($1,500 billion to $5,000 billion).

Leisure Time Leisure time is an economic good that adds to our economic well-being and the standard of living. Other things remaining the same, the more leisure we have, the better off we are. Our working time is valued as part of GDP, but our leisure time is not. Yet that leisure time must be at least as valuable to us as the wage that we earn for the last hour worked. If it were not, we would work instead of taking leisure. Over the years, leisure time has steadily increased. The workweek has become shorter, more people take early retirement, and the number of vacation days has increased. These improvements in economic well-being are not reflected in real GDP.

Environmental Quality Economic activity directly influences the quality of the environment. Burning oil and coal brings global warming and climate change. Depleting nonrenewable resources, clearing forests, and polluting lakes and rivers are other environmental consequences of industrial production.

Resources used to protect the environment are valued as part of GDP. For example, the value of catalytic converters that help to protect the atmosphere from automobile emissions is part of GDP. But the cost of pollution is not subtracted from GDP.

An industrial society possibly produces more atmospheric pollution than an agricultural society does. But pollution does not always increase as we become wealthier. Wealthy people value a clean environment and are willing to pay for one. Compare the pollution in China today with pollution in the United States. China, a poor country, pollutes its rivers, lakes, and atmosphere in a way that is unimaginable in the United States.

Whose production is more valuable: the chef's whose work gets counted in GDP …

… or the busy mother's whose dinner preparation and child minding don't get counted?

AT ISSUE

Should GNNP Replace GDP?

The standard view of economists is that despite its limitations, GDP is a useful measure of the value of production and the overall level of economic activity in a country or region.

But a prominent economist, Joseph Stiglitz, has argued that GDP is dangerously misleading and needs to be replaced by a measure that he calls Green Net National Product (or GNNP).

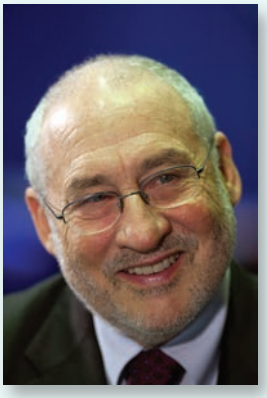
Let's look at both sides of this issue.

Joe Stiglitz says ...

- GDP has passed its use-by date.
- A *gross* measure is wrong because it ignores the depreciation of assets.
- A *domestic* measure is wrong because it ignores the incomes paid to foreigners who exploit a nation's resources.
- A *green* measure is needed to take account of the environmental damage that arises from production.
- GNNP subtracts from GDP incomes paid to foreigners, depreciation, the value of depleted natural resources, and the cost of a degraded environment.
- The existence of a market price for carbon emissions makes it possible to measure the cost of these emissions and subtract them from GDP.
- A bad accounting framework is likely to lead to bad decisions.
- America's "drain America first" energy policy is an example of a bad decision. It increases GDP but decreases GNNP and makes us poorer.

The Mainstream View

- As a measure of the value of market production in an economy, GDP does a good job.
- GDP is used to track the ups and downs of economic activity and it is a useful indicator for making macroeconomic stabilization policy decisions.
- GDP is *not* used to measure net national economic well-being nor to guide microeconomic resource allocation decisions.
- There is no disagreement that a *net national* measure is appropriate for measuring national economic well-being.
- There is no disagreement that "negative externalities" arising from carbon emissions and other pollution detract from economic well-being.
- The omissions from GDP of household production and underground production are *bigger* problems than those emphasized by Stiglitz.
- It isn't clear that depleting oil and coal resources is costly and misguided because advances in green energy technology will eventually make oil and coal of little value. The stone-age didn't end because we ran out of stone, and the carbon-age won't end because we run out of oil and coal!



Bad accounting frameworks are likely to lead to bad decisions. A government focused on GDP might be encouraged to give away mining or oil concessions; a focus on green NNP might make it realize that the country risks being worse off.

Joseph Stiglitz, "Good Numbers Gone Bad," *Fortune,* September 25, 2006

When Anglo-Australian company BHP Billiton mines copper in Papua New Guinea, the country's GDP rises, but profits go abroad and 40,000 who live by a polluted river lose their means of earning a living. GNNP measures that loss.

ECONOMICS IN ACTION

A Broader Indicator of Economic Well-Being

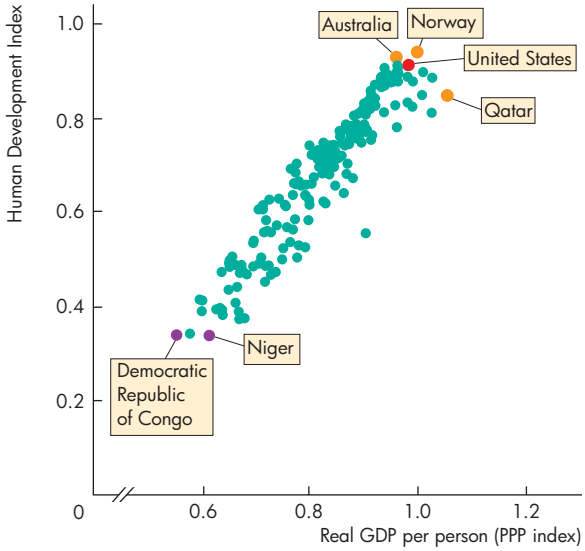
The limitations of real GDP reviewed in this chapter affect the standard of living and general well-being of every country. So to make international comparisons of the general state of economic well-being, we must look at real GDP and other indicators.

The United Nations has constructed a broader measure called the Human Development Index (HDI), which combines real GDP, life expectancy and health, and education. Real GDP per person (measured on the PPP basis) is a major component of the HDI so, as you can see in the figure, the two are strongly correlated.

The figure shows the data for 2012. In that year, Norway had the highest HDI and Australia had the second highest, but Qatar had the highest real GDP per person. The United States had the fifth highest HDI.

The HDI of the United States is lower than that of Norway and Australia because the people of those countries live longer and have better access to healthcare and education than do Americans.

African nations have the lowest levels of economic well-being. The figure shows that Niger had the lowest HDI and the Democratic Republic of Congo had the lowest real GDP per person.



The Human Development Index

Source of data: United Nations hdr.undp.org/en/statistics/data.

The Bottom Line Do we get the wrong message about the level and growth in economic well-being and the standard of living by looking at the growth of real GDP? The influences that are omitted from real GDP are probably large. Developing countries have a larger amount of household production than do developed countries, so the gap between their living standards is exaggerated. Also, as real GDP grows, part of the growth is a switch from home production to market production. This switch overstates the growth in economic well-being and the improvement in the standard of living.

It is possible to construct broader measures that combine the many influences that contribute to human happiness. The United Nations' Human Development Index or HDI (above), and Green Net National Product or GNNP (previous page) are two examples of dozens of other measures that have been proposed.

Despite all the alternatives, real GDP per person remains the most widely used indicator of economic well-being.

REVIEW QUIZ

1. Distinguish between real GDP and potential GDP and describe how each grows over time.
2. How does the growth rate of real GDP contribute to an improved standard of living?
3. What is a business cycle and what are its phases and turning points?
4. What is PPP and how does it help us to make valid international comparisons of real GDP?
5. Explain why real GDP might be an unreliable indicator of the standard of living.

Work these questions in Study Plan 21.3 and get instant feedback. Do a Key Terms Quiz. MyEconLab

You now know how economists measure GDP and what the GDP data tell us. *Economics in the News* on pp. 542–543 uses GDP to describe some possible future paths as we emerge from recession.

The Expansion Continues

U.S. Economy Roars Back with 4% Growth in the Second Quarter

Financial Times
July 30, 2014

The U.S. economy roared ahead with annualized growth of 4 percent in the second quarter, confirming that weakness early this year was an aberration and the recovery is back on track.

Growth easily beat expectations of 3.1 percent, with the strength of the rebound demonstrating that robust jobs data in recent months was not a fluke, and the world's largest economy is picking up speed. …

The second quarter strength comes after a dismal 2.9 percent annualized fall in the first quarter—which was revised to a 2.1 percent decline with this release. The rebound confirms there was no fundamental weakness in the first quarter. Most analysts blame the poor performance on bad weather, inventory rundowns, and difficulty estimating healthcare spending following the introduction of Obamacare.

"Some of the past quarter's growth performance reflects a catch-up from the dismal first quarter performance," said Gad Levanon, director of macroeconomic research at the Conference Board. "But this stellar growth figure also suggests that the economy has gained some momentum and could hold on to this newfound dynamism through the second half of 2014."

The details of the second quarter release were less positive than the headline figure. Of the 4 percent increase, 1.7 percentage points came from an inventory build-up, which reversed a big decline in the first quarter but is not sustainable. …

Consumption contributed 1.7 percentage points to growth, business investment added 0.7 percentage points and government spending contributed 0.3 percentage points. Net trade remained a drag, knocking off 0.6 percentage points in total, because of a large rise in imports. …

ESSENCE OF THE STORY

- U.S. real GDP grew at an annualized rate of 4 percent in the second quarter of 2014.
- The expected growth rate was 3.1 percent.
- U.S. real GDP shrank at an annualized rate of 2.9 percent in the first quarter of 2014.
- Of the 4 percent increase, 1.7 percentage points came from an increase in business inventories, 1.7 percentage points from consumption, 0.7 percentage points from investment, and 0.3 percentage points from government spending.
- A rise in imports decreased net exports and lowered real GDP by 0.6 percentage points.

MyEconLab More Economics in the News

ECONOMIC ANALYSIS

- The news article reports the first estimates of real GDP and its expenditure components for the second quarter of 2014.
- A news article on this topic appears every three months.
- In the second quarter of 2014, real GDP increased by $154 billion from $15,832 billion to $15,986 billion.
- The increase in real GDP during the second quarter was a bit less than 1 percent ($154 is 0.97 percent of $15,832).
- If this growth rate is maintained for a full year, real GDP will be 4 percent higher at the end of the year. That is what the news article means when it reports that real GDP grew at an annualized rate of 4 percent.
- The growth in the second quarter of 2014 came after a quarter in which real GDP shrank, so some of the second quarter growth was returning to the level at the end of 2013.
- Figure 1 shows the increases in real GDP and the expenditure components for the second quarter of 2014 as the blue bars and for the full year from the second quarter of 2013 as the red bars.
- Year-over-year, the red bars in Fig. 1, real GDP increased by $379 billion and consumption expenditure increased most.
- In the second quarter of 2014, as reported in the news article and shown by the blue bars in Fig.1, business inventories (shown separately from business fixed investment) and consumption contributed most to the expansion. Government expenditure barely changed, and net exports decreased aggregate expenditure (were "a drag" says the news report).
- The news article says that a big contributor to expansion came from a business "inventory build-up, which reversed a big decline in the first quarter but is not sustainable."
- Figure 2 shows whether the news article is correct.
- It is correct that an increase in business inventories were a large component of the second quarter expansion. They increased by $93 billion, which is 60 percent of the increase in real GDP.
- But the news article is not correct that inventories decreased in the first quarter. They increased by $35 billion despite a fall in real GDP.
- The news article might also be wrong about sustainability. Figure 2 shows that in almost every quarter (except one) since 2010 the change in business inventories has been positive—business inventories have increased.
- Figure 2 also shows that business inventories and real GDP generally change in the same direction but that inventories sometimes lag the change in real GDP.

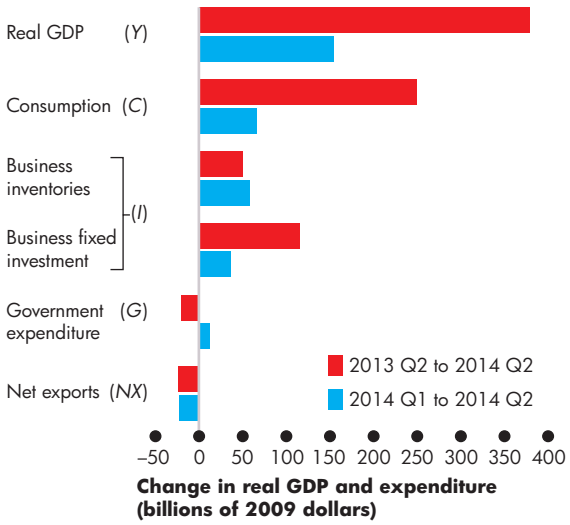


Figure 1 Aggregate Expenditure Changes

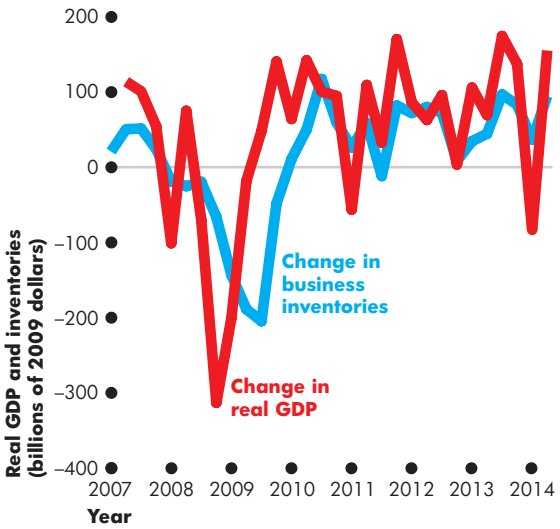


Figure 2 Quarterly Changes in Real GDP and Business Inventories

APPENDIX

Graphs in Macroeconomics

After studying this appendix, you will be able to:

- Make and interpret a time-series graph
- Make and interpret a graph that uses a ratio scale

The Time-Series Graph

In macroeconomics we study the fluctuations and trends in the key variables that describe macroeconomic performance and policy. These variables include GDP and its expenditure and income components that you've learned about in this chapter. They also include variables that describe the labor market and consumer prices that you study in Chapter 22.

Regardless of the variable of interest, we want to be able to compare its value today with that in the past; and we want to describe how the variable has changed over time. The most effective way to do these things is to make a time-series graph.

Making a Time-Series Graph

A **time-series graph** measures time (for example, years, quarters, or months) on the *x*-axis and the variable or variables in which we are interested on the *y*-axis. Figure A21.1 is an example of a time-series graph. It provides some information about unemployment in the United States since 1994. In this figure, we measure time in years starting in 1994. We measure the unemployment rate (the variable that we are interested in) on the *y*-axis.

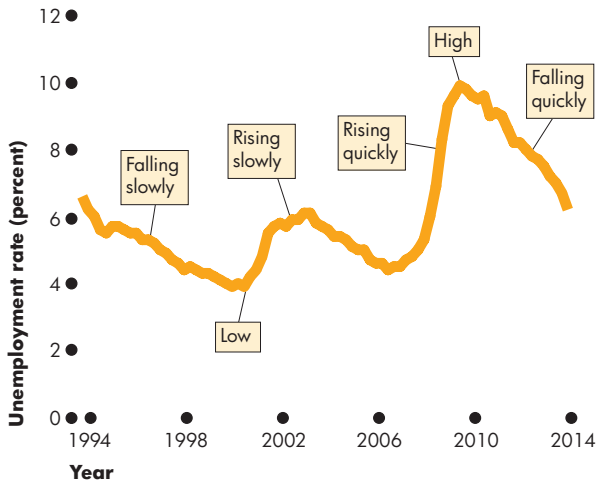
A time-series graph enables us to visualize how a variable has changed over time and how its value in one period relates to its value in another period. It conveys an enormous amount of information quickly and easily.

Let's see how to "read" a time-series graph.

Reading a Time-Series Graph

To practice reading a time-series graph, take a close look at Fig. A21.1. The graph shows the level, change, and speed of change of the variable.

FIGURE A21.1 A Time-Series Graph



A time-series graph plots the level of a variable on the *y*-axis against time (here measured in years) on the *x*-axis. This graph shows the unemployment rate each year from 1994 to 2014. The graph shows when unemployment was high, when it was low, when it increased, when it decreased, and when it changed quickly and slowly.

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- The *level* of the variable: It tells us when unemployment is *high* and *low*. When the line is a long distance above the *x*-axis, the unemployment rate is high, as it was, for example, in 2009. When the line is close to the *x*-axis, the unemployment rate is low, as it was, for example, in 2001.
- The *change* in the variable: It tells us how unemployment *changes*—whether it *increases* or *decreases*. When the line slopes upward, as it did in 2008 and 2009, the unemployment rate is rising. When the line slopes downward, as it did in 1997, the unemployment rate is falling.
- The *speed of change* in the variable: It tells us whether the unemployment rate is rising or falling *quickly* or *slowly*. If the line is very steep, then the unemployment rate increases or decreases quickly. If the line is not steep, the unemployment rate increases or decreases slowly. For example, the unemployment rate rose quickly in 2008 and slowly in 2003 and it fell quickly in 2012 and slowly in 1997.

Ratio Scale Reveals Trend

A time-series graph also reveals whether a variable has a **cycle**, which is a tendency for a variable to alternate between upward and downward movements, or a **trend**, which is a tendency for a variable to move in one general direction.

The unemployment rate in Fig. A21.1 has a cycle but no trend. When a trend is present, a special kind of time-series graph, one that uses a ratio scale on the *y*-axis, reveals the trend.

A Time-Series with a Trend

Many macroeconomic variables, among them GDP and the average level of prices, have an upward trend. Figure A21.2 shows an example of such a variable: the average prices paid by consumers.

In Fig. A21.2(a), consumer prices since 1974 are graphed on a normal scale. In 1974 the level is 100. In other years, the average level of prices is measured as a percentage of the 1974 level.

The graph clearly shows the upward trend of prices. But it doesn't tell us when prices were rising fastest or whether there was any change in the trend. Just looking at the upward-sloping line in Fig. A21.2(a) gives the impression that the pace of growth of consumer prices was constant.

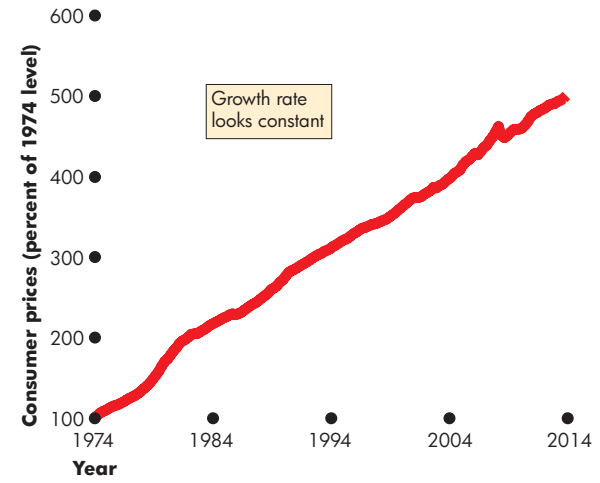
Using a Ratio Scale

On a graph axis with a normal scale, the gap between 1 and 2 is the same as that between 3 and 4. On a graph axis with a ratio scale, the gap between 1 and 2 is the same as that between 2 and 4. The ratio 2 to 1 equals the ratio 4 to 2. By using a ratio scale, we can "see" when the growth rate (the percentage change per unit of time) changes.

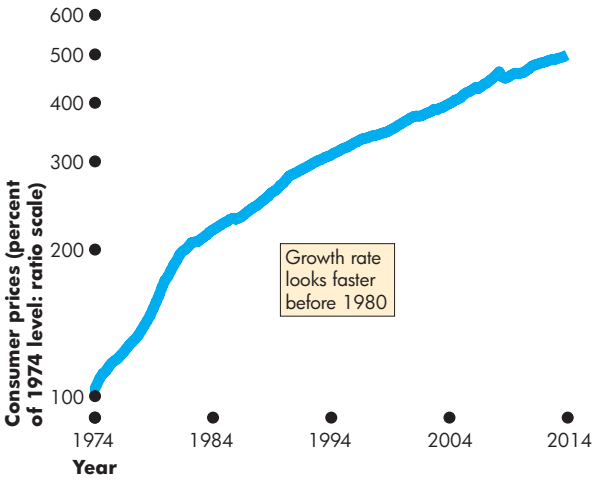
Figure A21.2(b) shows an example of a ratio scale. Notice that the values on the *y*-axis get closer together but the gap between 400 and 200 equals the gap between 200 and 100: The ratio gaps are equal.

Graphing the data on a ratio scale reveals the trends. In the case of consumer prices, the trend is much steeper during the 1970s and early 1980s than in the later years. The steeper the line in the ratio-scale graph in part (b), the faster are prices rising. Prices rose rapidly during the 1970s and early 1980s and more slowly in the later 1980s and 1990s. The ratio-scale graph reveals this fact. We use ratio-scale graphs extensively in macroeconomics.

FIGURE A21.2 Ratio Scale Reveals Trend



(a) Normal scale



(b) Ratio scale

The graph shows the average of consumer prices from 1974 to 2014. The level is 100 in 1974, and the values for the other years are percentages of the 1974 level. Consumer prices normally rise each year, so the line slopes upward. In part (a), where the *y*-axis scale is normal, the rate of increase appears to be constant.

In part (b), where the *y*-axis is a ratio scale (the ratio of 400 to 200 equals the ratio 200 to 100), prices rose faster during the 1970s and early 1980s and slower in the later years. The ratio scale reveals this trend.

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MATHEMATICAL NOTE

Chained-Dollar Real GDP

In the real GDP calculation on p. 535, real GDP in 2014 is 1.6 times its value in 2009. But suppose that we use 2014 as the reference base year and value real GDP in 2009 at 2014 prices. If you do the math, you will see that real GDP in 2009 is $150 million at 2014 prices. GDP in 2014 is $300 million (in 2014 prices), so now the numbers say that real GDP has doubled. Which is correct: Did real GDP increase 1.6 times or double? Should we use the prices of 2009 or 2014? The answer is that we need to use *both* sets of prices.

The Bureau of Economic Analysis uses a measure of real GDP called *chained-dollar real GDP*. Three steps are needed to calculate this measure:

- Value production in the prices of adjacent years
- Find the average of two percentage changes
- Link (chain) back to the reference base year

Value Production in Prices of Adjacent Years

The first step is to value production in *adjacent* years at the prices of *both* years. We'll make these calculations for 2014 and its preceding year, 2013.

Table 1 shows the quantities produced and prices in the two years. Part (a) shows the nominal GDP calculation for 2013—the quantities produced in 2013 valued at the prices of 2013. Nominal GDP in 2013 is $145 million. Part (b) shows the nominal GDP calculation for 2014—the quantities produced in 2014 valued at the prices of 2014. Nominal GDP in 2014 is $300 million. Part (c) shows the value of the quantities produced in 2014 at the prices of 2013. This total is $160 million. Finally, part (d) shows the value of the quantities produced in 2013 at the prices of 2014. This total is $275 million.

TABLE 1 Real GDP Calculation Step 1: Value Production in Adjacent Years at Prices of Both Years

	Item	Quantity (millions)	Price (dollars)	Expenditure (millions of dollars)
(a) In 2013				
C	T-shirts	3	5	15
I	Computer chips	3	10	30
G	Security services	5	20	100
Y	Nominal GDP in 2013			**145**
(b) In 2014				
C	T-shirts	4	5	20
I	Computer chips	2	20	40
G	Security services	6	40	240
Y	Nominal GDP in 2014			**300**
(c) Quantities of 2014 valued at prices of 2013				
C	T-shirts	4	5	20
I	Computer chips	2	10	20
G	Security services	6	20	120
Y	2014 production at 2013 prices			**160**
(d) Quantities of 2013 valued at prices of 2014				
C	T-shirts	3	5	15
I	Computer chips	3	20	60
G	Security services	5	40	200
Y	2013 production at 2014 prices			**275**

Step 1 is to value the production of adjacent years at the prices of both years. Here, we value the production of 2013 and 2014 at the prices of both 2013 and 2014. The value of 2013 production at 2013 prices, in part (a), is nominal GDP in 2013. The value of 2014 production at 2014 prices, in part (b), is nominal GDP in 2014. Part (c) calculates the value of 2014 production at 2013 prices, and part (d) calculates the value of 2013 production at 2014 prices. We use these numbers in Step 2.

Find the Average of Two Percentage Changes

The second step is to find the percentage change in the value of production based on the prices in the two adjacent years. Table 2 summarizes these calculations.

Part (a) shows that, valued at the prices of 2013, production increased from $145 million in 2013 to $160 million in 2014, an increase of 10.3 percent.

Part (b) shows that, valued at the prices of 2014, production increased from $275 million in 2013 to $300 million in 2014, an increase of 9.1 percent. Part (c) shows that the average of these two percentage changes in the value of production is 9.7. That is, $(10.3 + 9.1) \div 2 = 9.7$.

This average percentage change is the *growth rate* of real GDP in 2014. This growth rate depends only on production and prices in 2013 and 2014.

The final step is to find the *level* of real GDP.

TABLE 2 Real GDP Calculation Step 2: Find Average of Two Percentage Changes

Value of Production	Millions of dollars	
(a) At 2013 prices		
Nominal GDP in 2013	145	
2014 production at 2013 prices	160	
Percentage change in production at 2013 prices		10.3
(b) At 2014 prices		
2013 production at 2014 prices	275	
Nominal GDP in 2014	300	
Percentage change in production at 2014 prices		9.1
(c) Average percentage change in 2014		**9.7**

Using the numbers calculated in Step 1, the change in production from 2013 to 2014 valued at 2013 prices is 10.3 percent, in part (a). The change in production from 2013 to 2014 valued at 2014 prices is 9.1 percent, in part (b). The average of these two percentage changes is 9.7 percent in part (c).

Link (Chain) to the Base Year

The *level* of real GDP depends on the choice of a *base year*. To see how, we'll first suppose that the base year is 2013.

By definition, real GDP and nominal GDP are equal in the base year. So real GDP in 2013 (in 2013 dollars) is $145 million (in Table 1).

In 2014, real GDP grew by 9.7 percent, so real GDP in 2014 (in 2013 dollars) is 9.7 percent greater than $145 million, which equals $159 million. (Check the calculation: Real GDP increased by $14 million, which is 9.7 percent of $145 million.)

Today, the base year is 2009 and to find the level of real GDP in other years, both before and after 2009, more calculations are needed.

The BEA must calculate the percentage change in real GDP for *each* pair of years from the base year to the most recent year. And to find real GDP for years before the base year, the BEA must calculate the growth rates for each pair of years back to the earliest one for which it has data.

Finally, using the percentage changes it has calculated, the BEA finds the levels of real GDP in 2009 prices by linking them to the value of real GDP in 2009.

To illustrate this third step, we'll assume that the BEA has used the method we've described to calculate the percentage changes of real GDP for the years 2006 through 2014. Figure 1 shows these percentage changes and illustrates the chain-link calculations.

In the reference base year, 2009, real GDP equals nominal GDP, which we'll assume is $125 million. The growth rate in 2009 was 6 percent, so real GDP in 2009 is 6 percent higher than it was in 2008, which means that real GDP in 2008 is $118 million ($118 \times 1.06 = 125$).

The growth rate in 2010 was 4 percent, so real GDP in 2010 is 4 percent higher than it was in 2009, which means that real GDP in 2010 is $130 million ($125 \times 1.04 = 130$).

By repeating these calculations for each year, we obtain the *chained-dollar real GDP* in 2009 dollars for each year.

For 2013, the *chained-dollar real GDP* in 2009 dollars is $159 million. So the 9.7 percent growth rate in 2014 that we calculated in Table 2 means that real GDP in 2014 is $174 million ($159 \times 1.097 = 174$).

Notice that the growth rates are independent of the reference base year, so changing the reference base year does not change the growth rates.

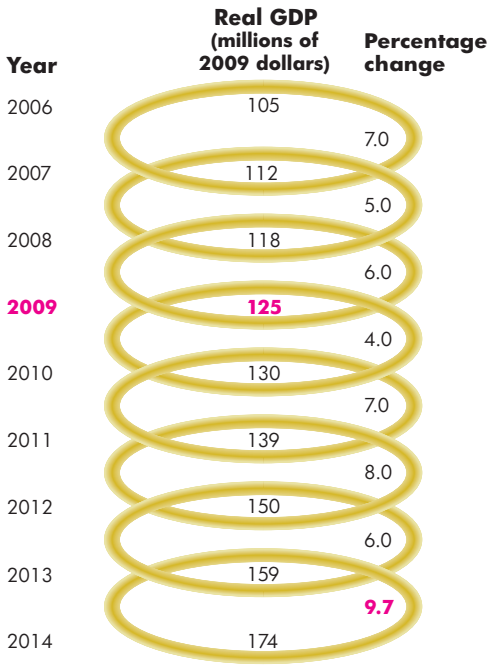

Figure 1 Real GDP Calculation Step 3: Link (Chain) to Base Year

SUMMARY

Key Points

Gross Domestic Product (pp. 530–532)

- GDP, or gross domestic product, is the market value of all the final goods and services produced in a country during a given period.
- A final good is an item that is bought by its final user, and it contrasts with an intermediate good, which is a component of a final good.
- GDP is calculated by using either the expenditure or income totals in the circular flow model.
- Aggregate expenditure on goods and services equals aggregate income and GDP.

Working Problems 1 to 3 will give you a better understanding of gross domestic product.

Measuring U.S. GDP (pp. 533–535)

- Because aggregate expenditure, aggregate income, and the value of aggregate production are equal, we can measure GDP by using the expenditure approach or the income approach.
- The expenditure approach sums consumption expenditure, investment, government expenditure on goods and services, and net exports.
- The income approach sums wages, interest, rent, and profit (plus indirect taxes less subsidies plus depreciation).
- Real GDP is measured using a common set of prices to remove the effects of inflation from GDP.

Working Problems 4 to 6 will give you a better understanding of measuring U.S. GDP.

The Uses and Limitations of Real GDP

(pp. 536–541)

- Real GDP is used to compare the standard of living over time and across countries.
- Real GDP per person grows and fluctuates around the more smoothly growing potential GDP.
- A slowing of the growth rate of real GDP per person during the 1970s has lowered incomes by a large amount.
- International real GDP comparisons use PPP prices.
- Real GDP is not a perfect measure of the standard of living because it excludes household production, the underground economy, leisure time, and environmental quality.

Working Problem 7 will give you a better understanding of the uses and limitations of real GDP.

Key Terms

MyEconLab Key Terms Quiz

Business cycle, 537
Consumption expenditure, 531
Cycle, 545
Depreciation, 532
Expansion, 537
Exports, 532
Final good, 530
Government expenditure, 532
Gross domestic product (GDP), 530
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Net investment, 532
Nominal GDP, 535
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Real GDP, 535
Real GDP per person, 536
Recession, 537
Time-series graph, 544
Trend, 545

WORKED PROBLEM

MyEconLab You can work this problem in Chapter 21 Study Plan.

Items in Dreamland's national accounts include

- Government expenditure on goods and services: $600
- Consumption expenditure: $1,950
- Rent and interest: $400
- Indirect taxes less subsidies: $350
- Investment: $550
- Wages: $1,600
- Profit: $500
- Net exports: $200
- Depeciation: $450

Questions

1. Use the expenditure approach to calculate GDP.
2. Calculate net domestic income at factor cost.
3. Calculate net domestic income at market prices.
4. Use the income approach to calculate GDP.

Solutions

1. The expenditure approach sums the expenditure on final goods and services. That is, GDP is the sum of consumption expenditure, investment, government expenditure, and net exports. That is, GDP = $1,950 + $550 + $600 + $200 = $3,300.

Key Point: GDP equals the sum of consumption expenditure, investment, government expenditure on goods and services, and net exports. See the figure.

2. Net domestic income at factor cost is the income paid to factors of production: wages, rent, interest, and profit. Net domestic income at factor cost equals $1,600 + $400 + $500 = $2,500.

Key Point: The incomes earned by the factors of production (labor, land, capital, and entrepreneurship) sum to net domestic income at factor cost. See the figure.

3. Expenditure on goods and services equals the quantity bought multiplied by the market price. Incomes are total factor costs. The market price of a good or service equals the cost of the factors of production used to produce it if production is not subsidized and sale of the good is not taxed.

   If the producer of a good receives a subsidy, then the market price of the good is less than the cost of producing it. If a tax is imposed on the sale of the good, then the market price exceeds the cost of producing it. So

   Market price = Factor cost + Indirect taxes less subsidies.

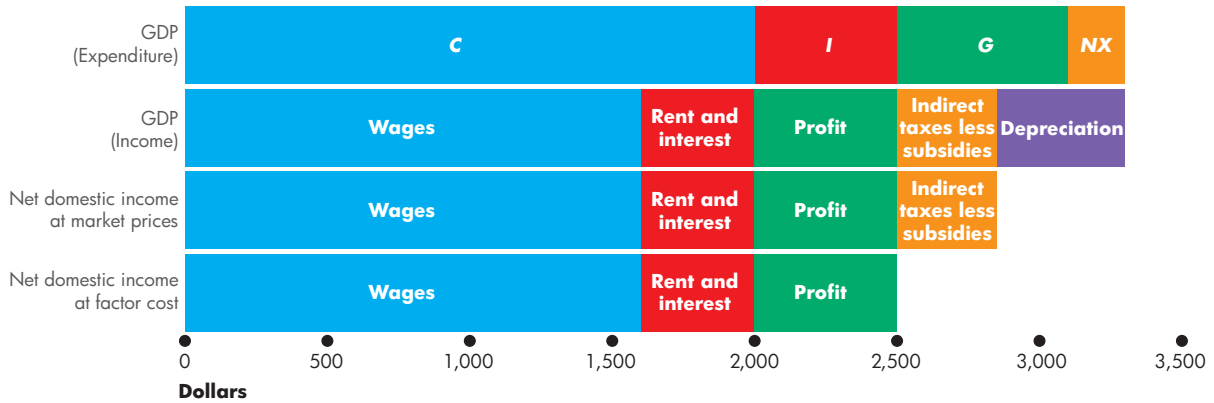
   Net domestic income at factor cost is $2,500, so net domestic income at market prices equals $2,500 + $350 = $2,850.

Key Point: To convert from factor cost to market prices add indirect taxes less subsidies. See the figure.

4. GDP is a gross measure of total production at market prices while net domestic income at market prices is a net measure. So using the income approach to measuring GDP, depreciation must be added to net domestic income at market prices to convert it to GDP. That is, using the income approach, GDP = $2,850 + $450 = $3,300.

Key Point: To convert net domestic income at market prices into GDP add depreciation. See the figure.

Key Figure

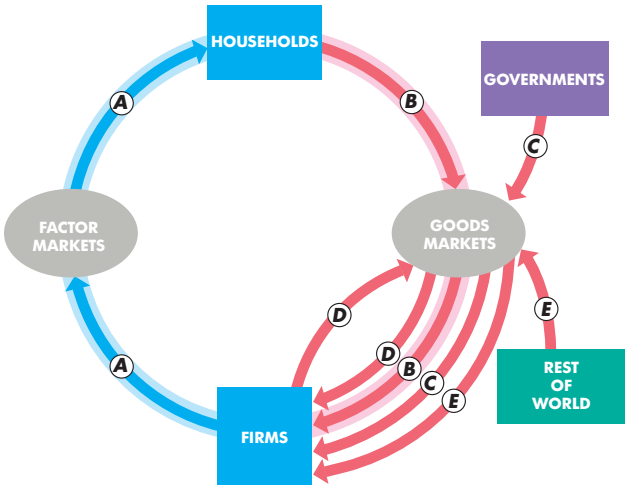


STUDY PLAN PROBLEMS AND APPLICATIONS

MyEconLab You can work Problems 1 to 8 in Chapter 21 Study Plan and get instant feedback. Problems marked update with real-time data.

Gross Domestic Product (Study Plan 21.1)

1. Classify the following items as a final good or service or an intermediate good or service and identify each item as a component of consumption expenditure, investment, or government expenditure on goods and services:
   - Airline ticket bought by a student.
   - New airplanes bought by Southwest Airlines.
   - Cheese bought by Domino's.
   - Your purchase of a new iPhone.
   - New house bought by Bill Gates.
2. The following figure illustrates the circular flow model.



During 2014, flow *A* was $13.0 trillion, flow *B* was $9.1 trillion, flow *D* was $3.3 trillion, and flow *E* was −$0.8 trillion. Calculate (i) GDP and (ii) Government expenditure.

3. Use the following data to calculate aggregate expenditure and imports of goods and services.
   - Government expenditure: $20 billion
   - Aggregate income: $100 billion
   - Consumption expenditure: $67 billion
   - Investment: $21 billion
   - Exports of goods and services: $30 billion

Measuring U.S. GDP (Study Plan 21.2)

4. The table in the next column lists some national accounts data for the United States in 2008.

Item	Billions of dollars
Wages	8,000
Consumption expenditure	10,000
Other factor incomes	3,200
Investment	2,000
Government expenditure	2,800
Net exports	–700
Depreciation	1,800

   a. Calculate U.S. GDP in 2008.
   b. Explain the approach (expenditure or income) you used to calculate GDP.

Use the following data to work Problems 5 and 6.

Tropical Republic produces only bananas and coconuts. The base year is 2013, and the table gives the quantities produced and the market prices.

Quantities	2013	2014
Bananas	800 bunches	900 bunches
Coconuts	400 bunches	500 bunches
Prices	**2013**	**2014**
Bananas	$2 a bunch	$4 a bunch
Coconuts	$10 a bunch	$5 a bunch

5. Calculate nominal GDP in 2013 and 2014.
6. Calculate real GDP in 2014 expressed in base-year prices.

The Uses and Limitations of Real GDP (Study Plan 21.3)

7. Use the following table to work out in which year the U.S. standard of living (i) increases and (ii) decreases. Explain your answer.

Year	Real GDP	Population
2006	$13.0 trillion	300 million
2007	$13.2 trillion	302 million
2008	$13.2 trillion	304 million
2009	$12.8 trillion	307 million

Mathematical Note

8. An island economy produces only fish and crabs.

Quantities	2013	2014
Fish	1,000 tons	1,100 tons
Crabs	500 tons	525 tons
Prices	**2013**	**2014**
Fish	$20 a ton	$30 a ton
Crabs	$10 a ton	$8 a ton

Calculate the island's chained-dollar real GDP in 2014 expressed in 2013 dollars.

ADDITIONAL PROBLEMS AND APPLICATIONS

MyEconLab You can work these problems in MyEconLab if assigned by your instructor. Problems marked update with real-time data.

Gross Domestic Product

9. Classify each of the following items as a final or an intermediate good or service, and identify which is a component of consumption expenditure, investment, or government expenditure on goods and services:
   - Financial services bought by China Investment Corporation.
   - Desktop computers bought by Barclays.
   - New taximeters imported from China by the London Taxi Company.
   - New DVD bought by a student from Virgin Megastore.

Use the figure in Problem 2 to work Problems 10 and 11.

10. In 2013, flow *A* was $1,000 billion, flow *C* was $250 billion, flow *B* was $650 billion, and flow *E* was $50 billion. Calculate investment.
11. In 2014, flow *D* was $2 trillion, flow *E* was −$1 trillion, flow *A* was $10 trillion, and flow *C* was $4 trillion. Calculate consumption expenditure.

Use the following information to work Problems 12 and 13.

The French state-owned DCNS shipyard provides parts and equipment for Brazilian submarines. Renault do Brasil produces cars for the Brazilian market in Paraná.

12. Explain where these activities appear in the Brazilian National Income and Product Accounts.
13. Explain where these activities appear in France's National Income and Product Accounts.

Use the following news clip to work Problems 14 and 15, and use the circular flow model to illustrate your answers.

Boeing Bets the House

Boeing is producing some components of its new 787 Dreamliner in Japan and is assembling it in the United States. Much of the first year's production will be sold to ANA (All Nippon Airways), a Japanese airline.

Source: *The New York Times*, May 7, 2006

14. Explain how Boeing's activities and its transactions affect U.S. and Japanese GDP.
15. Explain how ANA's activities and its transactions affect U.S. and Japanese GDP.

Measuring U.S. GDP

Use the following data to work Problems 16 and 17.

The table lists some macroeconomic data for the United States in 2009.

Item	Billions of dollars
Wages	8,000
Consumption expenditure	10,000
Other factor incomes	3,400
Investment	1,500
Government expenditure	2,900
Net exports	−340

16. Calculate U.S. GDP in 2009.
17. Explain the approach (expenditure or income) that you used to calculate GDP.

Use the following data to work Problems 18 and 19.

An economy produces only apples and oranges. The base year is 2012, and the table gives the quantities produced and the prices.

Quantities	2012	2013
Apples	60	160
Oranges	80	220
Prices	**2012**	**2013**
Apples	$0.50	$1.00
Oranges	$0.25	$2.00

18. Calculate nominal GDP in 2012 and 2013.
19. Calculate real GDP in 2012 and 2013 expressed in base-year prices.
20. **GDP Expands 11.4 Percent, Fastest in 13 Years**
    China's gross domestic product grew 11.4 percent last year and marked a fifth year of double-digit growth. The increase was especially remarkable given that the United States is experiencing a slowdown due to the sub-prime crisis and housing slump. Citigroup estimates that each 1 percent drop in the U.S. economy will shave 1.3 percent off China's growth, because Americans are heavy users of Chinese products. In spite of the uncertainties, China is expected to post its sixth year of double-digit growth next year.

    Source: *The China Daily*, January 24, 2008

    Use the expenditure approach for calculating China's GDP to explain why "each 1 percent drop in the U.S. economy will shave 1.3 percent off China's growth."