# Chapter 5

## Macroeconomic Measurement: The Current Approach

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Chapter 5  Macroeconomic Measurement: The Current Approach

As we pointed out in Chapter 2, being able to make wise economic choices depends on having a good sense about the size of the relevant economic stocks and flows. Whether the choices being considered are your personal decisions about how much money to spend in the bookstore, or are decisions by being made by multi-person entities such as households, community groups, businesses, nonprofits, and governments, good decision-making requires good information.

In macroeconomics, we consider how good economic choices could be made at a national level, usually by governments interested in maintaining high employment levels, stable prices, and/or achieving other national goals such as national security. The amount of information required for such large tasks is daunting! While learning about how data is gathered and organized in order to create measures of macroeconomic performance may seem dry and dull at times, it is crucial for you to understand how common measures of economic performance are put together. What do they include? What do they leave out? Why might they be biased? To what extent might they be useful as measures of human well-being, and to what extent might they be misleading?

1. Measuring a Country’s Aggregate Behavior

The idea of creating a system of “national accounts” to guide U.S. decision makers first took hold during the Great Depression in the 1930s. Presidents Hoover and Roosevelt knew that national production was down, but other than a few numbers representing the volumes of railroad shipments and steel production, they had no information on by how much it was down. Likewise, they had little way of knowing whether the policy actions they were trying were actually helping the economy rebound.

The Department of Commerce commissioned economist Simon Kuznets to begin to develop national accounts. The first set of accounts was presented to Congress in 1937. Interest in keeping national accounts increased in the 1940s because of the need for national economic mobilization during World War II.

The national accounts have evolved over the decades for several reasons. The economy itself has evolved, for example moving from being strongly oriented towards agriculture and manufacturing towards a structure in which service and information activities are increasingly important. Improved data and collection techniques and new statistical methods have been developed in the decades since the 1930s. Perhaps most importantly, the purposes for which the accounts are intended and the most pressing topics of concern also change over time. Keeping track of environmental degradation, for example, was not a purpose for which the accounts were originally developed, although it is a pressing problem today.

In this chapter we explain how U.S. government agencies construct the major economic indicators used by contemporary macroeconomists. Even though GDP is often
referred to as if it measures economic well-being, it is in fact not very well suited for that purpose—although it does a good job of summarizing some of the topics for which it was specifically designed. This chapter will demonstrate how GDP, economic growth, measures of price changes, and national saving are commonly measured. In the next chapter, we discuss extensions of the national accounts that are currently being developed in order to update them to reflect better the concerns of the 21st century.

Discussion Questions

1. How might the purpose for which accounts are intended affect their design? For example, what sorts of economic activities do you think it would be most important to track if the purpose were to plan for fighting a war? To look at the level of overall well-being? To help ensure the present and future well-being of people who are children today?

2. What statistics about national economic performance have you seen mentioned in the news? Do you know what these statistics mean?

2. The National Accounts and Their Conventions

In the United States, the Bureau of Economic Analysis (BEA) publishes statistics concerning production, income, spending, prices and employment in the National Income and Product Accounts (NIPA).

Bureau of Economic Analysis (BEA): the agency in the United States in charge of compiling and publishing the national accounts

National Income and Product Accounts (NIPA): a set of statistics compiled by the BEA concerning production, income, spending, prices and employment

All systems of accounting make considerable use of “conventions” or assumptions. Accounting conventions are simply habits or agreements, adopted by people in order to try to make accounts as standardized and comparable across different time periods as possible. It is important for you to realize that the conventions don’t simply reflect the “world as it is.” There are many different ways of describing the world, and each convention chooses just one of the many possibilities.

A personal example might help you understand this problem. Perhaps you keep track of your own expenditures. Suppose you buy soft drinks at a grocery store, even though you don’t like them yourself, because you want to have a stock of them around to serve your friends when they visit. Suppose you then want to summarize your expenses by grouping them into larger categories such as “groceries” and “entertainment.” In which of these categories should you classify your soft drink purchases? They arguably could be classified as either. To keep your accounts meaningful, you will need to decide on—and consistently apply—a convention that assigns your soft drink expenditures to one category or the other (or partly to each). But, in national accounts as in this personal...
case, there is often an element of arbitrariness about conventions. And conventions can change over time, as old ways of doing things become outdated in the face of new developments.

Internationally, the United Nations System of National Accounts (SNA) provides guidelines to countries about how to construct systems of accounts, with a view to making national statistics more comparable across countries as well as across time periods. In 2003, the United States NIPA underwent a comprehensive revision, one of the objectives of which was greater harmonization with the SNA.

**United Nations System of National Accounts (SNA):** a set of guidelines for countries about how to construct systems of national accounts

2.1 Conventions about Sectors

The official system of U.S. national accounts uses the following four-way classification of sectors.

*Households and institutions sector.* The first sector includes both households, meaning families and unrelated individuals living together in a housing unit, and nonprofit institutions serving households. These include organizations such as nonprofit hospitals, universities, museums, trade unions, and charities. The BEA also refers to the *households and institutions sector* as the “personal” sector.

**households and institutions sector (BEA definition):** the sector consisting of households and nonprofit institutions serving households

*Business sector.* The BEA *business sector* is somewhat broader than just for-profit businesses. Certain business-serving nonprofit organizations, such as trade associations and chambers of commerce, are included in this category. In addition, government agencies that are like business enterprises in that they produce goods and services for sale—such as The U.S. Postal Service, municipal gas and electric companies, and airports—are also classified as being in the business sector.

**business sector (BEA definition):** the sector including all entities concerned with producing goods and services for profitable sale. It also includes business-serving nonprofit organizations and government enterprises.

*Government sector.* The *government sector* includes all federal, state and local government entities (except for the “business-like” government enterprises mentioned above).

**government sector (BEA definition):** the sector that includes all federal, state and local government entities (except for government enterprises).
The entities in the first three sectors include, for the national accounts, only those that are located within the physical borders of the United States. The foreign sector (or “rest of the world”) includes all entities—household, nonprofit, business or government—located outside the borders of the United States. An individual in another country who buys imported U.S. products, for example, or a company located abroad that sells goods or services to the U.S., figure into U.S. accounts as part of the foreign sector.

**foreign sector (BEA definition):** the sector consisting of entities located outside the borders of the United States.

### 2.2 Conventions about Capital Stocks

While natural, manufactured, human, and social capital are all crucial resources for economic activity, it is largely only manufactured capital that is currently included in the accounting of national non-financial assets. This might be due to the national accounts having originally been devised at a time when the relatively recent rise of manufacturing made the accumulation of machinery and factory buildings appear to be the main road to prosperity. In the 21st century, the rise in importance of knowledge and ecological concerns suggests that additional accounts should be added—a topic we will take up in the next chapter.

For the most part, the national accounts currently include only manufactured capital in the accounting of national assets.

The first category of manufactured capital in the national accounts is **fixed assets**, or fixed manufactured capital. Fixed assets are in turn classified as either non-residential or residential. Non-residential fixed assets are defined as including equipment such as machinery and structures such as factories and office buildings, owned by businesses or governments. In 1999, in partial recognition of the increasingly important role of knowledge and technology in production, computer software was added as an additional type of non-residential fixed asset. “Residential fixed assets” refers to the national stock of houses and apartment buildings, whether these are owned by individuals, rental companies, or public agencies.

**fixed assets (BEA):** equipment, structures, and software owned by businesses and governments, and housing

A second—and smaller—component of the manufactured capital stock is **inventories**. Inventories are stocks of raw materials, such as crude oil awaiting refining, or manufactured goods, such as the shoe inventory of a retail shoe store, that are being held until they can be used or sold. At the end of 2002, the value of the stock of inventories held by businesses such as manufacturers and retail outlets was estimated to total $1,508 billion. (The BEA does not calculate a value for inventories held outside the business sector.)

**inventories:** stocks of raw materials or manufactured goods being held until they can be used.
Ideally, measurement of the national capital stock should also include equipment owned by households, such as cars and stoves, that are used in household production of goods and services. The BEA calls all purchases by households that are expected to last longer than three years **consumer durable goods**. In 2003, the BEA began listing these in its accounts of assets.

**consumer durable goods**: consumer purchases that are expected to last longer than three years. These are generally items of equipment, such as vehicles and appliances, used by households to produce goods and services for their own use.

The BEA estimates of the total dollar value of these assets at the end of 2002 are given in Table 5.1. In this as in later tables, the entire column to the far right is added up to reach the total at the bottom of the table. The numerical column to the left gives values for subcategories. For example, the value of “nonresidential fixed assets” can be found as the sum of the values of “equipment and software” and “structures.” (Occasionally, you may find that numbers do not add up exactly due to rounding done at the BEA.)

### Table 5.1 The Estimated Size of U.S. Manufactured Capital Stock
(2002, end of year, Billions of dollars)

<table>
<thead>
<tr>
<th></th>
<th>17,402</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonresidential fixed assets</td>
<td></td>
</tr>
<tr>
<td>Equipment and software</td>
<td>5,138</td>
</tr>
<tr>
<td>Structures</td>
<td>12,264</td>
</tr>
<tr>
<td>Residential fixed assets</td>
<td></td>
</tr>
<tr>
<td>Inventories</td>
<td>1,508</td>
</tr>
<tr>
<td>Consumer durable goods</td>
<td>3,196</td>
</tr>
<tr>
<td><strong>Total: Fixed assets, Inventories, and Consumer Durable Goods</strong></td>
<td><strong>34,335</strong></td>
</tr>
</tbody>
</table>

Source: BEA, Standard Fixed Assets Tables, “Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods” published 6/18/2004; NIPA tables, “Table 5.7.5B. Private Inventories and Domestic Final Sales by Industry” published 7/30/2004; and authors’ calculations

### 2.3 Conventions about Investment

Investment, as discussed in Chapter 3, is a flow variable that measures *additions* to a capital stock. A machine added to a factory in 1990, for example, is considered to be part of the national *stock* of nonresidential assets for every year from the time it is installed until it is junked. However, the machine was only an *addition* to assets in 1990, and hence its value would only be counted as *investment* in that one year.

1 Recall that economists use the term “investment” to mean additions to stocks of *non*-financial assets, as opposed to the common on-the-street use of the term “investment” to refer to financial investment, such as the purchase of stocks and bonds!

2 Inventory investment (that is, changes in inventories) may be either positive or negative, depending on whether the level of inventories is higher or lower at the end of the year than it was at the beginning.
Ideally, productive investments by all sectors would be recognized in the national accounts. Traditionally, however, only the business sector was considered to be productive, so only businesses were counted as making investments. It was not until 1996 that government investment in fixed assets was recognized. While the NIPA has been moving towards recognizing more productive activities by the household and institutions sector (for example, in listing consumer durables along with fixed assets), it is still the case that equipment purchases by households are not counted as part of investment.

**Gross investment** includes all measured flows into the capital stock over a period of time. **Net investment** adjusts this measure for the fact that some portion of the capital stock wears out, becomes obsolete, or is destroyed—that is, depreciates—over the period. That is,

\[ \text{Net investment} = \text{Gross investment} - \text{depreciation} \]

- **gross investment**: all flows into the capital stock over a period of time
- **net investment**: gross investment minus an adjustment for depreciation of the capital stock

For example, suppose an office complex built in 1965 is torn down this year and replaced by a new, larger office complex. Measured gross investment for this year would include the full value of the new office complex. Net investment for this year would be calculated as the value of the new office complex minus the value of the (thoroughly depreciated) building that was torn down. If the new building has 100,000 square feet of space, while the old one had 60,000 square feet, for example, the economy has a net gain of only 40,000 square feet of office space. Net investment, which measures only the value of the new space and any improvements in quality, gives a better idea of the actual addition to productive capacity.

Gross investment is always zero or positive. However if, over a period of time, the capital stock depreciates faster than it is being replaced, net investment can be negative. This can sometimes happen to manufactured capital stocks when a country is hit by major disasters such as wars or floods.

You may have noted that the numbers given for fixed assets in Table 5.1 are quoted as dollar values. Determining a money value for assets is not an easy thing—even when, as in the national accounts, we limit attention only to manufactured capital. If you have ever taken an accounting class, you know that numerous conventions have been invented reflecting different ways of thinking about how to measure such things as depreciation and the value of inventories.
Discussion Questions

1. The BEA definitions of sectors use some conventions that are not obvious. To which sector might the BEA assign each of the following entities? Why?
   a. a local city-government-owned golf course that charges fees similar to local private courses.
   b. a large non-profit hospital.
   c. a U.S.-owned movie company whose offices and studio are in Japan.
   d. a non-profit trade association, such as the Chocolate Manufacturers Association.

2. Under the BEA definitions, would spending on education be counted as investment? Would buying shares in a company be considered investment? Why?


   Certainly the most talked-about single number that comes out of the national accounts is GDP. A wide range of policymakers and media outlets have traditionally awaited the announcement of newly published figures on GDP with great anticipation. The figures on the growth rate of GDP are often taken to signal the success or failure of macroeconomic policymaking.

3.1 The Definition of Gross Domestic Product

   According to the BEA, gross domestic product (GDP) is supposed to measure the total value of final goods and services newly produced in a country over a period of time (usually one year).

   | gross domestic product (GDP) (BEA definition): A measure of the total value of final goods and services newly produced in a country over a period of time (usually one year). |

   This definition contains several key phrases. Some of them are easy to understand, while others rely on complicated conventions.

   “Final goods and services.” A final good is one that is ready for use. That is, no further productive activity needs to be applied before the good can be consumed (if it is a good that is used up as it is put to use) or put to work producing other goods and services (for example, if it is a piece of equipment). The reason for limiting measurement to final goods and services is to avoid double counting. For example, suppose that during a year, paper is produced by one company and sold to another company that uses it to make books. The books are then sold to their final buyers. Books in this case are the final goods, while the paper used in them is an intermediate good. By limiting the accounting to final goods, production is only counted once—the paper is only counted as part of the books.

   | final good: a good that is ready for use, needing no further processing |
**intermediate good:** a good that will undergo further processing

“*Over a period of time.*” Since GDP measures a flow, it of course must be measured over some time period. Macroeconomists usually work with GDP measured on a yearly basis. Estimates of GDP are released more often than once a year—generally on a quarterly basis (the first quarter covering January through March, the second April through June, and so on). However, even when only a part of the year is being covered, GDP and its growth rates are usually expressed in annual terms.

“*Newly Produced.*” Only new goods and services are ultimately counted. Many market transactions and many flows of payments do not represent new production, and hence are not registered as part of GDP. For example, if you buy a book published in 1990 at a used book shop, the value of the book itself is not included in this year’s GDP. Only the retail services provided by the used book shop are “newly produced,” and are part of this year’s GDP.

“*In a country.*” This means that the goods and services are produced within the physical borders of the country. If a U.S. citizen goes abroad to work, for example, what he or she produces while away is not part of U.S. GDP. On the other hand, the work of a Japanese citizen at a Japanese-owned factory is part of U.S. GDP if that factory is located inside the U.S.

How is the “*total value*” measured? This is a complicated topic, coming up next. It is also a controversial one, as we will see in the next chapter.

### 3.2 The Three Approaches to Measuring GDP: An Introduction

The BEA publishes tables showing the components of GDP, as well as many other tables dealing with assets, employment, prices and other topics in the National Income and Product Accounts. (These are easily accessed at www.bea.gov.) To understand these tabulations, however, you need to understand how aggregate production, spending, and income are related in an economic system.

Imagine a simple economy with no foreign sector, no depreciation, no inventories, no transfers, no non-market production, and in which companies pay out all their earnings. In this case, three quite different measures of counting GDP would in theory all add up to the same number:

\[
\text{Value of Production} = \text{Value of Spending} = \text{Value of Income} \\
\text{(in an imaginary simple economy)}
\]

Using a *production approach*, which might seem to be the most natural and direct method, we could sum up the dollar value of all final goods and services produced in each sector—by the household and institutions sector, the business sector, and the government sector.
However, using the *spending approach*, we could look at who *buys* the final goods and services that have been produced. Since we assumed that no goods are carried as inventory in this very simple economy, everything produced must be bought. Totaling up the dollar value of spending on all various kinds of goods and services by all sectors in this imaginary simple economy will give a second way of arriving at the figure for a country’s aggregate production.

Lastly, since in this simple economy everyone who is involved in production also receives a monetary payment for their contribution to it, we could, alternatively, take an *income approach*. In this approach, we total up the compensation received by everyone involved in production, including workers, investors, creditors, and owners of land or equipment rented for productive use.

In this very simple economy if, say, $10 million worth of goods and services is produced, then the amount spent on goods and services must also be $10 million and the amount of payment received as income must also be $10 million. Sometimes in dealing with national accounts economists hence use the terms “production,” “income,” and “expenditure” interchangeably.

**Discussion Questions**

1. Which of the following would be included in U.S. GDP?
   a. the value of Los Angeles hotel rooms rented to Italian tourists
   b. the value of a Renaissance-era painting sold at an auction in New York
   c. the value of steel production, that is used in making cars during the same year
   d. the value of new military aircraft

2. Can you explain why economists often use the terms “production,” “income,” and “spending” interchangeably?

**4. Gross Domestic Product: Calculating Its Value**

While there is a rough equivalence in theory among the production, spending and income approaches to calculating GDP, making estimates for an actual economy requires a number of conventions and adjustments.

**4.1 The Product Approach**

The BEA measures the “value” of final goods and services primarily—at least in concept—by their *dollar market value*. For example, if the business sector produces 1000 automobiles of a certain type this year which are which are then sold to final users for $20,000 each, this adds $20 million to GDP.

Rather than looking at the final sale, however, it is sometimes useful for accounting and analytical purposes to follow an alternative approach. This is to think
about how much each industry contributes to the value of the final good or service. In the value-added approach to GDP accounting, you start with the raw materials—say, iron ore—used in producing a good or service—say, an automobile—and then see how much market value is added at each stage in the production process.

For example:

1. You find the value of iron ore as it is sold from the mining company to the steel manufacturer. Minus the value of any intermediate goods used, this is counted as being the value added to the ore in the ground by the mining company. Conveniently, this value added in production can also be measured as the sum of the incomes paid out by the mining company.

2. Then, the value added by the steel manufacturer is calculated as the value of the steel sold to the auto manufacturer, minus the amount the steel maker paid for the iron ore and other material and energy inputs. (We subtract off the value of intermediate good, iron ore, so we don’t count it twice.) This value added by the steel manufacturer can also be measured by looking at the incomes it pays out.

3. The value added by the auto manufacturer is calculated as the value of the automobile it sells less the value of the intermediate inputs (steel, rubber, etc.) it purchased. This is equivalent to the incomes paid out in the process of auto production.

4. Summing up the value added at each stage of production should lead to the same number as we would get by directly assessing the final value of the car—the amount it sells for on the market.

The BEA maintains an extensive set of Input-Output Accounts to keep track of the contributions to GDP by various industries. These tables show outputs of each industrial sector (for example, agriculture, manufacturing, or services) can become inputs (intermediate goods) to production in other sectors.

value-added: the value of what a producer sells less the value of the intermediate inputs it uses. This is equal to the incomes paid out by the producer.

The fact that the calculated total value of final goods should add up to be the same number, whichever of the two methods is used—looking only at the markets for final goods, or, alternatively, going through a value-added accounting—serves to provide “checks” on the validity of data the BEA collects from different sources.

---

3 What about the contribution of natural resources, such as the deposits of iron ore, to the production of the car? The production of the car depletes these resources. The national accounts, as currently structured, however, do not seek to keep track of changes in natural capital.
While finding the market value of production may seem fairly straightforward for manufacturing industries, in practice the idea of “market value” is often much harder to determine. In practice, the BEA uses imputation to estimate the value of many components of GDP. An imputation is a sort of educated guess, usually based on the value of similar outputs or on the value of inputs used in production.

**imputation**: a procedure in which values are assigned for some category of products, usually using values of related products or inputs

For example, the housing stock of a country produces a flow of services—the services of shelter. This is an important component of consumption by households. For rental units, the market value of the housing services can be directly observed by looking at the rents the occupants pay. For the value of services being generated by houses occupied by their owners, however, the BEA must impute a value. They use data from the rental housing market to impute what owner-occupiers might be said to be “paying in rent” (to themselves).

In cases where no similar marketed product exists, the BEA often falls back on using a value-added approach, looking exclusively at the value of inputs. We know, for example, that governments purchase many intermediate goods, and then produce their outputs of goods and services using the services of workers they employ and the services of structures and equipment. But rarely are government outputs—new highways, the services of parks, the services of public education, national defense, etc.—actually sold on markets. How, then, is the production of the government to be valued?

In the actual GDP accounts, the value of government production is imputed by adding up the amount that governments pay their workers, the amount they pay for intermediate goods and services, and an allowance for depreciation of fixed assets. Likewise, the production of nonprofit institutions is measured in large part by looking at their inputs. For example, data on payroll expenses forms an important part of the information used in estimating the value of the services produced by nonprofit agencies.

The value of non-marketed production by governments and nonprofit institutions is usually imputed by measuring the value of inputs used.

Imputations are also used when data is difficult or impossible to obtain. While it might be tempting to imagine the BEA as an all-knowing agency that can simply directly observe all market transactions, in fact gathering data is a laborious (and often expensive) process. The BEA relies on a variety of censuses and surveys to obtain information, as well as on regulatory and administrative data such as government budgets and tax records. Market transactions that people take pains not to have observed by the government—such as illegal drug deals or work performed “off the books” to avoid taxes—hence are usually not represented in the national statistics. The BEA updates all its estimates periodically, as it receives better data or improves its statistical techniques—hence you may see many slightly varying numbers quoted for, say “U.S. GDP, 2003” depending on when the data were published.
In one significant case, however, the designers of the national accounts decided not to even attempt to impute a value for production. This is the case of the production of goods and services within households for their own use. The official measure of production by households includes the value of services produced by the house (that is, the rent or imputed rent) and production within the households to the extent that work is paid (that is, done by hired housekeepers, nannies, private gardeners, and so on). But activities like unpaid child care, cooking, or the cleaning or landscaping of a home done without pay by household members—traditionally, mostly by women—are not counted in GDP. This creates an anomaly in the accounts. For many years, textbooks noted that “if a man marries his housekeeper, GDP falls.” That is, marriage would convert the woman’s housekeeping work from being paid and counted, to being unpaid and uncounted.

How much of GDP is produced by entities within each of the BEA-defined sectors? Not surprisingly, given the conventions and accounting procedures, the BEA attributes a very large share of productive activity to the business sector, as shown in Table 5.2. For the period from January through December of 2002, the share of business in the flow of total production was estimated to be about $8.1 trillion, out of a total 10.5 trillion, or about 77%. The household and institutions sector was estimated to contribute about 12%, and the government sector the remaining 11%.

Table 5.2 Gross Domestic Product, Product Approach
(2002, Billions of dollars)

<table>
<thead>
<tr>
<th>Households and institutions production</th>
<th>1,226</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private households</td>
<td>704</td>
</tr>
<tr>
<td>Nonprofit institutions</td>
<td>522</td>
</tr>
<tr>
<td>Business production</td>
<td>8,066</td>
</tr>
<tr>
<td>Government production</td>
<td>1,189</td>
</tr>
<tr>
<td>Federal government</td>
<td>345</td>
</tr>
<tr>
<td>State and local governments</td>
<td>844</td>
</tr>
<tr>
<td><strong>Total: Gross domestic product</strong></td>
<td>10,481</td>
</tr>
</tbody>
</table>

Source: BEA, NIPA “Table 1.3.5 Gross Value Added By Sector”, published 12/23/2003

We can also summarize the product approach by the equation:

\[ GDP = \text{Business production} + \text{Household and institutions production} + \text{Government production} \]
This sort of equation is called an \textit{identity} or an \textit{accounting identity}. It holds simply because of the way that the various terms have been defined. If we once agree on the definitions of terms, then there remains nothing controversial about an identity.\footnote{Later in this textbook, when we deal with macroeconomic modeling, we will introduce another kind of equation, called a behavioral equation. A behavioral equation represents an economist’s supposition about how some economic actor behaves—and since it may or may not hold well in practice, it can be more controversial.}

\textbf{identity (accounting identity):} an equation where the two sides are equal by definition

The foreign sector does not contribute to the production of GDP. Can you explain why? (Hint: Look back at the definition of GDP.)

4.2 The Spending Approach

The spending approach adds up the value of newly produced good bought by the household and institution, business, foreign, and government sectors. The estimated values for these expenditures for 2002 are listed in Table 5.3.

\textbf{Table 5.3 Gross Domestic Product, Spending Approach} (2002, Billions of dollars)

<table>
<thead>
<tr>
<th>Household and institutions spending (personal consumption expenditures)</th>
<th>7,385</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable goods</td>
<td>911</td>
</tr>
<tr>
<td>Nondurable goods</td>
<td>2086</td>
</tr>
<tr>
<td>Services</td>
<td>4388</td>
</tr>
<tr>
<td>Business spending (gross private domestic investment)</td>
<td>1,589</td>
</tr>
<tr>
<td>Fixed investment</td>
<td>1,584</td>
</tr>
<tr>
<td>Change in private inventories</td>
<td>5</td>
</tr>
<tr>
<td>Net foreign sector spending (net exports of goods and services)</td>
<td>-426</td>
</tr>
<tr>
<td>Exports</td>
<td>1,007</td>
</tr>
<tr>
<td>Less: Imports</td>
<td>1,433</td>
</tr>
<tr>
<td>Government spending (government consumption expenditures and gross investment)</td>
<td>1,933</td>
</tr>
<tr>
<td>Federal</td>
<td>680</td>
</tr>
<tr>
<td>State and local</td>
<td>1253</td>
</tr>
<tr>
<td><strong>Total: Gross domestic product</strong></td>
<td><strong>10,481</strong></td>
</tr>
</tbody>
</table>

Source: BEA, NIPA, “Table 1.1.5 Gross Domestic Product” published 12/29/2003

Purchases of goods and services by households and nonprofit institutions serving households are called “personal consumption expenditures” by the BEA. By convention,
these are all considered “final” goods and services (even though, as discussed earlier, many of these are used in household and nonprofit production processes).

Business spending on final goods and services is called “gross private domestic investment” by the BEA. This includes business spending on fixed assets including structures, equipment, and software, as well as the value of changes in inventories within that sector.5

The simple economy we discussed when noting how, in concept, “production = spending = income” was a closed economy, with no foreign sector. While sometimes countries isolate themselves from world trade (China during 1960s being a prime example), for the most part global economic relations have become an increasingly important as advances in transportation and communication have accelerated. Since the U.S. is an open economy, we need to take into account interactions with the foreign sector.

| **closed economy**: an economy with no foreign sector |
| **open economy**: an economy with a foreign sector |

Some of the goods and services produced inside the U.S. are bought by entities in the foreign sector. The value of these exported goods must be added to the value of domestic spending in calculating GDP. On the other hand, some of the spending by U.S. residents is for goods and services produced abroad. Such spending is, in fact, already included in the calculation of spending by the various other sectors in Table 5.4. So the value of imported goods and services must be subtracted off to arrive at a measure of domestic production.

Net exports measures the overall impact of international trade on GDP. It is the difference between exports and imports.

\[
\text{Net exports} = \text{Exports} - \text{Imports}
\]

Net exports may be either positive (if we sell more abroad than we buy) or negative (if we buy more than we sell). In 2002, for example, we can see in Table 5.3 that the U.S. imported goods and services worth $426 billion more than the value of the goods and services exported. (In the table, the fact that the value of imports is subtracted rather than added is denoted by putting the number in italic type.) Net exports were hence negative in that year.

| **Net exports**: the value of exports less the value of imports |

---

5 Why isn’t business spending on wages or on materials such as energy and raw goods counted here? Recall that GDP only accounts for final goods and services. The value of such inputs will be reflected in GDP as the products of the businesses are bought by households, institutions, or governments. Including the value of such inputs with business spending as well would result in double-counting. Investment goods and inventories, however, stay within the business sector.
Lastly, we come to the expenditures made by the government sector. The BEA calls these “government consumption expenditures and gross investment” and breaks these down by whether they are made at the federal level or at the state and local level. These figures represent only spending for final goods and services, so they exclude the parts of government budgets that go for transfers (such as social security). In 2002, about 65% of federal government spending went for national defense. About 17% of total government spending was considered to be investment spending, while the rest was considered consumption.

If we want to highlight the various sectors involved, we can summarize the spending approach with the identity:

\[
GDP = \text{Household and institution spending} \\
+ \text{Business spending} \\
+ \text{Net foreign sector spending} \\
+ \text{Government spending}
\]

Or, if we want to highlight the portions that are (by convention) considered to be consumption versus those considered to be investment, we can summarize this approach with the identity:

\[
GDP = \text{Personal consumption} \\
+ \text{Private investment} \\
+ \text{Net exports} \\
+ \text{Government consumption} + \text{Government investment}
\]

4.3 The Income Approach

The production-related incomes earned by all people and organizations located inside the United States are summed up in a measure called national income (NI).\(^6\)

**national income (NI):** a measure of all domestic incomes earned in production

If this were a simple economy with no foreign sector and no depreciation, the sum of the incomes from production, NI, would exactly equal GDP. But in our more complex economy, three adjustments are needed to reconcile figures on domestic income and domestic production.

First, we need to note that some domestic incomes reflect foreign production. For example, as mentioned above, the profits of a U.S. company may include earnings from overseas plants. Such incomes must be subtracted from NI in order to reconcile this measure with the figure for gross domestic product. Conversely, the income from some domestic production is received by foreign residents, and so not counted in NI. A German factory located in the U.S. may send its profits back to its Berlin headquarters,

---

\(^6\) The sources of these incomes, and their distribution, is a topic we will cover in a later chapter.
for example. The value of these incomes must be added to NI in order to approximate GDP. In 2002, income receipts from the rest of the world exceeded income paid out by $21 billion. These “net income payments from the rest of the world” must be subtracted off NI to get a measure closer to GDP, as shown in Table 5.4.

Table 5.4 Gross Domestic Product, Income Approach (2002, Billions of Dollars)

<table>
<thead>
<tr>
<th>National income</th>
<th>9291</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Net income payments from the rest of the world</td>
<td>21</td>
</tr>
<tr>
<td>Depreciation (consumption of fixed capital)</td>
<td>1289</td>
</tr>
<tr>
<td>Statistical discrepancy</td>
<td>-77</td>
</tr>
<tr>
<td><strong>Total: Gross domestic product</strong></td>
<td><strong>10,481</strong></td>
</tr>
</tbody>
</table>


Second, we need to account for the fact that not all of GDP creates income, since some domestic production simply goes into replacing structures, equipment and software that have worn out or become obsolete. So we must add in depreciation (what the BEA calls “consumption of fixed capital”) to get a number closer to GDP.

The third adjustment in Table 5.4 is what is called the “statistical discrepancy.” It reflects the fact that, no matter how diligently the BEA compiles the accounts, it cannot in fact exactly reconcile the results from the income approach with the results from the product and spending approaches.

We can summarize the meaningful parts of the income approach by the identity:

\[
GDP = \text{National income} - \text{Net income payments from the foreign sector} + \text{Depreciation}
\]

Discussion Questions

1. The previous section explained why a nation’s “production” and “income” can be thought of as roughly equal in a conceptual sense. Why, in practice, does the value of domestic production actually differ from the total of domestic incomes?

---

7 When net income payments from the rest of the world are added to GDP, the result is a measure called gross national product (GNP). For many years, GNP was used as the primary measure of U.S. production. It measures a country’s production in terms of the output produced by its workers and companies, no matter where in the world they were located. The BEA switched its emphasis from GNP to GDP in 1991, believing that it is more important, for the purposes for which the accounts are used, to track economic activity within the borders of a country.
2. Sometimes you may see GDP defined as “The total market value of all final goods and services newly produced in a country over a period of time.” Given the above discussion, how true is this definition, really? Does GDP really only count goods and services exchanged in markets? Does it really account for all production?

5. Growth, Price Changes and Real GDP

Economic growth, traditionally defined as a state in which GDP is on the rise, is historically a topic of wide policy make and media concern. Likewise, inflation, or the growth rate of prices, is also closely followed.

5.1 Calculating GDP Growth Rates

So far, we have concentrated on calculating GDP in only one year. To calculate rates of economic growth, economists must look at how GDP changes over time. The percentage change in GDP from year to year can be calculated using the standard percentage change formula.\(^8\)

\[
\text{growth rate} = \frac{\text{GDP in a year} - \text{GDP in the previous year}}{\text{GDP in the previous year}} \times 100
\]

For example, United States GDP in 2001 was estimated to be about $10.08 trillion, while in 2002 it was estimated to be about $10.48 trillion. Fitting these into the equation, we have

\[
growth rate = \frac{10.48 - 10.08}{10.08} \times 100
\]

\[
= .04 \times 100
\]

\[
= 4.0
\]

indicating that GDP grew about 4% between 2001 and 2002.

5.2 Nominal vs. Real GDP

Does the number we just calculated mean that the level of aggregate production in 2002 was 4% larger than production in 2001? It does not. So far, the measure of GDP we have been discussing is nominal GDP, or GDP expressed in terms of the prices of goods and services that were current at the time. The figure for GDP for 2002 that we used, for example, is based on prices as they were in 2002, and the figure for GDP in 2001 is based on prices that prevailed in 2001.

\(^8\) Commonly you will see in the news growth rates quoted for shorter periods such as quarters, expressed in terms of “annual growth rates”--what the rate of growth would be if the economy were to continue to expand (or contract) at this speed for the entire year. Such calculations require more complicated formulas.
**nominal GDP**: gross domestic product expressed in terms of current prices

Not only does output change between two years, but generally the *prices at which output is valued* change as well. **Real GDP** is a measure of GDP that seeks to reflect better the actual value of goods and services produced, by removing the effect of changes in prices.

**real GDP**: a measure of gross domestic product that seeks to reflect the actual value of production goods and services produced, by removing the effect of changes in prices.

For example, suppose a very simple economy produces only two goods, apples and oranges. The number of pounds of each produced in each of two years, and the market prices per pound, are given in Table 5.5.

**Table 5.5 GDP in an “Apples and Oranges” Economy**

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Value (at Year 1 Prices) = price × quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Apples</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oranges</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Value (at Year 2 Prices) = price × quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Apples</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oranges</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

growth rate of nominal GDP from Year 1 to Year 2 = \[
\frac{(300-200)/200}{200} \times 100 = .5 \times 100 = 50\% 
\]

Since GDP is just the sum of the dollar values of the goods produced in a year, in Year 1 the value of nominal GDP is $200. In Year 2, the value of nominal GDP is $300. The percentage growth of GDP from year 1 to Year 2 is 50%, applying the formula from the previous section.

But if you look carefully, you can see that only part of the change is due to an increase in the production: The quantity of oranges produced rises from 50 pounds to 75 pounds. Some of the increase in the measured value of nominal GDP is due an increase in the price of apples, from $1.00 to $1.50,

You may be surprised to learn that there is no perfect, faultless way to measure changes in “real” production, even in this extremely simple case! The problem is that while GDP is measured as the sum of the money values of the goods and services produced, we have choices about how to measure “money value.” We might use the
prices in Year 1, or the prices in Year 2, or perhaps some combination of the two. Hence, in order to get an idea of the “real” value of production, economists at the BEA have, once again, been forced to adopt conventions. These conventions are designed to yield reasonable, even though imperfect, measures of real output change.

Why can’t we just create a number for “real” GDP by adding up the physical quantities produced? It might be tempting to think about just counting up the pounds of fruit produced—up from 150 to 175 pounds. While it may seem vaguely plausible to add up apples and oranges, what if we tried to add in other quantities measured by weight, such as the number of pounds of carpenter’s nails and cut diamonds produced in the year? And how would we add “pounds” of products to measures of other outputs, such as education services? Clearly, it makes no sense to simply add up physical quantities of dissimilar items. Dollar values, however, provide a common measure for the level of production of a variety goods and services, which can be sensibly added up. Hence we use dollar values, adjusted for price changes, to try to get a sensible aggregate measure of production.

News in Context: GDP Grew 3.0% in the Second Quarter


U.S. economic growth slowed in the second quarter of 2004, according to estimates released today by the U.S. Bureau of Economic Analysis. Gross domestic product (GDP), the most comprehensive measure of U.S. economic activity, increased at an inflation-adjusted annual rate of 3.0 percent in the second quarter after increasing 4.5 percent in the first quarter.

The slowdown in GDP growth was mainly accounted for by decelerations in consumer spending (especially for food and clothing) and, to a lesser extent, in inventory investment. In contrast to the slowdowns in consumer spending and inventory investment:

- residential investment accelerated on the strength of house sales,
- business investment accelerated, partly on the strength of aircraft and computer purchases, and
- exports accelerated, as most categories of both goods and services were stronger than in the first quarter.

Prices paid by U.S. residents increased 3.5 percent…

5.3 “Constant Dollar” Real GDP

Until 1995, the BEA calculated real GDP using the “constant dollar method.” Since the constant dollar method is relatively easy to understand and contains most of the intuition you need as a beginning economics student, we will cover it in some detail. (This intuition also carries over to price change measures, covered later in this chapter.)
The constant dollar method uses prices from one particular year, called the **base year**, to evaluate the value of production in all years.

**base year** (in the constant dollar method of estimating GDP): the year whose prices are chosen for evaluating production in all years. Real and nominal GDP are equal in the base year.

Applying the constant dollar method to our simple “apples and oranges” example, for instance, we might express GDP in both Year 1 and Year 2 in terms of Year 1’s prices. Year 1 is thus the base year. Year 2, the year for which we are trying to calculate GDP, would be called the current year. This calculation is shown in part (a) of Table 5.6, where we have paired up quantities from both Year 1 and Year 2 with the prices from Year 1. (We do not repeat the calculations for Year 1, since the result is just nominal GDP, which we can look up in Table 5.5). Year 2 GDP expressed in “constant (Year 1) dollars” is $250.

**Table 5.6 Calculation of Constant Dollar Real GDP and Growth Rates**

<table>
<thead>
<tr>
<th>(a) Using Year 1 prices</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP in Year 1 using Year 1 prices =</td>
<td>$200</td>
</tr>
<tr>
<td>GDP in Year 2 using Year 1 prices:</td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>Price, Year 1</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td>Oranges</td>
<td>$2.00</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Growth rate of real GDP from Year 1 to Year 2 = \(\frac{(250-200)}{200} \times 100\) = .25 × 100 = 25%

<table>
<thead>
<tr>
<th>(b) Using Year 2 prices</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP in Year 1 using Year 2 prices:</td>
<td></td>
</tr>
<tr>
<td>Apples</td>
<td>Price, Year 2</td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>$1.50</td>
</tr>
<tr>
<td>Oranges</td>
<td>$2.00</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GDP in Year 2 using Year 2 prices = $300.00

Growth rate of real GDP from Year 1 to Year 2 = \(\frac{(300-250)}{250} \times 100\) = .20 × 100 = 20%

The growth rate of constant dollar real GDP in part (a) of Table 5.6 is be calculated using real instead of nominal GDP in the growth formula given earlier. Measured in this fashion, real GDP would be said to have grown by 25%. Note that this is less than the 50% growth figure for nominal GDP. As we saw, some of the growth in nominal GDP is due to price changes, not production changes.
Real GDP in the base year is, by definition, the same as nominal GDP in the base year—Year 1’s product evaluated in Year 1’s prices. If we had data for additional years, either from earlier or later periods, we could create a whole series of real GDP numbers, all of them expressed in constant (Year 1) dollars.

This convention, however, has a number of problems. One is that it makes measured GDP growth calculations depend on which year is chosen as base. For example, what if we make Year 2 the base instead? Applying Year 2 prices to both years, calculations in part (b) of Table 5.6 show that GDP growth would then be measured as 20% instead of 25%. It can be confusing to have to deal with different figures that purport to represent the same economic event!

Constant dollar estimates of GDP also suffer from various biases and inaccuracies, which become more important the more dissimilar relative prices and spending patterns are between the base year and a current year. Yet updating the base year to be closer to the current year also creates problems.

5.4 “Chained Dollar” Real GDP

Beginning in 1996, the BEA switched to calculating real GDP using the “chained dollar” method. The exact way in which real chained dollar GDP and its growth rate are calculated is explained in the Appendix to this chapter. While this method of deriving measures of real GDP is less intuitive than the old constant dollar measure, the concept behind the new measure is still the same—real GDP still is an attempt to measure output change free of the influence of changing prices.

While there is still one year for which real and nominal GDP are equal—now called the reference year and currently set at 1996—the prices from this year are no longer applied to all other years. Instead, chained dollar estimates use the prices from two adjacent years in estimating year-to-year real GDP growth. Real GDP is currently expressed in BEA publications in terms of “chained (1996) dollars.” Unlike the constant dollar method, the chained dollar method yields a unique estimated growth rate.

| reference year (in the chained dollar method of estimating GDP): the year in which real and nominal GDP are equal |

Unfortunately, while this method has arguably increased the accuracy of GDP growth calculations, one drawback is a steep jump in computational complexity. The key new concept in the new method is an emphasis on estimating quantity indexes for GDP in the current year relative to the year before and relative to the reference year.

| quantity index: an index measuring changes in levels of quantities produced |

An index number is a figure that measures the change in size of a magnitude, such as a quantity or price, as compared to its magnitude in some other period.
Generally, the value of the index number in the reference year is set to 100, though sometimes other values (such as 1 or 10) are used.

**index number**: a figure that measures the change in size of a magnitude, such as a quantity or price, as compared to its magnitude in some other period.

The new method has some other drawbacks, as well. The sum of real components of GDP in chained dollar terms do not generally exactly add up to real GDP. Users of the data are also warned not to make comparisons of chained dollar amounts for years far away from the reference year. The BEA tries to make the data more usable by providing tables in which, for example, year to year growth rates in components of GDP are already calculated for the user.

In Figure 5.1 you can see how measures of real and nominal GDP diverge. Because prices were generally rising over the period 1990-2002, nominal GDP grew faster than real GDP, as shown by the more steeply rising line.

![Nominal GDP grows faster than real GDP when prices are rising.](image)

**Figure 5.1** U.S. GDP (Trillions of Dollars) 1990—2002

Nominal GDP grows faster than real GDP when prices are rising.

### 5.5 Price Indexes

Price indexes are interesting both for how they relate to calculation of real GDP and on their own because of the policy interest in measuring (and controlling) inflation.

The price index most often reported in the news is the **consumer price index** (CPI), calculated by the U.S. Bureau of Labor Statistics (BLS). The CPI measures changes in the prices of goods and services bought by households.
consumer price index (CPI): an index measuring changes in prices of goods and services bought by households

The CPI is calculated using a weighted average of the prices of the various goods and services it tracks. The mathematics of this is worth a little explaining. A “weighted average” is an average in which the different numbers being averaged together are “weighted” to indicate their relative importance in the calculation. You are probably already familiar with this, in the calculation of your own Grade Point Average now or in high school. Each grade you receive in a course is “weighted” by the number of credits or hours the course is worth. These weighted grade points are summed up and then divided by the total number of credits or hours to yield your GPA. An “A” received in a 2-credit course thus properly receives less emphasis in the calculation than an “A” received in a 4-credit course.

Similarly, in measuring price levels in the economy, we want to give greater emphasis to prices at which many transactions are made, and less emphasis to the prices of relatively minor goods and services. The way to do this is to weight each price by a corresponding quantity of goods produced and sold at that price.

Once again, however, we face choices about what standards to use. Should we use as weights the quantities bought in Year 1, Year 2, or some combination? To calculate the CPI, the Bureau of Labor Statistics uses a constant weight method. This means that the quantities bought during one time period is chosen as “base.” As you can see, the problem is analogous to the calculation of “constant dollar” GDP—only now it is a common set of quantity weights, rather than prices, from the base period that are applied to every calculation.

Currently the base quantities used for the CPI come from expenditure surveys administered during 1993-1995. These quantities are said to represent a typical “market basket” of goods bought by households. The CPI for the base year is set at 100. The CPI for other years is calculated as the ratio of the sum of current prices weighted by the base year “market basket” to the sum of base year prices weighted by the base year “market basket,” times 100.

\[
\text{Consumer Price Index (CPI)} = \frac{\text{sum of current prices weighted by base quantities}}{\text{sum of base prices weighted by base quantities}} \times 100
\]

Consider, again, our “apples and oranges” economy, assuming that the quantities given reflect purchases by consumers. Table 5.7 shows how we would calculate a CPI for Year 2, using the Year 1 “market basket” as the base. The price index for the base year (Year 1) is set at 100, and the CPI for Year 2 can be calculated as 125. The growth rate of prices between the two years—that is, the inflation rate experienced by consumers—is thus 25%.
Table 5.7 Calculation of the Consumer Price Index (for Year 2, when Year 1 is Base)

<table>
<thead>
<tr>
<th>Sum of Year 2 Prices Weighted by Year 1 Quantities</th>
<th>weighted sum of prices = ( \text{price \times quantity} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>$1.50 \times 100 = $150</td>
</tr>
<tr>
<td>Oranges</td>
<td>$2.00 \times 50 = $100</td>
</tr>
<tr>
<td>Sum of Year 1 Prices Weighted by Year 1 Quantities</td>
<td>$200</td>
</tr>
</tbody>
</table>

Calculations for Year 2:

- Price index = \( \frac{250}{200} \times 100 = 125 \)
- Inflation rate = \( \frac{[(125-100)/100] \times 100}{100} = 25\% \)

Because the CPI uses constant weights, it may tend to overstate inflation for periods after the base year. When the price of a good or service rises relative to other goods, people generally tend to buy relatively less of it.\(^9\)

The CPI is not the only price index in use. The producer price index (PPI) measures prices that domestic producers receive for their output, and so tracks many intermediate goods not included in the CPI market basket. Import and Export Price Indexes track prices of goods traded between domestic residents and the foreign sector. Because they track different goods, these indexes may vary from each other.

The BEA uses the CPI, PPI and other indexes created by the BLS in creating its own national income and product statistics, and also creates a price index of its own. While the other indexes reflect price levels of specific groups of goods and services of interest to consumers and producers, the index published by the BEA reflects changes in all the prices of goods and services included in GDP. Called the implicit price deflator (or the GDP deflator), it is calculated for any year as:

\[
\text{Implicit Price Deflator} = \left( \frac{\text{Nominal GDP}}{\text{Real GDP}} \right) \times 100
\]

where real GDP is calculated using the chained dollar method. Calculations are demonstrated in the Appendix.

**implicit price deflator (GDP deflator):** a price index derived by dividing nominal GDP by real GDP

---

\(^9\) Because of this bias, beginning in 2002 the BLS also began to release some “chained” CPIs on an experimental basis.
Economics in the Real World: How Quantity Weights Can Lose Validity Over Time

Why do economists and statisticians make a fuss about updating the quantity weights used in calculating the Consumer Price Index? Consider how household expenditure patterns have changed over time.

In 1901, nearly half of the budget of a typical urban, working family went towards food, while 15% towards shelter and an equal proportion towards clothing. The family spent nothing at all on cars or gasoline--since automobiles had not yet been invented!

By 1950, the picture had changed considerably. Now only a third of the family’s spending went towards food, while only 11% went towards shelter and 12% towards clothing. On average, families now spent about 12% of their budget on expenses related to private vehicles, since by this time automobile ownership was becoming widespread.

In recent data on consumer expenditures, the share devoted to food has dropped even further—to 14%. Expenditures on clothing have dropped to less than 5% of a household’s budget, on average. Meanwhile, families are spending more on shelter (19% of their budget) and private vehicle expenses (18% of their budget), than they were at mid-century.

Using expenditure patterns from one of these periods to “weight” the CPI in another would clearly result in biased figures. Using the 1901 expenditure pattern nowadays would, for example, mean that auto and gasoline prices would not figure into the CPI at all.

The invention of new goods and services (for example, MP3 players) and quality improvements in existing goods (for example, in products for home entertainment and computing) continue to create special challenges for the economists working on measuring price changes.


5.6 Growth and Growth Rates

We have calculated year-to-year growth rates for GDP and prices. But suppose we want to ask how much GDP has grown over the last 5 years, or 20 years? How do we calculate those numbers? The answer is rather complicated, but fortunately, as one of the appendices to this chapter demonstrates, you can use NIPA published tables to answer such questions.

However, a handy way to get a grasp on the relation of annual growth rates to changes over a longer period of time is by using the rule of 72. Taking the number 72 and dividing by an annual growth rate will give you approximately the number of years it
will take for an amount to double if it grows at that constant rate (as long as the numbers you are using are not extremely high or low). For example, if real GDP grew at a constant 4% rate per year, it would double in about 18 years (since 72/4 = 18).

**rule of 72:** a shorthand calculation which states that dividing an annual growth rate into the number 72 yields approximately the number of years it will take for an amount to double

**Discussion Questions**

1. The “constant dollar” method of estimating real GDP uses prices for one year to calculate measures of GDP for all years. Why is it sometimes important to evaluate GDP in the current year using prices from some other year? Why can’t we just always use current prices? Explain.

2. How is the “constant dollar” method of estimating real GDP similar to the use of “constant weights” in the computation of the Consumer Price Index? Explain.

**6. Savings, Investment, and Trade**

At a personal level, you produce goods and services, earn income, consume, save, and borrow or lend. One of the reasons you keep personal accounts is to try to track your inflows and outflows, so you know whether you are running down your personal assets or building them up. If you can save money from your current income, you are bettering your financial position for the future. On the other hand, if you run down your savings or go into debt merely to finance a high level of consumption, you may find yourself in trouble later on. Running down financial savings or going into debt is can be a good choice for your future only if you use the funds to gain some other valuable asset. Students often go into debt in order to finance their education, for example, with the idea that it will later pay off in terms of a higher income.

There are analogous issues at the national level. Besides keeping track of economic growth and inflation, systems of national accounts serve another important purpose. They allow us to look at the savings and asset situation of a national economy as a whole (at least as far as manufactured assets and financial flows are concerned).

**6.1 The Relationship of Savings, Investment, and Trade**

The analogous category at the national level to your personal day-to-day consumption spending is the consumption spending done by the household and institutions and government sectors. This is spending on goods and services that are presumably “used up” right now—they are not expected to help the country over the long term. The analogous category to your income is—at least roughly—GDP.

Recall that the spending approach to GDP says that
\[ GDP = \]
\[ Personal\ consumption + Private\ investment \]
\[ + Net\ exports + Government\ consumption + Government\ investment \]

Rearranging, we can get

\[ GDP – Personal\ consumption – Government\ consumption = \]
\[ Private\ investment + Government\ investment + Net\ exports \]

Since saving is what is left over from income after spending on consumption,

\[ Saving = Investment + Net\ Exports \]

Thinking about these quantities in terms of valuable goods and services, this important identity says, intuitively, that goods and services that are produced in our domestic economy in excess of what we currently need for consumption can be investment goods—additions to our stock of manufactured assets (including replacement of depreciated assets)—or can sold to foreign countries (in excess of the value of what we import from them.)

6.2 Financing Spending

Another way to look at the relation of saving, investment, and trade is to think of how the various sectors finance their purchases of goods and services. In a contemporary economy, goods are rarely traded for goods, but rather money is used as a means of exchange. So corresponding to any flow of goods and services transacted in exchanges there is an equivalent flow of monetary funds.

Consider, for a moment, a closed economy. In this case the last identity would reduce to:

\[ Saving = Investment \quad \text{(in a closed economy)} \]

This says that, in a closed economy as a whole, the total amounts that the various sectors choose not to spend on consumption goods is available for spending on investment goods. How does financial saving get turned into tangible investments?

In the national accounts, it is primarily businesses and the government who are counted as investing. They finance their investment expenditures either from their own savings or by borrowing someone else’s savings. Household savings, in the form of income not spent on consumption, can be made available for investment by the other sectors—as when the funds in a household’s bank deposit are lent out to a business, or a household buys a government bond. The “saving = investment” identity tells us that at an aggregate national level in a closed economy, only what the country as a whole saves out of current income can be available to finance investment for the future.
When we consider an open economy, things get a more complicated. Now the nation as a whole can also on net borrow from, or lend to, the foreign sector, and the relevant identity is:

\[ \text{Saving} = \text{Investment} + \text{Net Exports} \]

If net exports are positive, we sell more goods abroad than we buy. How do people abroad pay for all our goods, if we the value of what we sell to them exceeds the value of what they sell to us? They are not earning enough from their sales to pay us! The most important way they can finance their purchases of our goods is by borrowing from us. They would need to borrow the amount by which our exports to them exceed our imports from them. So the identity can be (approximately) rewritten as: 10

\[ \text{Saving} = \text{Investment} + \text{Net foreign lending} \]

That is, if we have extra savings, above and beyond what is being used for domestic investment, we can loan it to foreigners so they can buy our goods.

In recent years, however, the U.S. has tended to have net exports that are negative—we tend to buy more from foreign countries than we sell. This means that we need to borrow from them. The following identity means exactly the same thing as the last one, but is easier to use to represent the recent U.S. situation:

\[ \text{Saving} = \text{Investment} – \text{Net foreign borrowing} \]

When we are in a situation of borrowing (that is, when Net Foreign Borrowing is a positive number) then the amount we are really “putting away for the future”—that is, saving—is less than what we would guess if we only looked at what we are investing. While we may be investing domestically, if “net foreign borrowing” is positive we are also putting the country’s future financially “in hock” to other countries by borrowing from them.

Should we worry if our country has to borrow from foreigners? As in the case of your personal finance, it makes a difference what the borrowing is for. If the borrowing finances the purchase of productive new private or government investment goods, then it may be a way of actually improving the country’s outlook for the future. As mentioned in Chapter 1, for many decades, international authorities encouraged poor countries to borrow heavily for development projects, using exactly this reasoning. But if the funds borrowed largely go into investments that do not pay off financially, or if the borrowing only finances a high level of consumption, there is reason to worry. A country that borrows a lot may be in trouble when it comes time to pay back its loans. Many poor countries have, in recent years, in fact found themselves unable to pay the interest on—much less pay back—the enormous foreign debts that they have built up over the years.

10 Other ways of financing positive net exports include foreigners receiving our goods as gifts, paying for them out of transfer income, or selling us their assets (such as land or businesses) in return.
6.3 Net National Production and Saving

The investment concept used in defining *gross* domestic product (GDP) is *gross* investment. To calculate what the level of production is during a year, above and beyond the production that simply replaces worn out manufactured capital, we need another concept, net national product (NNP). NNP is GDP less depreciation (just as net investment, we saw earlier, is gross investment less depreciation):

\[
Net \text{ national product} = GDP - Depreciation
\]

**net national product (NNP):** a measure of national production above that needed to replace worn-out manufactured capital, found by subtracting depreciation from GDP

So far we have discussed gross saving, the gross amount a country sets aside from spending. But at the same time that we are saving, some capital goods are wearing out. To really find out what we have “put aside for the future,” we need to subtract off depreciation from our measures of saving as well. For example, if even though our savings were positive, they did not finance enough investment to make up for deterioration of the capital stock, we would actually start the next year in a *worse* position. **Net saving** is gross saving minus depreciation.

\[
Net \text{ saving} = (Gross) \text{ Saving} - Depreciation
\]

Using the equation (above) relating savings to investment and foreign borrowing, we can rewrite this as:

\[
Net \text{ saving} = (Gross) \text{ Investment} - Depreciation - Net \text{ foreign borrowing}
\]

Net saving is a better measure than gross saving of whether we are “putting aside for the future.”

The BEA creates a table on “Saving and Investment.” Important lines from this are reproduced in Table 5.8

**Table 5.8 Saving and Investment** (2002, Billions of Dollars)

<table>
<thead>
<tr>
<th>Gross Domestic Investment</th>
<th>1926</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less: Depreciation</td>
<td></td>
</tr>
<tr>
<td>(consumption of fixed capital)</td>
<td>1289</td>
</tr>
<tr>
<td>Less: Net Foreign Borrowing</td>
<td>465</td>
</tr>
<tr>
<td>Statistical discrepancy</td>
<td>79</td>
</tr>
<tr>
<td><strong>Total: Net Saving</strong></td>
<td>251</td>
</tr>
</tbody>
</table>

Source: BEA, NIPA, “Table 5.1 Savings and Investment” published 12/23/2003. To simplify, small items have been absorbed into “statistical discrepancy.”
As we can see in Table 5.8, in 2002, while gross domestic investment totaled nearly $2 trillion, more than half of this was countered by depreciation, and the U.S. also added nearly half-a-trillion dollars to its foreign indebtedness. Overall, then, what was “put aside for the future” in term of manufactured capital or finances was only about one-quarter of a trillion dollars, according to NIPA estimates.

Discussion Questions

1. Suppose the country of Atlantis is investing and exporting a great deal, while it imports little. What can you say about its level of national saving? Suppose the country of Olympus invests more than it saves. How can it do this?

2. For many years it was often said that the level of government debt was not much of a problem, no matter how high it was, since we “owe it to ourselves.” Taxpayers within the U.S. would, of course, eventually have to pay back the debt (or at least pay interest on it, as it gets refinanced time after time). But their payments would be going to owners of government bonds who were also primarily people within the U.S. Over the years, however, many U.S. government bonds have been purchased by foreigners. Does this complicate this picture? Explain.

7. Gross Domestic Product in the Traditional Macroeconomic Model

During the mid-to-late 20th century, it became popular to teach macroeconomic principles using an especially simple representation of the basic macroeconomic identities. The traditional macroeconomic model that will be explored at length in later chapters is based on a representation of national accounts that adds further simplifications to the conventions adopted by the BEA.

**traditional macroeconomic model:** a simple, mechanical model that portrays the macroeconomy as being made up of businesses that produce and invest, and households and governments that (only) consume.

As in the NIPA, three of the recognized sectors in the traditional model are the business, government, and foreign sectors. Instead of a “household and institutions” sector, however, the model posits only a “household” sector. While in actuality nearly 10% of measured Personal Consumption Expenditures comes from nonprofit institutions such as hospitals and universities, nonprofit institutions are ignored in the traditional model. Personal Consumption Expenditures—shortened to **consumption** and denoted by **C**—are treated as representing only household spending.

**consumption (C) (traditional macro model):** the component of GDP that represents spending by households.

The traditional model follows the NIPA in not accounting for investments in natural, human and social capital. **Investment (I)** is limited to spending on structures,
equipment, and inventories. While current BEA practice recognizes that governments undertake investments, investment in the model is assumed to be exclusively an activity of the business sector. **Government spending** \((G)\) on goods and services, in this model, is not generally considered to have an investment component.

### Investment \((I)\) (Traditional Macro Model):
The component of GDP that represents spending on structures, equipment and inventories by business firms.

### Government Spending \((G)\) (Traditional Macro Model):
The component of GDP that represents spending by federal, state and local governments (and which is assumed to be consumption-oriented).

The foreign sector and **net exports** \((NX)\) are treated similarly to the way they are in the national accounts. GDP is often represented by the notation \(Y\), and referred to interchangeably as aggregate “product,” “income,” or “spending.” The basic identity of the model is taken from the spending approach to GDP accounting:

\[
Y = C + I + G + NX
\]

That is, aggregate spending (or income or product) in the traditional macro model is defined as the sum of consumption spending by households, investment spending by business firms, government spending, and net exports. (Compare this to Table 5.3 above.)

### Net Exports \((NX)\): (Traditional Macro Model):
The component of GDP that represents the value of exports less the value of imports.

The basic identity of the traditional macro model is

\[
Y = C + I + G + NX
\]

What might be the most startling assumption of this model, however, is that not only is it assumed that governments and households do not invest, it is assumed that **governments and households do not produce**. Production is assumed to be accomplished only by the business sector. For example, most presentations of this model include a circular flow diagram for the production and spending similar to Figure 5.2.\(^\text{11}\) In this diagram, business firms are represented as producing the whole of GDP. The government and “consumers” (households) make use of this production, by buying most of the goods and services provided. Business investment spending also contributes to total spending. The effect of the rest of the world can be to either add to, or subtract from, the flow of spending, depending on whether net exports are positive or negative.

\(^{11}\) In some cases, the diagrams include financial flows such as taxes, transfers, and savings. These are omitted here for simplicity.
In the traditional macroeconomic model, only business firms are portrayed as producing. Governments and households appear only as actors who buy the firms’ products, and non-profit institutions and the environment do not appear at all.

While this much simplified model can be useful in some applications, users also need to be on guard for ways in which this very simple image of an economy, which leaves out important aspects of real economies, can create distortions in our way of thinking about economic life.

Discussion Questions

1. What is the basic identity of the traditional macro model? Why is the left-hand side of the equation referred to interchangeably as “product,” “income,” or “spending”? Which approach to counting GDP does the identity reflect?

2. Do you think the National Income and Product Accounts focus attention on the most important characteristics of an economy in the 21st century? What about the traditional macro model? Give examples of some important contemporary economic problems for which the national accounts and the traditional model might give useful frameworks for study and analysis, and some examples of some problems where they would not.
Review Questions

1. For what purpose was national accounting in the United States originally begun?
2. Who compiles the National Income and Product Accounts?
3. What are the four sectors of the economy, according to the BEA? What sorts of entities are included in each?
4. What forms of capital assets are tracked by the BEA?
5. Explain the difference between gross and net investment.
6. Explain four key phrases that appear in the definition of GDP.
7. What are the three approaches to GDP measurement?
8. Explain why, in a simple economy, the three approaches would yield the same figure for the value of total production.
9. Explain how the value-added approach results in the same figure for the value of a final good, as taking the price the good sells for in a market.
10. How are “market values” determined for goods and services that are not exchanged in markets, or when data is not available?
11. Describe the components of GDP according to the product approach.
12. Describe the components of GDP according to the spending approach.
13. What are the major differences between GDP and national income?
14. Describe the reasoning behind the “constant dollar” approach to calculating real GDP.
15. What are some problems with the “constant dollar” approach to calculating real GDP? What are some problems with the “chained dollar” approach?
16. Describe the reasoning behind the “constant weight” method used in estimating the Consumer Price Index.
17. Is there only one kind of price index? Explain.
18. Explain how savings, investment, and trade are related in the national accounts.
19. Explain how a country can finance an excess of imports over exports.
20. What additional simplifying assumptions does the traditional macro model impose, beyond those made in the NIPA?
Exercises

1. If you look at the government supplied statistical tables regarding the national accounts, you might find that they often go into considerable detail about “farm” vs. “non-farm” activities, while it is much harder to dig out good information on, for example, the activities of the finance industry. Can you conjecture how this might relate to the history of the national accounts?

2. In which line (or lines) of Table 5.2 (the product approach) would the value of each of the following be counted? “Not counted in any category” is also an option.
   a. production of fresh apples, domestically grown for profitable sale
   b. state health inspection services
   c. education services provided by a private, nonprofit domestic college
   d. childcare services provided by a child’s parents and relatives
   e. production by a U.S.-owned company at its factory in Singapore

3. In which line (or lines) of Table 5.4 (the income approach) would the value of each of the following be counted? If it is part of “net income flows from the rest of the world” explain whether it reflects domestic (or foreign) production, and whether it reflects domestic (or foreign) income. “Not counted in any category” is also an option.
   a. wages paid by your local supermarket to its employees
   b. profits received by a U.S. electronics firm from its factory in Mexico
   c. business spending to replace worn-out equipment
   d. wages paid by a U.S. electronics firm to the employees of its factory in Mexico
   e. profits received by a Japanese automaker from its factory in the United States

4. In which line (or lines) of Table 5.3 (the spending approach) would the value of each of the following be counted? “Not counted in any category” is also an option.
   a. a new refrigerator bought by a family
   b. a book newly produced in Indiana and bought by a store in Mexico
   c. new computers, manufactured in Asia, bought by a U.S. accounting company
   d. meals produced and served in Virginia to military personnel
   e. new computers, produced in the U.S., bought by a U.S. computer retail chain and not yet sold by the end of the year
   f. a 3-year old couch bought by a used furniture store in Arizona
   g. cleaning services bought by a nonprofit hospital in New York
   h. the services of volunteers in an environmental action campaign
5. Using the relations among accounting categories demonstrated in the tables and identities in the text, use the following information on values (measured in Neverlandian pesos) from the country of Neverland in 2010

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>household and institutions spending</td>
<td>650</td>
</tr>
<tr>
<td>household and institutions production</td>
<td>150</td>
</tr>
<tr>
<td>net income payments from the rest of the world</td>
<td>5</td>
</tr>
<tr>
<td>nonprofit institutions production</td>
<td>50</td>
</tr>
<tr>
<td>state and local government spending</td>
<td>30</td>
</tr>
<tr>
<td>change in private inventories</td>
<td>2</td>
</tr>
<tr>
<td>depreciation</td>
<td>60</td>
</tr>
<tr>
<td>business spending</td>
<td>50</td>
</tr>
<tr>
<td>exports</td>
<td>225</td>
</tr>
<tr>
<td>imports</td>
<td>125</td>
</tr>
<tr>
<td>government production</td>
<td>200</td>
</tr>
<tr>
<td>statistical discrepancy</td>
<td>0</td>
</tr>
<tr>
<td>GDP</td>
<td>850</td>
</tr>
</tbody>
</table>

To find values for the following categories:

a. private household production
b. business production
c. fixed investment spending (by business)
d. federal government spending
e. national income

6. Suppose an extremely simple economy produces only two goods, pillows and rugs. In the first year, 50 pillows are produced, and sold at $5 each; 11 rugs are produced, and sold at $50 each. In the second year, 56 pillows are produced, and sold for $5 each; 12 rugs are produced, and sold at $60 each.

a. What is nominal GDP in each of the two years?
b. What is the growth rate of nominal GDP?
c. What is real GDP in each year, expressed in terms of constant Year 1 dollars?
d. What is the growth rate of real GDP (in constant Year 1 dollars)?

7. Assume the same simple economy described in the previous question, and assume that both rugs and pillows are consumer goods.

a. What would be the Consumer Price Index for the second year, using the first year as the base?
b. What is the growth rate of prices (inflation rate) from the first to the second year?
8. Match each concept in Column A with a definition or example in Column B

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. a negative (subtracted) item in GDP</td>
<td>i. the year in which real and nominal values are equal</td>
</tr>
<tr>
<td>b. a major cause of difference between GDP and NI</td>
<td>ii. purchases of computer software</td>
</tr>
<tr>
<td>c. an imputed value</td>
<td>iii. consumption of fixed capital (depreciation)</td>
</tr>
<tr>
<td>d. an entity in the government sector</td>
<td>iv. unpaid household production</td>
</tr>
<tr>
<td>e. reflects the prices of all goods and services counted in GDP</td>
<td>v. implicit price deflator</td>
</tr>
<tr>
<td>f. reference year</td>
<td>vi. national income</td>
</tr>
<tr>
<td>g. an assumption of the traditional macro model</td>
<td>vii. spending on imported cheese</td>
</tr>
<tr>
<td>h. something not counted in by the BEA in calculating GDP</td>
<td>viii. a measure that seeks to remove the effects of price changes</td>
</tr>
<tr>
<td>i. real GDP</td>
<td>ix. Consumer Price Index</td>
</tr>
<tr>
<td>j. a component of the “income approach” to GDP accounting</td>
<td>x. what homeowners “pay” themselves in rent</td>
</tr>
<tr>
<td>k. a constant weight price index</td>
<td>xi. “governments do not produce”</td>
</tr>
<tr>
<td>l. part of business investment (gross private domestic investment)</td>
<td>xii. a state university</td>
</tr>
</tbody>
</table>

9. List the key simplifying assumptions of the traditional macro model concerning:
   a) the forms of capital included in the model
   b) the sectors of the economy
   c) who in the economy produces and invests

10. (If Appendix is assigned.) Using the data in Table 5.10, compute
    d. If the rate of growth of nominal GDP from 1998 to 1999 were to continue for many years, about how long would it take for nominal GDP to double?

11. (If Appendix is assigned.) The “chained Year 1 dollar” estimate of real GDP in the apples-and-oranges example (see Appendix) is smaller than the “constant Year 1 dollar” estimate of real GDP. Can you explain why? (Hint: Compare the GDP growth rates derived using the two methods.)
Appendix: Technical Issues in GDP Accounting

A1 Fisher Indexes and Chained Dollar Real GDP

Chained dollar measures of real GDP and GDP growth are based on the use of index numbers. The ratio of two values of GDP in adjacent years, measured at a common set of prices, can be used as an quantity index to measure production in one year relative to another.

The calculation of chained dollar real GDP starts with the calculation of a Fisher quantity index which measures production in one year relative to an adjacent year by using an average of the ratios that would be found by using first one year, and then the other, as the source of prices at which production is valued. The type of average used is a “geometric” average. Instead of adding two numbers and then dividing by two, as you would in calculating the most common type of average (the arithmetic mean), to get a geometric average you multiply the two numbers together and then take the square root. The formula for this Fisher quantity index is:

\[
Fisher\ Quantity\ Index\ (for\ year-to-year\ comparison) = \sqrt{\left(\frac{Year\ 2\ GDP\ in\ Year\ 1\ prices}{Year\ 1\ GDP\ in\ Year\ 1\ prices}\right) \times \left(\frac{Year\ 2\ GDP\ in\ Year\ 2\ prices}{Year\ 1\ GDP\ in\ Year\ 2\ prices}\right)}
\]

This index has a value of 1 in the reference year, which we take to be Year 1.

**Fisher quantity index:** an index which measures production in one year relative to an adjacent year by using an average of the ratios that would be found by using first one year, and then the other, as the source of prices at which production is valued

The growth rate of real GDP between the reference year and the next year can then be calculated as:

\[
growth\ rate = (Fisher\ quantity\ index - 1) \times 100
\]

For example, we have already made many of the necessary calculations for the “apples and oranges” economy in Tables 5.5 and 5.6. Plugging these in, we get

\[
Fisher\ quantity\ index\ (for\ Year\ 2\ compared\ to\ Year\ 1) = \sqrt{\left(\frac{250}{200}\right) \times \left(\frac{300}{250}\right)} = \sqrt{1.25 \times 1.20} = \sqrt{1.5} = 1.225
\]

The growth rate of real GDP for the “apples and oranges” economy between these two years is
growth rate \( = (1.225 – 1) \times 100 = 22.5\% \)

Notice that this growth rate is between the two growth rates (20% and 25%) we obtained by using the constant dollar method with various base years. The Fisher quantity index method gives us a unique average number for estimated growth.

A quantity index for the current year in terms of a reference year that may be several years in the past is created by “chaining together” year-to-year Fisher quantity indexes to make a chain-type quantity index comparing real production relative to the reference year. The chain-type quantity index has a value of 100 in the reference year. In any subsequent year, it is set equal to the chain-type quantity index from the previous year multiplied by the Fisher quantity index calculated for the current year.

chain-type quantity index: an index comparing real production in the current year to the reference year, calculated using a series of year-to-year Fisher quantity indexes.

Finally, estimation of real GDP in (chained) dollar terms is made by multiplying the chain-type quantity index for a year times the level of nominal GDP in the reference year, and dividing by 100.

For example, suppose we take our “apples and oranges” economy, making Year 1 the reference year. Year 1’s chain-type quantity index is thus set equal to 100, and its nominal and real GDP are equal. These are shown in Table 5.8. The chain-type quantity index for Year 2 is the previous year’s value (100) times the Fisher quantity index we just calculated (1.225). We multiply this result, the new index number 122.5, times nominal GDP in the base year ($200) and divide by 100 to get real GDP, $245. Whew!

Table 5.9 Deriving Real GDP in Chained (Year 1) Dollars

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal GDP</td>
<td>$200</td>
<td>$300</td>
</tr>
<tr>
<td>Fisher quantity index (current to previous year)</td>
<td>———</td>
<td>1.225</td>
</tr>
<tr>
<td>Chain-type quantity index</td>
<td>100</td>
<td>(100 \times 1.225 = 122.5)</td>
</tr>
<tr>
<td>Real GDP (chained Year 1 dollars)</td>
<td>$200</td>
<td>(\frac{(122.5 \times 200)}{100} = $245)</td>
</tr>
</tbody>
</table>

This can be continued for many years into the future—or into the past. (For example, if the Fisher quantity index calculated for Year 3 were to come out to be 1.152, then the chain-type quantity index for Year 3 would be 122.5 \(\times\) 1.152.)

(If you want to check to see that this actually makes some sense, calculate the percentage change in real GDP from Year 1 to Year 2 using the values in the table above. You will find it does, in fact, equal 22.5%!)
The implicit price deflator can be calculated for Year 2 (using Year 1 as the reference year) as \((300/245) \times 100 = 122.5\), showing a 22.5% price increase over Year 1.

A2 Making Comparisons Using the NIPA Tables

Table 5.10 shows actual data from the United States National Income and Product Accounts for some recent years. Nominal GDP rose from about $7.4 trillion in 1995 to nearly $10.5 trillion in 2002; real GDP rose from about $7.5 trillion to $9.4 trillion.

It is very easy to make comparisons between any year and the reference year. The chain-type quantity index and the implicit price deflator are both equal to 100 in the reference year (1996). The value for the chain-type quantity index for 2002 of 120.82 tells us that real GDP in 2002 was estimated to be 20.82% above its level in 1995, and the implicit price deflator of 110.66 tells us that prices were estimated to have grown by 10.66% over the same span of years. These are calculated as

\[
\text{percentage change} = \frac{\text{magnitude in a year} - \text{magnitude in the comparison year}}{\text{magnitude in the comparison year}} \times 100
\]

When the comparison year is the reference year, the “100s” just cancel out.

| Table 5.10 GDP and Price Measures for the U.S., 1995—2002 |
|----------------|---------|---------|---------|---------|---------|---------|---------|---------|
| GDP (billions of current dollars) | 7,400.5 | 7,813.2 | 8,318.4 | 8,318.4 | 8,781.5 | 9,824.6 | 10,082.2 | 10,446.2 |
| Real GDP (billions of chained 1996 dollars) | 7,543.8 | 7,813.2 | 8,159.5 | 8,508.9 | 8,859.0 | 9,191.4 | 9,214.5 | 9,439.9 |
| Chain-type quantity index | 96.55 | 100 | 104.43 | 108.91 | 113.39 | 117.64 | 117.94 | 120.82 |
| Implicit price deflator | 98.1 | 100 | 101.95 | 103.2 | 104.69 | 106.89 | 109.42 | 110.66 |

Source: BEA, NIPA Tables 1.1, 1.2, and 7.1

For other years, you’ll need to get out your calculator. For example, the growth in real GDP between 2001 and 2002 can be calculated using the chain-type quantity indexes as \([(120.82-117.94)/117.94] \times 100 = 2.44\%\). You would also get the same growth rate of real GDP (except for rounding errors) by comparing the real GDP numbers themselves. You can apply the percentage change formula to the implicit price deflator to derive the growth rate of prices.

Notice that seemingly small changes from year to year—real GDP grew at an annual rate of 4.4% or less in each year during in the period 1995-2002—aggregate up to substantial changes over time. Real GDP expanded by about 21% over these seven years.