2
Macroeconomic Data

Tools: GDP; accounting identities; price and quantity indexes.

Key Words: GDP; value added; real; nominal; index; deflator.

Big Ideas:

- GDP is three things at once: production (value added by production units), income (payments to labor and capital), and expenditure (consumption, investment, government spending, net exports).
- Current price variables (such as nominal GDP) can be decomposed into measures of price and quantity. There are several ways to do this, but none of them are perfect.

Gross Domestic Product (GDP) is our primary measure of macroeconomic performance: the total value of output produced in a particular economy over some period of time (typically a year or a quarter). Countries with high GDP per person are said to be rich, and those in which GDP has gone down are said to be in recessions. But what is GDP and how is it measured? We review its definition and construction below. Along the way, we also note connections among output, income, and expenditures, and explain how we separate changes in quantities from changes in prices.

The system that produces GDP and related numbers is known as the National Income and Product Accounts (NIPA). The national accounts are analogous to financial statements: They give us a picture of an economy, just as financial statements give us pictures of firms. Similar methods are used in most countries, so the numbers are (in principle) comparable.

2.1 Measuring GDP

GDP is the total value of goods and services produced in a given region, typically a country. In the US, for example, GDP was 15,533.8 billion US dollars in 2011: 15.5 trillion dollars. With a population of 312 million (average for the year), that amounts to nearly $50,000 per person. But where does this number come from? What does it mean?

The standard approach to measuring GDP is to add up the value produced by every firm or production unit in the economy. The question is how we separate value produced by one firm from value produced by another in an economy in which the value chain typically involves many firms. Walmart, for example, has enormous sales, but most of the value is already built into products by suppliers. As a concrete example, consider a fictional firm that assembles PCs from parts made elsewhere. Its only other expense is labor. Let's say that the firm's income statement looks like Table 2.1.

The question is how we measure this firm's contribution to output. The straightforward answer is 40m, the total value of its sales. But if we think about this a minute, we realize that 6m of this was produced somewhere else, so it shouldn't be counted as part of the firm's output. A better answer is 34m, the value the firm has added to the parts. That, in fact, is the accepted answer: We base GDP on *value added* , not on sales. To get GDP for the whole economy, we sum the value added of every production unit.

Another way to compute value added is to sum payments to labor and capital. In this case, we add 20m paid to workers (labor) to 14m net income paid to owners of the firm (capital). That gives us total payments of 34m, the same number we found above using a different method. Since this approach is based on the income received by labor and capital, we see that the value of production and income are the same. More on this in the next section.

Usually, when we compare the GDPs of two countries, we presume that the country with the larger GDP produces more in some useful sense. But

Table 2.1: PC assembler's simple income statement.

Sales revenue	40,000,000
Expenses	26,000,000
Wages	20,000,000
Cost of goods sold (parts)	6,000,000
Net Income	14,000,000

suppose that they produce different goods: Country A produces 10 billion apples and country B produces 10 billion bananas. Which produces more? We generally assume that if apples are worth more than bananas, then country A produces more. The idea is that market prices tell us which goods are more valuable, apples or bananas. The same idea underlies our measurement of value added.

To make this concrete, suppose the 40m sales of our fictitious company consists of 20,000 PCs at $2,000 each. Our presumption is that the market price of $2,000 reflects economic value, and we use it as part of our calculation of GDP. In some cases, this isn't so obvious. In, say, North Korea, prices do not generally reflect market forces, so it's not clear how we would calculate economic value. There are also some subtle issues in market economies about how to value non-market activities, such as washing your own clothes, and "bads," such as pollution. Typically, neither is valued in the national accounts. We don't claim this is right, but it's what we do.

Example (salmon value chain). A fisherman catches a salmon and sells it to a smokehouse for $5. After smoking it, the smokehouse sells it to Fairway for $10, which, in turn, sells it to a restaurant for $15. The same restaurant buys lettuce from a farmer at Union Square for $3. The restaurant puts the lettuce and salmon together on a plate and sells it to an NYU student for $25. How much does each production unit contribute to GDP? What is the overall contribution to GDP?

Answer. The contributions (value added) are $5 each for the fisherman, smokehouse, and Fairway, $3 for the farmer, and $7 for the restaurant, for a total of $25.

Note that we could have computed GDP by counting only the value of the final good in the value chain. This is true in general: GDP can be computed as the total value of final goods produced in the economy. Intermediate products (salmon, lettuce, PC parts) must then be ignored, as their value shows up at the end of the value chain.

We'll finish this section with two subtle issues. One is the treatment of government services. We generally treat government as a producer of value added and measure its output at cost. If we pay the mayor $100,000, that's counted as $100,000 of value added whether she does a good job or not. The other is that capital expenditures are not treated as intermediate inputs. Basically, we ignore them when we compute the value added of a firm. Why? Because the expense is balanced by an equal addition to the firm's value. With firms, financial statements do something similar: We spread the expense out over time in the form of depreciation. Here, we measure

Table 2.2: PC assembler's complicated income statement.

Sales revenue	40,000,000
Expenses	32,000,000
Wages	20,000,000
Cost of goods sold	6,000,000
Interest	2,000,000
Depreciation	4,000,000
Net income	8,000,000

output gross of depreciation, so we ignore capital expenditures altogether as expense. It sounds a little strange, but that's what the national income and product accounts do.

2.2 Identities

Since every transaction has both a buyer and a seller, we can often approach any measurement problem from (at least) two directions. This gives rise to *identities*: relations that hold as a matter of accounting truth. They do not depend on any particular economic theory and, for that reason, are extremely useful.

Income (Gross Domestic Product = Gross Domestic Income). We've seen the first identity already: output and income are equal. Let's go back to our PC assembler to see this in action, adding a few things to make the example more realistic. In Table 2.2 we add two new expenses, interest and depreciation. These categories are counted as capital income. In the previous section, we computed (its contribution to) GDP as value added of 34m. Here, we compute GDI (I for Income) from payments to labor (20m) and capital (14m). Capital payments include the net income paid to owners of the firm, interest income paid to the debt holders, and depreciation. Adding labor income and capital income, we arrive at GDI of 34m. The answer, of course, is the same.

Since we include depreciation in our measures of output and income, we refer to them as *gross* — gross of depreciation. In principle, we could compute Net Domestic Product by subtracting depreciation, but most people stick with GDP because economic depreciation (as opposed to what shows up on financial statements and tax returns) is difficult to measure.

The national income and product accounts do this at the aggregate level: namely, measure output by adding up payments to inputs. By construction, then, output and income are the same. To give you a sense of real

numbers look like, we report the income for the US economy in Table 2.3. The statistical discrepancy is a reminder that the measurement system isn't perfect.

Table 2.3: Income components of US GDP.

Compensation of employees	9,258.4
Proprietor's income	1,346.7
Corporate profits	1,654.7
Rental income	610.8
Net interest income	678.0
Taxes and miscellaneous	1,264.8
Depreciation	2,746.7
Gross domestic product	17,560.1
Statistical discrepancy	-212.0

The numbers are for 2014, billions of US dollars, from the BEA's NIPA Table 1.10.

Expenditures (Gross Domestic Product = Gross Domestic Expenditure). Our second identity comes from the perspective of expenditures on final goods—the last stage in the value chain. We distinguish both who buys them (consumers, firms, governments, or foreigners) and whether they are consumption or investment. The most common decomposition of this sort is: GDP equals consumer expenditures C by households plus business and residential investment I plus government purchases of goods and services G plus net exports NX; in more compact notation,

$$Y \quad = \quad C + I + G + NX. \tag{2.1}$$

We refer to this as the *expenditure identity*. On the left, Y is the letter we use for GDP. (It's not clear where the letter Y comes from, but we follow a long tradition in using it this way.) On the right are the expenditure components of GDP. The point is that the two are equal: Everything that's produced is sold — to someone. (And if it's not sold, we call it an addition to inventories and include it in I. The idea is that firms produce the output and sell it to themselves.)

We refer to C as (personal or household) consumption. Investment (I) is primarily accumulation of physical capital by firms: purchases of new buildings and machines, plant and equipment in the language of national income accountants (two-thirds of the famous PPE and capex of financial accounting). It also includes new housing construction. In some sources, the sum of construction outlays and spending on equipment and software is referred to as "gross fixed capital formation." Investment also includes,

as noted, additions to the stock of inventories, a category that is small, on average, but highly variable.

Government purchases G consist of spending on goods and services (mainly wages) for both consumption and investment purposes. They do not include government outlays for social security, unemployment insurance, or medical care. We think of them, instead, as transfers since no goods or services are involved. It also omits interest payments on government debt, which we track separately. Net exports (NX) are exports minus imports: the trade balance, in other words.

Some recent numbers for the US are reported in Table 2.4.

Table 2.4: Expenditure components of US GDP.

		$ billions	Percent of GDP
Consumption	11,865.9		68.4%
Durable goods		1,280.2	
Nondurable goods		2,668.2	
Services		7,917.5	
Gross private investment	2,860.0		16.5%
Nonresidential		2,233.7	
Residential		549.2	
Change in inventories		77.1	
Government consumption	3,152.1		18.2%
Net exports of goods and services	−530.0		−3.1%
Exports		2,341.9	
Imports		2,871.9	
Gross domestic product	17,348.1		100.0%

The numbers are for 2014, from the BEA's NIPA Table 1.1.5.

Example (salmon value chain, continued). Suppose, in our example, that the salmon is imported from Norway. Then you'd think — and you'd be right — that it shouldn't count as US GDP. How does that work?

On the income side of the accounts, the contributions to GDP are the same as before: the contributions are $5 each for the fisherman, smokehouse, and Fairway, $3 for the farmer, and $7 for the restaurant, for a total of $25. But when the salmon is imported, $5 is attributed to Norway's GDP and only $20 to US GDP.

What if we looked at this from the perspective of expenditures on final goods? The final sale ($25) is the same as before, but the imported salmon

is now subtracted to give us a contribution to GDP of $20. Why subtracted? You'll recall that we needed to subtract imports from GDP, because purchases of imported goods do not reflect local production. That's what net exports does in the expenditure identity: it's a correction for the difference between production and expenditures.

Flows of funds. The expenditure identity follows the goods, but you can also follow the "money" (the financial funds) that goes along with the goods. For households, you might think about how income compares to consumption. If it's higher, we call what's left saving, which is a source of funds that can be used by others. We might also think about how firms finance investment in new plant and equipment. They might, for example, raise funds in capital markets from households.

Let's be specific. We'll look at two similar relations, both based on the expenditure identity. One is

$$S \;=\; Y - C - G \;=\; I + NX, \tag{2.2}$$

where S is (gross domestic) saving. This is a consolidated measure of saving in which we subtract both household and government expenditures from income. It's also a gross measure since income (GDP) includes depreciation. Investment is also gross, so the two sides of the relation balance. The other relation separates household and government activities:

$$S_p + S_g \;\equiv\; (Y - T - C) + (T - G) \;=\; I + NX,$$

where T is taxes collected by the government net of transfer payments and interest, $S_p = Y - T - C$ is (gross) private saving; and $S_g = T - G$ is government "saving" (the negative of the government deficit). Clearly, S_p and S_g are two components of national saving S. Most countries report a further breakdown of saving by households, governments, and firms, but this will be enough for us.

We refer to both versions as *flow of funds identities*. What do they tell us? Roughly speaking, the left side is a source of funds and the right a use of funds, and sources and uses balance. In the first version, saving is a source of funds that can be used to purchase corporate securities (which finance firms' new investment in plant and equipment) or foreign securities (which finance a trade deficit by the rest of the world if NX is positive). If net exports are negative, it's the reverse, of course: We sell securities to the rest of the world, which is then a source of funds. In the second version, household saving can also be used to purchase government securities (if government saving is negative).

Example (PC assembler, continued). Suppose that 10m of the 40m in sales are sold abroad. If this is the only firm in the economy, what are Y, NX, C, and S? Assume that investment and the government deficit are zero.

Answer. GDP remains 34m: production hasn't changed. Net exports equal exports (10m) minus imports (6m) or 4m. With no investment or government deficit, the 30m of local sales must be consumption. Saving is, therefore, 4m = 34m – 30m (income minus consumption). The flow-of-funds identity then tells us that saving of 4m is used to purchase 4m in foreign securities. Stated differently, the rest of the world (everyone but us) must have a trade deficit of 4m, which they finance by borrowing from us (the saving we mentioned).

2.3 Distinguishing prices from quantities

You'll see various versions of the terms *real* and *nominal* GDP. Nominal GDP measures output in dollars (or local currency units), and real GDP measures the quantity of output once overall changes in prices have been (somehow) taken out.

A *price index* or *deflator* is a measure of the overall level of prices — what we call the *price level*. If the price level rises over time, we say that the economy experiences inflation; if the price level decreases, the economy experiences deflation.

The question for this section is how we separate changes in quantities (real GDP growth) from changes in prices (inflation). The former is good (we have more stuff), but the latter is bad (prices are going up), so it makes some difference to us which we have. Like sales, GDP and related objects are values: products of price and quantity. You might well ask: How much of a change in value is a change in quantity, and how much a change in price? With one product, the answer is easy. With more than one, you need to average the prices or quantities somehow, and (sad to say) there's no obvious best way to do this. There are, instead, many ways to do it, and they give us different answers. We'll charge ahead anyway, but it's something to keep in mind.

One difficulty in separating prices and quantities is that prices of specific products change in different ways, and it's not clear how to average them to get a measure of "overall" prices. Two sensible approaches, known as fixed-basket and fixed-weight, respectively, give different answers. In practice, this isn't a huge problem (the answers usually aren't much different), but

it adds another element of fuzziness to macroeconomic data. The issue is that the economy has many goods and services whose prices and quantities change by different amounts over time. If all prices rose by ten percent between last year and this year, we would say that inflation is ten percent and divide this year's nominal output by 1.10 to get real output. But when prices of different products change by different amounts, things aren't that easy.

The consumer price index (CPI) is based on a fixed-basket approach which measures the change in the price level as the change in the total cost of a given basket of products (two quarts of milk, one hamburger, five newspapers, etc). The difficulty here is that people change what they consume over time, partly in response to price changes and partly because tastes and products change. Should we use last year's typical basket or this year's? The GDP deflator is based on a fixed-weight approach, and is constructed in two steps. We first compute a measure of real GDP by evaluating (typically different) expenditure quantities at constant prices. The price deflator is then the ratio of nominal to real GDP. The difficulty is, again, that prices change over time. So, should we use last year's prices or this year's?

Fixed-basket approach. The CPI indicates the change in the total cost of a basket of goods and services that is representative of a typical household's spending habits at a given date. Such a basket might include, say, five gallons of gasoline, one haircut, two pounds of chicken, three bottles of soda, and so on. Government statistical agencies do this by sending people to stores to check the prices of all the products in the basket. The CPI is the cost of the whole basket, normalized to equal 100 at some date. It's the same idea, really, as the Dow Jones Industrial Average or the S&P 500. Producer price indexes apply a similar methodology to goods purchased by firms. An example shows how the fixed-basket approach works.

Example (fish and chips). Consider an economy with two goods, fish and chips. At date 1, we produce 10 fish and 10 chips. Fish sell for 25 cents and chips for 50 cents. At date 2, the prices of fish and chips have risen to 50 cents and 75 cents, respectively. The quantities have changed to 8 and 12. We summarize the data in Table 2.5.

Table 2.5: Price and quantity data.

	Chips		Fish	
Date	Price	Quantity	Price	Quantity
1	0.5	10	0.25	10
2	0.75	12	0.50	8

Note that the two prices have not gone up by the same amount: the price of fish has doubled, while chip prices have gone up by only 50 percent. Another way to say the same thing is that the relative price of chips to fish has fallen from 2 (= .50/.25) to 1.5 (= .75/.50). What is the inflation rate?

Table 2.6: consumer price index computation.

Date	CPI
1	$7.50 = .50 \times 10 + .25 \times 10$
2	$12.50 = .75 \times 10 + .50 \times 10$

Answer. We construct the CPI using date 1 quantities. The index is shown in Table 2.6.

The inflation rate by this measure is $\pi = 12.50/7.50 - 1 = 0.667 = 66.7\%$). Since nominal GDP growth is 73.3 percent, real GDP growth is 4 percent:

$$g_Y \quad = \quad \frac{1 + g_{PY}}{1 + \pi} - 1 \quad = \quad \frac{1 + 0.733}{1 + 0.666} - 1 \quad = \quad 0.04.$$

By convention, the CPI in the base year (year 1 in this case) is normalized to 100. Normalizing is straightforward: Just divide all the values of the CPI by its value in the base year and multiply by 100. In our example, the index is 100 in year 1 and 166.7 in year 2.

Fixed-weight approach. Price deflators are typically computed from the ratio of GDP (or one of its other expenditure components) at current- and base-year prices (these are called nominal and real GDP.) Over several periods, this fixed-weight approach applies a constant set of prices to changing quantities. As before, this is easiest to see in an example.

Example (fish and chips, continued). We compute GDP at current prices and date 1 prices in Table 2.7. The GDP deflator (the ratio of nominal to real GDP) is 1.0 in year 1. This is trivial, as nominal and real GDP must coincide in the base year. In year 2, the deflator is 1.625 = 13/8, implying an inflation rate of 62.5 percent. Note the difference from the inflation rate computed with the CPI. In short, different approaches lead to

Table 2.7: Nominal and real GDP computation.

Date	Nominal GDP (current prices)	Real GDP (date 1 prices)
1	\$7.50 ($= .50 \times 10 + .25 \times 10$)	\$7.50 ($= .50 \times 10 + .25 \times 10$)
2	\$13.00 ($= .75 \times 12 + .50 \times 8$)	\$8.00 ($= .50 \times 12 + .25 \times 8$)

different measures of inflation. The conceptual difficulty with both methods is that it's not clear how to measure the price level when relative prices are changing. What can we do? We content ourselves with the knowledge that the differences are typically small and remind ourselves that macroeconomic measurement (like financial accounting) is as much art as science.

2.4 Fine points

Some other issues you may run across:

Causality. You might be tempted to interpret identities as saying that one side of an identity causes the other. Don't be. For example, you might hear someone say that low consumption is causing low output ("We need consumers to spend more."). However, the identity says only that if output goes down, then so must one or more of its components. No causality is implied. We could as easily say that consumption falls because output did. The point is not that there is no causal connection, but that no such connection is built into the identity.

Underground economy. Standard GDP figures do not include the value of goods and services produced by the so-called "underground" economy. This term generally refers to businesses that are not licensed to operate, such as sellers of counterfeit CDs in the streets of Bangkok, and businesses evading either income or social security taxes, such as Southern Spain's farms employing illegal immigrants as day laborers. Such activity is generally not reported and, therefore, does not show up in official statistics. In advanced economies such as the US and Japan, the size of the underground economy is thought to be small. But in developing countries, such as Peru and Lebanon, it has been estimated to be as large as 50 percent of official estimates of GDP.

Capital gains. We've seen that GDP reflects income, but there are kinds of income that are not included in GDP. The prime example is capital gains. They are part of your income, but do not show up in GDP because they do not reflect (at least not directly) the production and sale of current output. And since they're not in GDP, they're not in saving either. One curious result is that net worth can rise even when saving is zero. In the US, capital gains are a larger fraction of changes in net worth than saving. For similar reasons, GDP does not include interest on government debt. Why? Because it isn't a payment made for producing goods and services.

GDP v. GNP. While GDP measures output produced within the borders of a given country, Gross National Product (GNP) measures output produced by inputs owned by the citizens of that country. For example,

to compute Bangladesh's GNP, we need to add to GDP the income paid to Bangladeshi capital invested abroad and subtract income paid to capital installed in Bangladesh but owned by citizens of other countries. Similarly, with labor, we need to add the wages earned abroad by Bangladeshi people and subtract the wages earned in Bangladesh by foreign nationals. Thus, GNP is a measure of the income received by "locally-owned" labor and capital. In most countries, the differences between GDP and GNP are small. One exception is Ireland, where a large amount of foreign capital makes GNP significantly smaller than GDP (by about 20 percent last time we looked).

Net exports vs. current account. You may hear people refer to the US "current account" deficit. What are they talking about? The current account (we'll label this *CA* later in the course) is net exports (the trade balance) plus net receipts of foreign capital and labor income plus miscellaneous transfers from abroad. In the US, there's usually little difference, but Ireland is a different story. We'll generally use the terms current account, net exports, and trade balance as synonyms. Current account sounds a little cooler; you can use it to make people think you're an expert.

Chain weighting. The US — and many other countries, too — now uses a method that's somewhere between fixed-weight and fixed-basket methods: chain-weighting. It mitigates some of the problems of applying the same prices over long periods of time (when relative prices often change dramatically), but doesn't eliminate them. If we told you exactly what it is, your eyes would glaze over. But trust us, it's an improvement.

Prices and quality change. Many people feel that price indexes do not adequately account for increases in product quality. As a result, price increases are (slightly) overstated, and quantity increases are understated. Separating prices from quantities is particularly difficult with services because the quantity produced is inherently difficult to measure. (It sounds like the start of a joke: How can you tell when a lawyer is more productive?) Our best guess is that this adds less than 1 percent to the inflation rate: that is, inflation is probably 0.5 percent to 1 percent lower than reported. Not a lot, but it adds up over time.

Expenditure deflating. In most countries, real GDP is computed by applying price deflators to final goods, typically using the expenditure components. This isn't real GDP; it's real GDE (gross national *expenditure*). The two are often similar, but need not be if production is largely exported. As an extreme example, Saudi Arabia produces oil for export. If we adjust GDP for changes in prices of Saudi purchases (food, shelter, imported cars, and electronic equipment), then an increase in the price of oil can lead to an increase in real GDP, even if the quantity of oil produced hasn't changed.

An alternative is to adjust production quantities directly for price changes, which some countries do.

PPP-adjusted data. When we compare output across countries, people have noticed that if (say) the euro increases in value relative to the dollar, then it appears that Europeans have become richer than Americans. We say "appears" because we haven't taken into account that dollar prices of non-tradable goods, such as, haircuts and car-washes, are typically higher in Europe when the euro is strong. In other words, this is a change in prices, not quantities. A similar issue arises when comparing GDPs of a rich country such as Germany, and a developing country, such as Botswana. If we use local prices and simply convert them to dollars or euros at the spot exchange rate, Botswana will look poorer than it actually is because local prices of many basic goods are much lower in Botswana. The state-of-the-art way to address this issue is to apply the same prices to output in both locations to produce real GDP based on "purchasing power parity" (PPP). The logic is the same as with the GDP deflator, but the comparison is across countries rather than across time.

Seasonal adjustment. Quarterly or monthly data often exhibit systematic variations by season. Quarterly GDP, for example, typically has a sharp increase in the fourth quarter (holidays). Most macroeconomic data have been smoothed to eliminate this seasonal variation. The same thing happens with business data: Analysts often report changes relative to the same period the year before, which will help eliminate any seasonal effect.

Revisions. NIPA data are revised frequently and significantly. The "advance estimate" of real GDP is released in the first month following each quarter (month t, say). The fourth quarter estimate, for example, is released in late January. This estimate is revised in each of the next two months (months $t+1$ and $t+2$) as additional data becomes available. Subsequent revisions occur annually, as more new data (such as tax revenues) appears and as seasonal factors are updated. In addition, roughly every five years, a benchmark revision updates the base year for calculating real GDP. The current base year of 2009 was established in the July 2013 benchmark revision. Benchmark revisions also typically include technical improvements in the measurement of past economic activity. For example, the 2013 benchmark altered NIPA history all the way back to 1929. The idea was to capture more accurately the impact of R&D on investment, in addition to other less significant modifications.

NIPA revisions matter greatly to business decision makers and government policymakers who are making decisions in real time. It's an unfortunate fact of life that they're working with imperfect information. The standard deviation of revisions between each of the initial real GDP releases (in months

t, $t+1$, and $t+2$) and the most recent estimate was 1.6% for the 1983-2009 period. This represents a sizable uncertainty about the current state of the economy. It means that economic forecasters must first "backcast" GDP revisions.

By way of example, consider economic activity in the third quarter of 1990 as contemporary observers viewed it. The initial report of third-quarter 1990 real GDP showed quarter-to-quarter annualized growth of 1.8%. Two years later, the revised reading showed a decline of 1.6%. With the benefit of hindsight, the National Bureau of Economic Research Business Cycle Dating Committee estimates that a mild recession began in July 1990, but NIPA data released in 1990 and 1991 did not show it. Moreover, the Federal Reserve did not respond by easing monetary policy until the fourth quarter of 1990. As of August 2015, the latest estimate for the third quarter of 1990 was a change of 0.1%.

Executive summary

1. GDP measures the total value of production measured at market prices, the sum of value-added by every production unit in the economy.
2. Identities.
   - Output (GDP) = Income (payments to labor and capital, gross of depreciation).
   - Output (GDP) = Expenditures (purchases of goods): $Y = C + I + G + NX$
   - Flow of funds (How is investment financed?): $S = I + NX$
3. We use magic to separate changes in quantities from changes in prices:
   - Quantity indexes, such as real GDP, measure the overall movement of quantities.
   - Price indexes measure the overall movement of prices.

Review questions

1. Value added. Company A sells four tires to Company X for $400. Company B sells a CD player to Company X for $300. Company X installs both in a car, which it sells for $5000. What is the total contribution to GDP of these transactions?

   Answer. The contribution to GDP is $5000: $400 from A, $300 from B, and the rest from X.

2. Expenditures. Place each transaction into the appropriate expenditure component of US GDP:
   (a) Boeing sells an airplane to the Air Force.
   (b) Boeing sells an airplane to American Airlines.
   (c) Boeing sells an airplane to Virgin Atlantic airline.
   (d) Boeing sells an airplane to Halle Berry.
   (e) Boeing builds an airplane but fails to sell it.
   (f) Airbus sells a plane to Delta Air Lines.

   Answer.
   (a) G: It's a government purchase, as the Air Force is part of the Federal Government.
   (b) I: It's investment, as American Airlines will use the aircraft as capital good.
   (c) NX: It's export, since Virgin Atlantic is incorporated in the United Kingdom.
   (d) C: It's consumption (durable consumption), because Halle Berry will use the plane for her personal travel.
   (e) I: It's investment, because the plane will increase Boeing's inventory of unsold products.
   (f) I and $-$NX: It's an investment and an import, so the net is zero.

3. Prices and quantities. The following data describe the NYU economy:

	Prices			Quantities		
Year	PCs	Pizza	Beer	PCs	Pizza	Beer
2000	100	10	5	25	100	250
2005	50	20	15	50	125	200
2010	25	30	30	100	150	150

   (a) Compute real and nominal GDP and the GDP deflator using 2000 as the base year.
   (b) Compute the CPI using 2000 quantities as your basket.

   Answer. The numbers are

Year	Nominal GDP	Real GDP	Deflator	CPI	Base = 100
2000	4750	4750	100.00	4750	100.00
2005	8000	7250	110.34	7000	147.37
2010	11500	12250	93.88	11125	234.21

The point is that different methods give different answers. This is most striking if we compare the fourth and last columns. The last one is the CPI, indexed so that it's value is 100 in 2000. Note that the deflator has prices going down in 2010, and the CPI has prices rising—a lot! The reason is that the CPI has a fixed basket and doesn't account for the substitution effect: our tendency to buy more PCs as their price falls.

4. Investment and depreciation. This problem was suggested by Frederic Bouchacourt, MBA 09. The issue is how we deal with investment and depreciation; we need to make sure that they show up in output, expenditures, and income in the same way so that we get the same GDP number all three ways. Imagine an economy with three companies, named D, E, and F, which operate over years 1 and 2 as follows:
   - D produces apples and sells them to F for \$10 in years 1 and 2. This \$10 is paid to workers.
   - E builds a machine to can apples and sells it for \$10 to F in year 1 and does nothing in year 2. It pays its workers \$10 in year 1, nothing in year 2.
   - F buys apples from D for \$10 in years 1 and 2 and buys a machine to can apples from E for \$10 in year 1. F pays its workers \$10 each year. With the help of this machine, F produces canned apples in years 1 and 2 that are sold to final consumers for \$30 in each year. The machine is amortized equally over the two years: \$5 per year.

   In this economy:

   (a) What is GDP in years 1 and 2?

   (b) What are consumption and investment?

   (c) What are capital and labor income?

   (d) What is net domestic product in each year (GDP minus depreciation)?

   Answer.

   (a,b) We can find GDP two ways: as value added (summed across producers) or as expenditures (summed across categories). If we compute value added for each firm and sum, we have

	Year 1	Year 2
Firm D	10	10
Firm E	10	0
Firm F	20	20
GDP	40	30

Note that investment does not count as part of the cost of materials: That's the way the national accounts work. It's similar to financial accounting in that we don't consider new plant and equipment ("capex") an expense, although we may include depreciation of existing capital. The latter doesn't show up here because we measure output gross of depreciation.

If we look at the expenditure identity, we have consumption C of \$30 each year (canned apples) and investment I of \$10 in the first year only. Expenditures add to \$40 the first year, \$30 the second, so we get the same answer.

(c) Value added is payments to capital and labor. Since we know value added and payments to labor, payments to capital are the difference. Payments to labor are \$30 in year 1, \$20 in year 2. In year 1, capital receives $(10 - 10) + (10 - 10) + (20 - 10) = \$10$, of which \$5 is depreciation. In year 2, capital receives $(10-10)+0+(20-10) = \$10$, of which \$5 is depreciation.

(d) Net domestic product is GDP minus depreciation. Since depreciation is 5 each year, NDP is \$35 (=40–5) the first year, \$25 (=30–5) the second. Effectively, we've subtracted off the cost of the investment, but unlike other material costs, we do it over time rather than all at once. That's the logic of amortization: to spread the cost over time, since the benefits are presumably spread the same way. You can also calculate net domestic income just as we did gross domestic income, except that you subtract depreciation from capital income each period. That way, net domestic product equals net domestic income.

5. Real-world data. Find the appropriate data for US income and expenditures from the Bureau of Economic Analysis (BEA) online interactive tables, particularly Tables 1.10 and 1.1.5.

   (a) What are the expenditure components of GDP? How does the official version differ from ours? What is the share of consumption in Gross Domestic Product?

   (b) What are the components of Gross Domestic Income? How does the official version differ from ours? What is the share of labor compensation in Gross Domestic Income?

   (c) Are Gross Domestic Product and Gross Domestic Income the same? Why or why not?

If you're looking for more

Most macroeconomics textbooks cover similar material. If you're interested in how measurement issues affect international comparisons, here are some

particularly interesting papers on the subject:

- Ben Bernanke, "Economic measurement," relates GDP to measures of "economic well-being" and "happiness."
- Rob Feenstra, Hong Ma, Peter Neary, and Prasada Rao, "Who shrunk China?" describe the impact of various measurement issues on estimates of China's GDP.
- Chad Jones and Pete Klenow, "Beyond GDP," look at the relation between GDP per person and various other measures of individual welfare.

Symbols and data used in this chapter

Table 2.8: Symbol table.

Symbol	Definition
Y	Gross domestic product (= Expenditure = Income)
C	Private consumption
I	Private investment (incl. residential and business investment)
G	Government purchases of goods and services (not transfers)
X	Exports
M	Imports
NX	Net exports ($= X - M$)
S	Gross domestic saving ($= Y - C - G = I + NX$)
S_p	Private saving ($= Y - T - C$)
S_g	Government saving ($= T - G$)
T	Taxes collected net of transfer payments and interest
$\pi = g_P$	Discretely-compounded growth rate of price index (inflation)
g_Y	Discretely-compounded growth rate of real GDP
g_{PY}	Discretely-compounded growth rate of nominal GDP

Table 2.9: Data table.

Variable	Source
Nominal GDP	GDP
Compensation of employees	GDICOMP
Proprietor's income	PROPINC
Corporate profits after tax	W273RC1Q027BEA
Taxes on corporate profits	A054RC1Q027SBEA
Gross domestic income	GDI
Rental income	RENTIN
Depreciation	COFC
Consumption	PCE
Durable goods	PCDG
Nondurable goods	PCND
Services	PCESV
Gross private domestic investment	GPDI
Nonresidential investment	PNFI
Residential investment	PRFI
Change in inventories	CBI
Government consumption	GCE
Net exports of goods and services	NETEXP
Exports	EXPGS
Imports	IMPGS
Gross private savings	GPSAVE
Gross government savings	GGSAVE
GDP deflator	GDPDEF
Consumer price index	CPIAUCSL
Nominal GNP	GNP
Current account	BOPBCA

To retrieve the data online, add the identifier from the source column to http://research.stlouisfed.org/fred2/series/. For example, to retrieve nominal GDP, point your browser to http://research.stlouisfed.org/fred2/series/GDP

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