CHAPTER 2

The Data of Macroeconomics

Modified for ECON 2204
by Bob Murphy

Macroeconomics
N. Gregory Mankiw

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IN THIS CHAPTER, YOU WILL LEARN:

... the meaning and measurement of the most important macroeconomic statistics:

- gross domestic product (GDP)
- the consumer price index (CPI)
- the unemployment rate
Gross Domestic Product: Expenditure and Income

Two definitions:

- Total expenditure on domestically produced final goods and services.
- Total income earned by domestically located factors of production.

Expenditure equals income because every dollar a buyer spends becomes income to the seller.
The Circular Flow

Income ($)

Labor

Goods

Expenditure ($)

Households

Firms
Gross Domestic Product: Expenditure and Income

- One caveat:
- Measurement of income and expenditure is imperfect.
- Difference in GDP and Gross Domestic Income (GDI) is called the “Statistical Discrepancy.”

See Supplement 2-1
Gross Domestic Product: Expenditure and Income

Percentage Change in Output = 3.0 – 2 × \text{Change in Unemployment Rate}

= 3.0 – 2 × (–0.5)
= 4.0 percent, just above the 3.8 percent growth rate of GDP. But, if we adjust Okun’s law for a (conservative) 0.5 percentage point step-up in long-run productivity growth during the mid- to late 1990s (productivity growth is discussed in Chapter 9), then we obtain:

\[
\text{Percentage Change in Output} = 3.5 – 2 \times (–0.5) = 4.5 percent,
\]
and Okun’s law would exactly match GDI growth rate of 4.5 percent.

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

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

**Note:** Data are average annual percentage change over previous five years.

**Figure 1** Comparing Measures of Economic Growth

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**CHAPTER 2** The Data of Macroeconomics
Value added

*Value added:* The value of output minus the value of the intermediate goods used to produce that output.
Final goods, value added, and GDP

- GDP = value of final goods produced
  = sum of value added at all stages of production.

- The value of the final goods already includes the value of the intermediate goods, so including intermediate and final goods in GDP would be double counting.
The expenditure components of GDP

- consumption, $C$
- investment, $I$
- government spending, $G$
- net exports, $NX$

An important identity:

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

*value of total output*  
*aggregate expenditure*
Consumption (C)

Definition: The value of all goods and services bought by households. Includes:

- **Durable goods** last a long time. *E.g.*, cars, home appliances
- **Nondurable goods** last a short time. *E.g.*, food, clothing
- **Services** are intangible items purchased by consumers. *E.g.*, dry cleaning, air travel
### U.S. consumption, 2016

<table>
<thead>
<tr>
<th></th>
<th>Total (billions of dollars)</th>
<th>Per Person (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross Domestic product</strong></td>
<td>18,624</td>
<td>57,638</td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
<td>12,821</td>
<td>39,677</td>
</tr>
<tr>
<td><strong>Nondurable goods</strong></td>
<td>2,710</td>
<td>8,388</td>
</tr>
<tr>
<td><strong>Durable goods</strong></td>
<td>1,411</td>
<td>4,367</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td>8,699</td>
<td>26,922</td>
</tr>
</tbody>
</table>
Investment (I)

- Spending on capital, a physical asset used in future production

- Includes:
  - *Business fixed investment*
    Spending on plant and equipment
  - *Residential fixed investment*
    Spending by consumers and landlords on housing units
  - *Inventory investment*
    The change in the value of all firms’ inventories
<table>
<thead>
<tr>
<th>Category</th>
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</tr>
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<tbody>
<tr>
<td>Gross Domestic product</td>
<td>18,624</td>
<td>57,638</td>
</tr>
<tr>
<td>Consumption</td>
<td>3,057</td>
<td>9,461</td>
</tr>
<tr>
<td>Nonresidential fixed investment</td>
<td>2,316</td>
<td>7,168</td>
</tr>
<tr>
<td>Residential fixed investment</td>
<td>706</td>
<td>2,185</td>
</tr>
<tr>
<td>Inventory investment</td>
<td>35</td>
<td>109</td>
</tr>
</tbody>
</table>
Investment vs. capital

Note: Investment is spending on new capital.

Example (*assumes no depreciation)*:

- **1/1/2016:**
  Economy has $10 trillion worth of capital

- **During 2016:**
  Investment = $2 trillion

- **1/1/2017:**
  Economy will have $12 trillion worth of capital
Stocks vs. Flows

A **stock** is a quantity measured at a point in time.

*E.g.*, “The U.S. capital stock was $10 trillion on January 1, 2016.”

A **flow** is a quantity measured per unit of time.

*E.g.*, “U.S. investment was $2 trillion during 2016.”
## Stocks vs. Flows: Examples

<table>
<thead>
<tr>
<th>Stock</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>a person’s wealth</td>
<td>a person’s annual savings</td>
</tr>
<tr>
<td># of people with college degrees</td>
<td># of new college graduates this year</td>
</tr>
<tr>
<td>the govt debt</td>
<td>the govt budget deficit</td>
</tr>
</tbody>
</table>
Government spending (G)

- $G$ includes all government spending on goods and services.
- $G$ excludes transfer payments (e.g., unemployment insurance payments) because they do not represent spending on goods and services.
<table>
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</thead>
<tbody>
<tr>
<td>Gross Domestic product</td>
<td>18,624</td>
<td>57,638</td>
</tr>
<tr>
<td>Consumption</td>
<td>3,268</td>
<td>10,113</td>
</tr>
<tr>
<td>Federal</td>
<td>1,231</td>
<td>3,811</td>
</tr>
<tr>
<td>Defense</td>
<td>729</td>
<td>2,256</td>
</tr>
<tr>
<td>Nondefense</td>
<td>503</td>
<td>1,555</td>
</tr>
</tbody>
</table>
Net exports (NX)

- **NX** = exports – imports
  - **Exports**: the value of goods and services sold to other countries
  - **Imports**: the value of goods and services purchased from other countries
  - Hence, NX equals net spending from abroad on our goods and services
# U.S. net exports, 2016

<table>
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<th>Total (billions of dollars)</th>
<th>Per Person (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gross Domestic product</strong></td>
<td>18,624</td>
<td>57,638</td>
</tr>
<tr>
<td><strong>Net Exports</strong></td>
<td>−521</td>
<td>−1,613</td>
</tr>
<tr>
<td><strong>Exports</strong></td>
<td>2,215</td>
<td>6,854</td>
</tr>
<tr>
<td><strong>Imports</strong></td>
<td>2,736</td>
<td>8,647</td>
</tr>
</tbody>
</table>
NOW YOU TRY

An expenditure-output puzzle?

Suppose a firm:

- produces $10 million worth of final goods
- only sells $9 million worth
- Does this violate the expenditure = output identity?
Why output = expenditure

- Unsold output goes into inventory, and is counted as “inventory investment” . . . whether or not the inventory buildup was intentional.
- In effect, we are assuming that firms purchase their unsold output.
GDP: An important and versatile concept

We have now seen that GDP measures:

- total income
- total output
- total expenditure
- the sum of value added at all stages in the production of final goods and services
GNP vs. GDP

- **Gross national product (GNP):**
  Total income earned by the nation’s factors of production, regardless of where located.

- **Gross domestic product (GDP):**
  Total income earned by domestically-located factors of production, regardless of nationality.

\[
\text{GNP} - \text{GDP} = \text{factor payments from abroad minus factor payments to abroad}
\]

- Examples of factor payments: wages, profits, rent, interest & dividends on assets
In your country, which would you want to be bigger, GDP or GNP?

Why?
<table>
<thead>
<tr>
<th>Country</th>
<th>GNP</th>
<th>GDP</th>
<th>GNP – GDP (% of GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>127,672</td>
<td>116,355</td>
<td>9.7</td>
</tr>
<tr>
<td>Japan</td>
<td>6,150,132</td>
<td>5,961,066</td>
<td>3.2</td>
</tr>
<tr>
<td>China</td>
<td>8,184,963</td>
<td>8,227,103</td>
<td>-0.5</td>
</tr>
<tr>
<td>United States</td>
<td>16,514,500</td>
<td>16,244,600</td>
<td>1.7</td>
</tr>
<tr>
<td>India</td>
<td>1,837,279</td>
<td>1,858,740</td>
<td>-1.2</td>
</tr>
<tr>
<td>Canada</td>
<td>1,821,424</td>
<td>1,779,635</td>
<td>2.3</td>
</tr>
<tr>
<td>Greece</td>
<td>250,167</td>
<td>248,939</td>
<td>0.5</td>
</tr>
<tr>
<td>Iraq</td>
<td>216,453</td>
<td>215,838</td>
<td>0.3</td>
</tr>
<tr>
<td>Ireland</td>
<td>171,996</td>
<td>210,636</td>
<td>-18.3</td>
</tr>
</tbody>
</table>

GNP and GDP in millions of current U.S. dollars.
Other Measures of Income

- *Net National Product* = GNP – Depreciation
- *National Income* = NNP – Statistical Discrepancy
- *National Income* = Compensation of Employees + Proprietors’ Income + Rental Income + Corporate Profits + Net Interest + Indirect Business Taxes

Note: *Supplement 2-5* describes a change in definition of National Income to include Indirect Business Taxes.
Components of National Income, 2014

- Compensation of Employees: 61%
- Corporate Profits: 14%
- Proprietors' Income: 9%
- Rental Income: 4%
- Net Interest: 4%
- Indirect Business Taxes and Other: 8%
Other Measures of Income

- **Personal Income** = National Income - Indirect Business Taxes - Corporate Profits - Social Insurance Contributions - Net Interest + Dividends + Government Transfers to Individuals + Personal Interest Income

- **Disposable Personal Income** = Personal Income - Personal Tax and Nontax Payments

- **Disposable Personal Income** is what households and noncorporate businesses have to spend (or save).
Real vs. nominal GDP

- GDP is the *value* of all final goods and services produced.
- **Nominal GDP** measures these values using current prices.
- **Real GDP** measures these values using the prices of a base year.
Real vs. Nominal GDP: Fixed Base-Year Prices

\[ \text{GDP}_t = \sum_{i=1}^{n} P_{it} Q_{it} \]

\[ \text{RGDP}_t = \sum_{i=1}^{n} P_{iB} Q_{it} \]
Real GDP controls for inflation

- Changes in nominal GDP can be due to:
  - changes in prices
  - changes in quantities of output produced
- Changes in real GDP can only be due to changes in quantities.
- **One way to calculate changes in real GDP is by using fixed base-year prices.**
Measuring Economic Growth: Fixed Base-Year Prices

\[
\frac{RGDP_t}{RGDP_{t-1}} = \frac{\sum_{i=1}^{n} P_{iB} Q_{it}}{\sum_{i=1}^{n} P_{iB} Q_{it-1}}\]

\[
= \frac{\sum_{i=1}^{n} P_{iB} Q_{it-1} \left[ Q_{it} / Q_{it-1} \right]}{\sum_{i=1}^{n} P_{iB} Q_{it-1}}
\]
Measuring Economic Growth: Fixed Base-Year Prices

\[
\frac{\text{RGDP}_t}{\text{RGDP}_{t-1}} = \frac{\sum_{i=1}^{n} P_{iB} Q_{it-1} \left[ \frac{Q_{it}}{Q_{it-1}} \right]}{\sum_{i=1}^{n} P_{iB} Q_{it-1}}
\]

\[
\left[ 1 + g_t \right] = \sum_{i=1}^{n} \omega_{iB} \left[ \frac{Q_{it}}{Q_{it-1}} \right]
\]
Measuring Economic Growth: Fixed Base-Year Prices

\[
\left[ 1 + g_t \right] = \sum_{i=1}^{n} \omega_{iB} \left[ \frac{Q_{it}}{Q_{it-1}} \right]
\]

where

\[
\omega_{iB} = \frac{P_{iB} Q_{it-1}}{\sum_{i=1}^{n} P_{iB} Q_{it-1}}
\]
Measuring Economic Growth

A problem arises when using fixed base-year weights: Growth will vary depending on base year chosen.

Rapidly growing sectors with declining relative prices will be weighted “too much” as base year becomes further and further in the past. Opposite for slowly growing sectors.
Chain-Weighted Real GDP

- Over time, relative prices change, so the base year should be updated periodically—which BEA used to do.

- In essence, chain-weighted real GDP updates the base year every year, using an average of last year’s and this year’s prices, so it is more accurate than fixed base-year GDP.

- Official measure of GDP now produced by BEA.

*See Supplement 2-3.*
Chain-Weighted Real GDP

Step 1:

$$[1 + g_t]_{t-1} = \frac{\sum_{i=1}^{n} P_{i,t-1} Q_{i,t-1} \left[ \frac{Q_{i,t}}{Q_{i,t-1}} \right]}{\sum_{i=1}^{n} P_{i,t-1} Q_{i,t-1}}$$

Rewrite as:

$$[1 + g_t]_{t-1} = \sum_{i=1}^{n} \omega_{i,t-1} \left[ \frac{Q_{i,t}}{Q_{i,t-1}} \right]$$
Chain-Weighted Real GDP

Step 2:

\[
[1 + g_t]_t = \frac{\sum_{i=1}^{n} P_{it} Q_{it-1} \left[ Q_{it} / Q_{it-1} \right]}{\sum_{i=1}^{n} P_{it} Q_{it-1}}
\]

Rewrite as:

\[
[1 + g_t]_t = \sum_{i=1}^{n} \omega_{it} \left[ Q_{it} / Q_{it-1} \right]
\]
Chain-Weighted Real GDP

Step 3:

\[ [1 + g_t] = \left\{ [1 + g_t]_t \times [1 + g_t]_{t-1} \right\}^{0.5} \]

To get level of real GDP, use nominal GDP for a given year and apply growth rate:

\[ RGDP_t = \left[ 1 + g_t \right] \left[ 1 + g_{t-1} \right] \left[ 1 + g_{t-2} \right] \left[ 1 + g_{t-3} \right] GDP_{t-4} \]

Real GDP is measured here in year \( t-4 \) dollars.
GDP deflator

- **Inflation rate**: the percentage increase in the overall level of prices.
- One measure of the price level: **GDP deflator**

Definition:

\[
\text{GDP deflator} = 100 \times \frac{\text{Nominal GDP}}{\text{Real GDP}}
\]
Deflator: Fixed-Weight Growth Measures

\[
\text{GDP Deflator}_t = \frac{\text{GDP}_t}{\text{RGDP}_t}
\]

\[
= \frac{\sum_{i=1}^{n} P_{it} Q_{it}}{\sum_{i=1}^{n} P_{iB} Q_{it}}
\]

\[
= \sum_{i=1}^{n} P_{iB} Q_{it} \left[ \frac{P_{it}}{P_{iB}} \right]
\]

\[
= \frac{\sum_{i=1}^{n} P_{iB} Q_{it} \left[ \frac{P_{it}}{P_{iB}} \right]}{\sum_{i=1}^{n} P_{iB} Q_{it}}
\]
GDP deflator

- GDP Deflator is a Paasche (current-weighted) index when real GDP is computed as a Laspeyres (fixed-weighted) index:

\[
\text{GDP Deflator}_t = \frac{\sum_{i=1}^{n} P_{iB} Q_{it} \left[ \frac{P_{it}}{P_{iB}} \right]}{\sum_{i=1}^{n} P_{iB} Q_{it}}
\]
GDP deflator

- Rewriting this expression gives:

\[
\text{GDP Deflator}_t = \sum_{i=1}^{n} \gamma_i \left[ \frac{P_{it}}{P_{iB}} \right]
\]

where \( \gamma_i = \frac{P_{iB} Q_{it}}{\sum_{i=1}^{n} P_{iB} Q_{it}} \)
Chain-Weighted Real GDP

- We can compute a deflator for chain-weighted GDP in same manner used for the fixed-weight measure.
- This price measure is a chain-weighted index with quantity weights updated each year, but using an average of this year’s and last year’s quantities.
- As with the real GDP measure, the price measure updates the base year every year, ensuring the measure is never too far out of date.

See Supplement 2-3.
Two arithmetic tricks for working with percentage changes

1. For any variables $X$ and $Y$,

   percentage change in $(X \times Y)$
   \[
   \approx \text{percentage change in } X \\
   + \text{percentage change in } Y
   \]

Ex.: If your hourly wage rises 5% and you work 7% more hours, then your wage income rises approximately 12%.
Two arithmetic tricks for working with percentage changes

2. Percentage change in \((X/Y)\)
   \[
   \approx \text{percentage change in } X - \text{percentage change in } Y
   \]

Ex.: GDP deflator = 100 \times \frac{NGDP}{RGDP}.

If NGDP rises 9% and RGDP rises 4%, then the inflation rate is approximately 5%.
When is the Economy in a Recession?

- **Rule of Thumb: Two quarters of decline in Real GDP**

- **National Bureau of Economic Research uses more nuanced approach (see Supplement 1-3):**
  - Monthly Indicators rather than Quarterly.
  - “A significant decline in activity spread across the economy, lasting more than a few months, visible in industrial production, employment, real income, and wholesale-retail trade.”
CHAPTER 2 The Data of Macroeconomics

Monthly Change in Employment (thousands)
Real Personal Income Net of Transfers
(billions of 2005 dollars, seasonally adjusted annual rate)
Change in Industrial Production
(monthly percent change at an annual rate)
Monthly Real Retail Sales
(millions of 2005 dollars)
Consumer price index (CPI)

- A measure of the overall level of prices
- Published by the Bureau of Labor Statistics (BLS)

Uses:
- tracks changes in the typical household’s cost of living
- adjusts many contracts for inflation ("COLAs")
- allows comparisons of dollar amounts over time
How the BLS constructs the CPI

1. Survey consumers to determine composition of the typical consumer’s “basket” of goods

2. Every month, collect data on prices of all items in the basket; compute cost of basket

3. CPI in any month equals

$$100 \times \frac{\text{Cost of basket in that month}}{\text{Cost of basket in base period}}$$
The composition of the CPI’s “basket”

- Food and bev.: 15.7%
- Housing: 41.9%
- Apparel: 3.5%
- Transportation: 7.7%
- Medical care: 5.7%
- Recreation: 3.3%
- Education: 3.7%
- Communication: 3.4%
- Other goods and services: 15.1%
Understanding the CPI

For good $i = 1, \ldots, n$

- $C_i =$ amount of good $i$ in the CPI’s basket
- $P_{it} =$ price of good $i$ in month $t$
- $E_t =$ cost of the CPI basket in month $t$
- $E_B =$ cost of the basket in the base period
Understanding the CPI

\[
\text{CPI} = \frac{E_t}{E_B} = \frac{\sum_{i=1}^{n} Q_{iB} P_{it}}{\sum_{i=1}^{n} Q_{iB} P_{iB}}
\]

\[
= \frac{\sum_{i=1}^{n} Q_{iB} P_{iB} \left[ P_{it} / P_{iB} \right]}{\sum_{i=1}^{n} Q_{iB} P_{iB}}
\]
Understanding the CPI

\[
\text{CPI} = \frac{E_t}{E_B} = \sum_{i=1}^{n} \gamma_{iB} \left[ \frac{P_{it}}{P_{iB}} \right]
\]

where the weights are given by:

\[
\gamma_{iB} = \frac{Q_{iB} P_{iB}}{\sum_{i=1}^{n} Q_{iB} P_{iB}}
\]
Understanding the CPI

The CPI is a weighted average of prices relative to their value in the base period.

The weight on each “price relative” reflects that good’s relative importance in the CPI’s basket.

Note that the weights remain fixed over time—the CPI is a Laspeyres Index.
Why the CPI may overstate inflation

- **Substitution bias:**
The CPI uses fixed weights, so it cannot reflect consumers’ ability to substitute toward goods whose relative prices have fallen.

- **Introduction of new goods:**
The introduction of new goods makes consumers better off and, in effect, increases the real value of the dollar. But it does not reduce the CPI, because the CPI uses fixed weights.

- **Unmeasured changes in quality:**
Quality improvements increase the value of the dollar but are often not fully measured.
The size of the CPI’s bias

- In 1995, a Senate-appointed panel of experts estimated that the CPI overstates inflation by about 1.1% per year.
- So the BLS made adjustments to reduce the bias.
- Now, the CPI’s bias is probably under 1% per year.
- See Supplements 2-8 and 2-9.
CPI vs. GDP deflator

Prices of capital goods:
- included in GDP deflator (if produced domestically)
- excluded from CPI

Prices of imported consumer goods:
- included in CPI
- excluded from GDP deflator

The basket of goods:
- CPI: fixed
- GDP deflator: changes every year
The PCE deflator

- Another measure of the price level: Personal Consumption Expenditures Price Index, the ratio of nominal to real consumer spending

- How the PCE is like the CPI:
  - only includes consumer spending
  - includes imported consumer goods

- How the PCE is like the GDP deflator:
  - the “basket” changes over time

- The Federal Reserve prefers PCE.
Core Measures of Inflation

- BLS and BEA produce measures of inflation that exclude food and energy sectors.
- These are known as “Core” inflation measures.
- Produced for both the CPI and the PCE Price Index.
- Federal Reserve often focuses on core inflation as a better measure of underlying trends in prices.
The GDP deflator, CPI, and PCE deflator
Categories of the population

- **Employed**
  working at a paid job

- **Unemployed**
  not employed but looking for a job

- **Labor force**
  the amount of labor available for producing goods and services; all employed plus unemployed persons

- **Not in the labor force**
  not employed, not looking for work
Two important labor force concepts

- **Unemployment rate**
  percentage of the labor force that is unemployed

- **Labor force participation rate**
  the fraction of the adult population that “participates” in the labor force, *i.e.* is working or looking for work

- **Household (Current Population) Survey**
  used to measure these concepts
NOW YOU TRY

Computing labor statistics

U.S. adult population by group, Dec 2014

Number employed = 147.4 million
Number unemployed = 8.7 million
Adult population = 249.0 million

Calculate

- the labor force
- the unemployment rate
- the labor force participation rate
NOW YOU TRY

Data: \( E = 147.4, \ U = 8.7, \ POP = 249.0 \)

- Labor force
  \[ L = E + U = 147.4 + 8.7 = 156.1 \]

- Unemployment rate
  \[ U/L \times 100\% = (8.7/156.1) \times 100\% = 5.6\% \]

- Labor force participation rate
  \[ L/POP \times 100\% = (156.1/249.0) \times 100\% = 62.7\% \]
The establishment survey

- The BLS obtains a second measure of employment by surveying businesses, asking how many workers are on their payrolls.

- Neither measure is perfect, and they occasionally diverge due to:
  - treatment of self-employed persons
  - new firms not counted in establishment survey
  - technical issues involving population inferences from sample data
Two measures of employment growth

Percentage change from 12 months earlier

-6% -5% -4% -3% -2% -1% 0% 1% 2% 3% 4% 5% 6%


- household survey
- establishment survey