GDP is measured quarterly as part of the National Income and Product Accounts (NIPA).


Output includes goods and services, where goods can be stored in inventory, and services cannot.

GDP only measures **final** goods and services.

Three approaches:

1. Product approach
2. Expenditure approach
3. Income approach
A Fictional Economy Example

- An island economy consists of a coconut producer, a restaurant, consumers, and the government.

- The coconut producer owns the trees and employs workers to harvest the coconuts. The producer sells these coconuts to consumers and restaurants and pays taxes to the government.

- The restaurant purchases coconuts and hires workers to sell meals to consumers. The restaurant also pays taxes.

- The government employs an army to provide national defense.
Computing GDP Using the Production Approach

- **Value added** = revenue − cost of intermediate goods.

- **Nominal GDP** = sum of value added to all industries.

- **Value added in this fictional economy** is:
  - Coconuts: $20 million.
  - Restaurant food: $30 million − $12 million = $18 million.
  - Government: $5.5 million.

- **GDP is** $43.5 million.
Computing GDP Using the Expenditure Approach

- **GDP** = total expenditures = \( C + I + G + NX \).

- **Total expenditures:**
  - **Consumption:** $8 million in coconuts + $30 million at restaurants.
  - **Investment:** $0
  - **Government expenditures:** $5.5 million.
  - **Net exports:** $0

- **GDP** is $43.5 million.
Computing GDP Using the Income Approach

- **Total Income:**
  - Wage income: $14.5 million.
  - After-tax profits: $24 million.
  - Interest income: $0.5 million.
  - Taxes: $4.5 million

- **GDP is $43.5 million.**
A Few Remarks

- GNP measures the value of output produced by domestic factors of production, regardless of where the production takes place.
  - Example: a Nike plant in Southeast Asia vs. a Honda plant in Ohio.

\[ GNP = GDP + NFP. \]

\[ GDP_{2002} = 10,446.2 \text{ billion}, \]
\[ GNP_{2002} = 10,436.7 \text{ billion} \Rightarrow NFP_{2002} = -9.5 \text{ billion}. \]

- No market prices for government production, so value imputed at cost of inputs.

- GDP does not capture the underground economy or household production.
  - Household production is goods and services produced and consumed (or invested) within a household. No market prices to impute value.
    - Example: owner occupied housing vs. renting out your house.
The Components of Aggregate Expenditure

- **Consumption augments current material living standards.**
  - Types of consumption: durable goods, nondurable goods, and services.

- **Investment augments the future production of output.**
  - Types of investment: nonresidential fixed, residential fixed, and inventories.

- The distinction between consumption and investment not always clean cut.

<table>
<thead>
<tr>
<th>Table 2.9</th>
<th>Gross Domestic Product for 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component of GDP</td>
<td>$Billions</td>
</tr>
<tr>
<td>GDP</td>
<td>14,264.6</td>
</tr>
<tr>
<td>Consumption</td>
<td>10,057.9</td>
</tr>
<tr>
<td>Durables</td>
<td>1023.2</td>
</tr>
<tr>
<td>Nondurables</td>
<td>2965.1</td>
</tr>
<tr>
<td>Services</td>
<td>6069.6</td>
</tr>
<tr>
<td>Investment</td>
<td>1993.5</td>
</tr>
<tr>
<td>Fixed Investment</td>
<td>2040.5</td>
</tr>
<tr>
<td>Nonresidential</td>
<td>1552.8</td>
</tr>
<tr>
<td>Residential</td>
<td>487.7</td>
</tr>
<tr>
<td>Inventory Investment</td>
<td>-47.0</td>
</tr>
<tr>
<td>Net Exports</td>
<td>-669.2</td>
</tr>
<tr>
<td>Exports</td>
<td>1859.4</td>
</tr>
<tr>
<td>Imports</td>
<td>2528.6</td>
</tr>
<tr>
<td>Government Expenditures</td>
<td>2882.4</td>
</tr>
<tr>
<td>Federal Defense</td>
<td>734.9</td>
</tr>
<tr>
<td>Federal Nondefense</td>
<td>337.0</td>
</tr>
<tr>
<td>State and Local</td>
<td>1810.4</td>
</tr>
</tbody>
</table>
Investment is a flow variable that adds new capital goods and services to the existing capital stock.

\[ K_{t+1} = (1 - \delta)K_t + I_t \]

Capital refers to a durable factor of production and inventories.

- Types: physical capital (machinery, computers, buildings, roads, etc.), human capital, intangible capital, etc.
- Major measurement difficulties.
- Financial assets are often lumped together with capital but are actually claims to future objects.
The Distribution of National Income

- Employees’ compensation: wages, salaries, and fringe benefits.
- Proprietors’ income: income of noncorporate business.
- Rental income: income that landlords receive from renting.
- Corporate profits: income after payments to workers and creditors.
- Net interest: interest paid by domestic businesses and foreigners.
Nominal and Real GDP and Price Indices

- A **price index** is a weighted average of the prices of a basket of goods and services that gives a measure of the **price level**.

- Allows us to measure the **inflation rate** and thus decompose changes in nominal GDP into **real** and **nominal** changes.

- An example to calculate nominal GDP growth:

<table>
<thead>
<tr>
<th>Data for Real GDP Example</th>
<th>Apples</th>
<th>Oranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity in year 1</td>
<td>$Q^a_1 = 50$</td>
<td>$Q^o_1 = 100$</td>
</tr>
<tr>
<td>Price in year 1</td>
<td>$P^a_1 = $1.00$</td>
<td>$P^o_1 = $0.80$</td>
</tr>
<tr>
<td>Quantity in year 2</td>
<td>$Q^a_2 = 80$</td>
<td>$Q^o_2 = 120$</td>
</tr>
<tr>
<td>Price in year 2</td>
<td>$P^a_2 = $1.25$</td>
<td>$P^o_2 = $1.60$</td>
</tr>
</tbody>
</table>

$$GDP_1 = P^a_1 Q^a_1 + P^o_1 Q^o_1 = $130$$

$$GDP_2 = P^a_2 Q^a_2 + P^o_2 Q^o_2 = $292$$

$$\% \Delta GDP = \left( \frac{GDP_2}{GDP_1} - 1 \right) \times 100\% = 125\%$$
A Real GDP Example

<table>
<thead>
<tr>
<th>Data for Real GDP Example</th>
<th>Apples</th>
<th>Oranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity in year 1</td>
<td>( Q_1^a = 50 )</td>
<td>( Q_1^o = 100 )</td>
</tr>
<tr>
<td>Price in year 1</td>
<td>( P_1^a = $1.00 )</td>
<td>( P_1^o = $0.80 )</td>
</tr>
<tr>
<td>Quantity in year 2</td>
<td>( Q_2^a = 80 )</td>
<td>( Q_2^o = 120 )</td>
</tr>
<tr>
<td>Price in year 2</td>
<td>( P_2^a = $1.25 )</td>
<td>( P_2^o = $1.60 )</td>
</tr>
</tbody>
</table>

- Calculate real GDP growth using year 1 as the base year:
  \[
  RGDP_1^1 = GDP_1, \quad RGDP_1^2 = P_1^a Q_2^a + P_1^o Q_2^o = $176
  \]
  \[
  g_1 = \left( \frac{RGDP_2^1}{RGDP_1^1} - 1 \right) \times 100\% = 35.4\%
  \]

- Calculate real GDP growth using year 2 as the base year:
  \[
  RGDP_2^1 = GDP_2, \quad RGDP_2^2 = P_2^a Q_1^a + P_2^o Q_1^o = $222.50
  \]
  \[
  g_2 = \left( \frac{RGDP_2^2}{RGDP_1^2} - 1 \right) \times 100\% = 31.2\%
  \]

- **Chain-weighting** helps correct for relative price changes:
  \[
  g_c = \left( \sqrt{(1 + g_1)(1 + g_2)} - 1 \right) \times 100\% = 33.3\%
  \]
Measures of the Price Level

- Two common price level measures: **implicit GDP price deflator** and **consumer price index (CPI)**.

Implicit GDP price deflator = \( \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100 \)

Current year CPI = \( \frac{\sum_i P_{i\text{current}} Q_{i\text{base}}}{\sum_i P_{i\text{base}} Q_{i\text{base}}} \times 100 \)
Inflation calculations can differ substantially depending on whether the CPI or the GDP deflator is used.

Major implications for credit and labor contracts as well as for monetary policy.

Three problems:

1. Relative prices change over time.
   - Substitution effect is ignored by CPI.
   - Boskin Commission attributed substantial upward bias to CPI.
   - Implications for taxes, Social Security payments, etc.

2. Improvements in the quality of goods.

3. New goods that did not previously exist.
Savings, Wealth, and Capital

- **Private disposable income** \( Y^d = Y + NFP + TR + INT - T \).

- **Private sector saving** \( S^p = Y^d - C = Y + NFP + TR + INT - T - C \).

- **Government saving** \( S^g = T - TR - INT - G \). Government deficit \( D = -S^g \).

- **National saving** \( S = S^p + S^g = Y + NFP - C - G = GNP - C - G \).

- \( Y = C + I + G + NX \Rightarrow S = I + NX + NFP = I + CA \).
People divided into three groups:

1. **Employed**— part-time and full-time workers during the past week.

2. **Unemployed**— those who were not employed during the past week but actively searching for work at some time during the last 4 weeks.

3. **Not in the labor force**— those neither employed nor unemployed.

Unemployment rate = \( \frac{\text{Number unemployed}}{\text{Labor force}} \)

Participation rate = \( \frac{\text{Labor force}}{\text{Working age population}} \)

Unemployment is a useful measure of **labor market tightness**, but two measurement problems:

1. The unemployment rate does not count **discouraged workers**.

2. The unemployment rate does not adjust for search intensity.
Business Cycles

- Business cycles are fluctuations of the economy about a trend.

- Different ways to compute trends: linear regression, Kalman filter, Hodrick-Prescott filter, etc.

- The H-P filter divides a time series $y_t$ into cyclical and growth components, $y_t = y_t^c + y_t^g$, where $y_t^g$ is chosen to solve, for a given $\lambda$,

$$\min_{\{y_t^g\}} \sum_{t=1}^{T} (y_t^c)^2 + \lambda \sum_{t=1}^{T} [(y_{t+1}^g - y_t^g) - (y_t^g - y_{t-1}^g)]^2$$

- Periods of below-trend growth (negative cyclical component) differ from periods of recession as defined by the NBER.
Business Cycles

Real GDP vs. Time

- Trend
- Peak
- Trough
- Amplitude

Percentage Deviation from Trend vs. Year

- 1940 to 2010
- Key Business Cycles:
  - 1974–1975
  - 1981–1982
  - 1990–1991
  - 2001
  - 2008–2009

Graph showing fluctuations in Real GDP over time, with key business cycles marked.
Business Cycles

- Business cycle analysis studies the properties of the cyclical components of different time series and their co-movements.

- Objects of interest:
  1. Volatilities (both absolute and relative to GDP).
  2. Whether a series is procyclical, countercyclical, or acyclical.
  3. Whether a series is a leading or lagging indicator.

---

**Figure:**
- Positive correlation between \( x \) and \( y \) (a).
- Negative correlation between \( x \) and \( y \) (b).
- \( x \) is a leading variable (c).
- \( y \) is a lagging variable (d).
## Co-movement Summary

### Correlations and Standard Deviations of Cyclical Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Correlation</th>
<th>Standard Deviation (% of S.D. of GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>0.76</td>
<td>75.6%</td>
</tr>
<tr>
<td>Investment</td>
<td>0.83</td>
<td>469.2%</td>
</tr>
<tr>
<td>Price Level</td>
<td>-0.26</td>
<td>57.6%</td>
</tr>
<tr>
<td>Money Supply</td>
<td>0.38</td>
<td>77.9%</td>
</tr>
<tr>
<td>Employment</td>
<td>0.81</td>
<td>59.3%</td>
</tr>
<tr>
<td>Average Labor Productivity</td>
<td>0.83</td>
<td>62.8%</td>
</tr>
</tbody>
</table>

### Summary of Business Cycle Facts

<table>
<thead>
<tr>
<th>Component</th>
<th>Cyclicality</th>
<th>Lead/Lag</th>
<th>Variability Relative to GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>Procyclical</td>
<td>Coincident</td>
<td>Smaller</td>
</tr>
<tr>
<td>Investment</td>
<td>Procyclical</td>
<td>Coincident</td>
<td>Larger</td>
</tr>
<tr>
<td>Price Level</td>
<td>Countercyclical</td>
<td>Coincident</td>
<td>Smaller</td>
</tr>
<tr>
<td>Money Supply</td>
<td>Procyclical</td>
<td>Leading</td>
<td>Smaller</td>
</tr>
<tr>
<td>Employment</td>
<td>Procyclical</td>
<td>Lagging</td>
<td>Smaller</td>
</tr>
<tr>
<td>Real Wage</td>
<td>Procyclical</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Average Labor Productivity</td>
<td>Procyclical</td>
<td>Coincident</td>
<td>Smaller</td>
</tr>
</tbody>
</table>