Measurement and Structure of the National Economy

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Introduction

How are things like GDP, private expenditure, or inflation measured?

1. National income accounting: production, income, and expenditure
2. Gross Domestic Product
3. Saving and wealth
4. Real GDP, price indexes, and inflation
5. Real and nominal interest rates

1. National Income Accounting

National Income Accounting

National Accounts

Accounting framework used to measure current economic activity.

- Most countries have some sort of national accounts that follow a standard methodology
- This allows us to obtain comparable measures of GDP in Canada and Senegal, for example
- In the US, this system is called NIPA (National Income and Product Accounts)
- It is maintained by the Bureau of Economic Analysis (BEA) `http://www.bea.gov`, and most variables can be pulled from FRED
- National Accounts were mostly developed around World War II as a way to systematically measure the industrial production capacity of an economy

Three Approaches to National Income Accounting

- There are three different approaches to measuring economic activity that should all give the same answer:
  1. The **product approach** measures the total amount of final output produced in the economy in a given period of time
  2. The **income approach** measures the total income received by the factors that produced output in a given period of time
  3. The **expenditure approach** measures the expenditure of the agents who ultimately purchased output in a given period of time
- Save for misreporting, the key idea behind national income accounting is that

$$\text{Production} = \text{Income} = \text{Expenditure}$$

National Income Accounting: Example

Imagine an economy with two companies:

- OrangeInc produces oranges that are sold to the public and JuiceCorp
- JuiceCorp buys oranges from OrangeInc and makes orange juice that is sold to the public

OrangeInc		JuiceCorp	
Wages paid to employees	$ 15,000	Wages paid to employees	$ 10,000
Taxes paid to government	$ 5,000	Taxes paid to government	$ 2,000
Revenue from sale of oranges	$ 35,000	Oranges purchased from OrangeInc	$ 25,000
Oranges sold to public	$ 10,000	Revenue from sale of juice to public	$ 40,000
Oranges sold to JuiceCorp	$ 25,000		

National Income Accounting: Product Approach

OrangeInc		JuiceCorp	
Wages paid to employees	$ 15,000	Wages paid to employees	$ 10,000
Taxes paid to government	$ 5,000	Taxes paid to government	$ 2,000
Revenue from sale of oranges	$ 35,000	Oranges purchased from OrangeInc	$ 25,000
Oranges sold to public	$ 10,000	Revenue from sale of juice to public	$ 40,000
Oranges sold to JuiceCorp	$ 25,000		

Value Added

The **value added** of a producer is the value of its output minus the value of inputs purchased from other producers.

Product Approach: total value added produced in this economy

$$\text{Production} = \underbrace{\$35,000}_{\text{OrangeInc production}} + \overbrace{\$40,000}^{\text{JuiceCorp production}} - \underbrace{\$25,000}_{\text{JuiceCorp intermediates}} = \$50,000$$

Value added avoids double counting intermediates.

National Income Accounting: Income Approach

OrangeInc		JuiceCorp	
Wages paid to employees	$ 15,000	Wages paid to employees	$ 10,000
Taxes paid to government	$ 5,000	Taxes paid to government	$ 2,000
Revenue from sale of oranges	$ 35,000	Oranges purchased from OrangeInc	$ 25,000
Oranges sold to public	$ 10,000	Revenue from sale of juice to public	$ 40,000
Oranges sold to JuiceCorp	$ 25,000		

Factor of Production

Resources that are used in the production process to generate output.

Income Approach: total income received by factors of production

$$\text{Income} = \underbrace{\$15,000}_{\text{OrangeInc wages}} + \overbrace{\$20,000}^{\text{pre-tax OrangeInc profits}} + \underbrace{\$10,000}_{\text{JuiceCorp wages}} + \overbrace{\$5,000}^{\text{pre-tax JuiceCorp profits}} = \$50,000$$

If after-tax profits are used, we should consider income received by the government ($ 7,000) and obtain the same result.

National Income Accounting: Expenditure Approach

OrangeInc		JuiceCorp	
Wages paid to employees	\$ 15,000	Wages paid to employees	\$ 10,000
Taxes paid to government	\$ 5,000	Taxes paid to government	\$ 2,000
Revenue from sale of oranges	\$ 35,000	Oranges purchased from OrangeInc	\$ 25,000
Oranges sold to public	\$ 10,000	Revenue from sale of juice to public	\$ 40,000
Oranges sold to JuiceCorp	\$ 25,000		

Expenditure Approach: total amount spent by the ultimate users of output

$$\text{Expenditure} = \underbrace{\$10,000}_{\text{OrangeInc sales to public}} + \overbrace{\$40,000}^{\text{JuiceCorp sales to public}} = \$50,000$$

Again, considering only final expenditure avoids double counting.

Fundamental Identity of National Accounting

$$\text{Production} = \text{Income} = \text{Expenditure} = \$50,000$$

- Everything that is produced is purchased by someone (even if by the producer themselves, i.e. inventories), so

$$\text{Production} = \text{Expenditure}$$

- Expenditure is paid to sellers. These receipts, in turn, are used to pay for the factors of production (including profits and taxes), so

$$\text{Income} = \text{Expenditure}$$

- The value of everything is that is produced is paid to sokmeone (even if to the producer themselves, as profits), so
-

$$\text{Production} = \text{Income}$$

2. Gross Domestic Product

Gross Domestic Product: Product Approach

The three approaches can be used to construct GDP under slightly different definitions.

GDP (Product Approach)

The market value of final goods and services newly produced within a nation during a fixed period of time.

Let's unpack this definition:

- **Market value**: goods and services are counted in GDP at the value that they are sold in the market
  - Allows us to measure production of very different goods and services (i.e., we can add up shoes and consulting services)
  - Ignores nonmarket goods and services (i.e. cooking at home, raising a child), as well as the informal/underground economies
  - May mismeasure the value of public good service provision (value of the court system, public education, or national defence)

Gross Domestic Product: Product Approach

- **Newly produced**: GDP counts the value of new production in a fixed period of time, excluding things that were produced in previous periods.
  - New house sales count towards GDP; existing home sales do not.
- **Final goods and services**: GDP excludes intermediate goods and services
  - All production may be classified as final or intermediate
  - Production is called intermediate if it is then used in the production of a different good or service during the same period of time.
  - This can get complicated:
    - **Capital Goods** contribute to but are not "used up" in the production of other goods, i.e. factory machines or company vehicles. They are classified as final goods.
    - **Inventories** are stocks of unsold finished goods and raw materials held by firms. They are considered investment by the seller and treated as final goods as well.

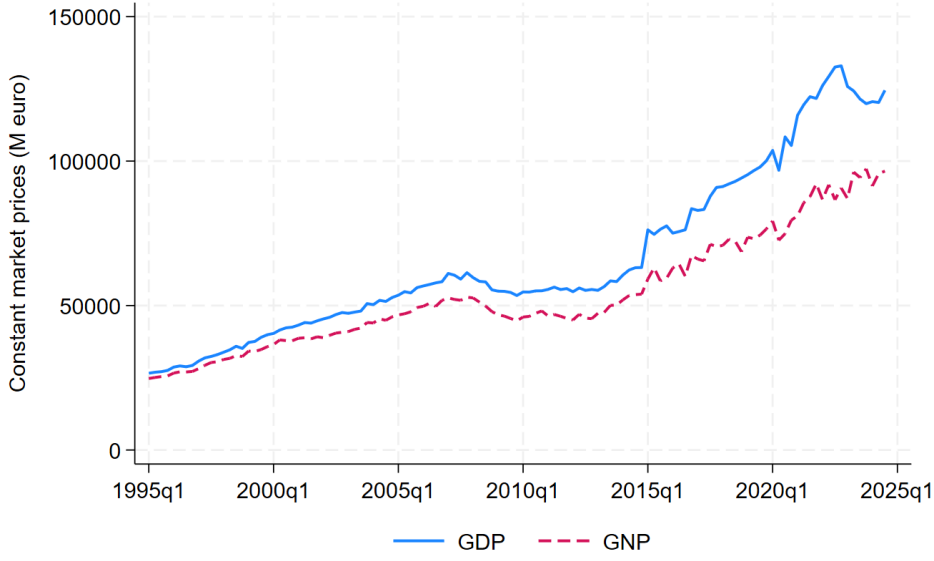
GDP versus GNP

- GDP measures total production **within a nation**
- Gross National Product (GNP) measures total production by domestic factors of production, regardless of location
  - value of US labor in a car factory in Canada counts towards US GNP but not GDP
  - value of Japanese management in a Toyota factory in Kentucky counts towards US GDP but not GNP
- GDP is equal to GNP minus **net factor payments from abroad**
- NFP = payments to domestic factors by RoW minus payments to foreign factors in the domestic economy

$$GDP = GNP - NFP$$

NFP can be large for countries with large numbers of emigrants, for example.

Ireland: GDP vs GNP



Source: Central Bank of Ireland

Gross Domestic Product: Expenditure Approach

The expenditure approach computes GDP based on major expenditure categories, using the **income-expenditure identity**

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

- Y = GDP (or income, or output, or expenditure)
- C = private consumption
- I = investment
- G = government purchases
- NX = net exports = $X - M$

Gross Domestic Product: Expenditure Approach

TABLE 2.1

Expenditure Approach to Measuring GDP in the United States, 2014

	Billions of dollars	Percent of GDP
Personal consumption expenditures (C)	**11,930**	**68.5**
Consumer durables	1303	7.5
Nondurable goods	2666	15.3
Services	7962	45.7
Gross private domestic investment (I)	**2852**	**16.4**
Business fixed investment	2211	12.7
Nonresidential structures	507	2.9
Equipment	1017	5.8
Intellectual property products	686	3.9
Residential investment	559	3.2
Inventory investment	82	0.5
Government purchases of goods and services (G)	**3175**	**18.2**
Federal	1219	7.0
National defense	762	4.4
Nondefense	458	2.6
State and local	1956	11.2
Net exports (NX)	**−538**	**−3.1**
Exports	2337	13.4
Imports	2875	16.5
Total (equals GDP) (Y)	**17,419**	**100.0**

Note: Numbers may not add to totals shown owing to rounding.
Source: Bureau of Economic Analysis web site, *www.bea.gov*, NIPA Table 1.1.5, May 29, 2015

Gross Domestic Product: Expenditure Approach

- **Consumption**: spending by households on final goods and services, including those produced abroad.
- About 2/3 of GDP
- Includes
  - Nondurable goods (ex: food, clothing, fuel)
  - Durable goods (ex: cars, furniture, appliances)
  - Services (ex: education, healthcare, restaurants)

Durable vs Nondurable Goods

Gross Domestic Product: Expenditure Approach

- **Investment**: spending by households and firms on
  - Changes in inventories (inventory investment)
  - New capital goods (fixed investment), which include
    - Business fixed investment: structures, equipment, intellectual property
    - Residential investment: new homes and apartment buildings
- About 1/5 of GDP

Gross Domestic Product: Expenditure Approach

- **Government Purchases**: spending by the government on newly produced goods and services, including government investment.
  - This is only a fraction of total government spending: a large share of govt spending are transfers to households
  - Mostly done by state and local, not federal govt
  - About 1/6 of GDP
- **Net Exports**: total exports of goods and services minus imports of goods and services.
  - Subtracting imports adjusts for the domestic expenditure on goods and services that are produced abroad.

Gross Domestic Product: Income Approach

Compute GDP by adding income received by factors of production and taxes paid to the government. It consists of computing **national income**, which is the sum of

1. Compensation of employees, excluding those who are self-employed. Includes wages, salaries, employee benefits, and employer contributions to Social Security.

2. Proprietor's income, which includes the income of the self-employed.

3. Rental income, earned by individuals who rent land and structures.

4. Corporate profits. This is revenue minus wages, interest, rents, and other costs. Corporate profits are used to pay taxes to the government, dividends to shareholders, and can be retained within the corporation.

Gross Domestic Product: Income Approach

5. Net interest, equal to interest earned by individuals minus interest paid.

6. Taxes on production and imports, which include indirect business taxes and some types of taxes (residential real estate, motor vehicles) paid by individuals

7. Business current transfer payments. Payments made by business to individuals that are not wages or payments for services, i.e. charity donations.

8. Current surplus of government enterprises, which corresponds to net profits of government-owned businesses.

Gross Domestic Product: Income Approach

- National Income may not add up to total production, which generates a **statistical discrepancy**

$$\text{Net National Product} = \text{National Income} + \text{Statistical Discrepancy}$$

- As capital goods are used, they wear down. **Depreciation** is an accounting terms that corresponds to the value of capital that is lost during production.

$$\text{Gross National Product} = \text{Net National Product} + \text{Depreciation}$$

- National income includes income earned by US factors abroad, and does not include income earned by foreign factors domestically. Thus GNP has to be adjusted with NFP

$$\text{Gross Domestic Product} = \text{Gross National Product} - \text{NFP}$$

Gross Domestic Product: Income Approach

TABLE 2.2

Income Approach to Measuring GDP in the United States, 2014

	Billions of dollars	Percent of GDP
Compensation of employees	9228	53.0
Proprietors' income	1380	7.9
Rental income of persons	640	3.7
Corporate profits	2090	12.0
Net interest	486	2.8
Taxes on production and imports	1146	6.6
Business current transfer payments	141	0.8
Current surplus of government enterprises	−34	−0.2
Total (equals **National Income**)	**15,077**	**86.6**
Plus Statistical discrepancy	−182	−1.0
Equals **Net National Product**	**14,894**	**85.5**
Plus Consumption of fixed capital	2736	15.7
Equals **Gross National Product (GNP)**	**17,631**	**101.2**
Less Factor income received from rest of world	828	4.8
Plus Payments of factor income to rest of world	616	3.5
Equals **Gross Domestic Product (GDP)**	**17,419**	**100.0**

Note: Numbers may not add to totals shown owing to rounding.
Source: Bureau of Economic Analysis web site, *www.bea.gov*, NIPA Tables 1.7.5 and 1.12, May 29, 2015

Private Disposable Income

- The income approach classifies income depending on the nature of the different factors of production earning that income (i.e. labor, land, capital, etc.)
- Often, it is useful to classify income depending on whether it is earned by the private or government sectors

Private disposable income

Amount of income the private sector has available to spend during a period.

- PDI is a useful measure of the spending potential of the private sector of the economy

$$PDI = Y + NFP + Tr + INT - T$$

  - Y is GDP
  - NFP are net factor payments from abroad
  - Tr are transfers from the government
  - INT is interest on government debt
  - T are taxes

Net Government Income

- Similarly, it is useful to define **net government income**

$$NGI = T - Tr - INT$$

- Note that if we sum PDI and NGI we obtain GNP

$$\begin{aligned} PDI + NGI &= \underbrace{Y + NFP + Tr + INT - T}_{\text{PDI}} + \underbrace{T - Tr - INT}_{\text{NGI}} \\ &= Y + NFP + (Tr - Tr) + (INT - INT) + (T - T) \\ &= Y + NFP = GNP \end{aligned}$$

3. Saving and Wealth

National Wealth

- Income is a useful flow measure, but it can provide an incomplete picture of someone's financial situation
- A retired person can have very little current income, but own a large number of assets that are worth a lot of money
- For this reason, it is useful to measure wealth besides income

National Wealth

National Wealth is the wealth of a national economy. Wealth is the value of assets minus the value of liabilities.

- In the context of households and businesses, wealth is also called **net worth**
- The growth rate of wealth depends on the rate at which the economy saves (or dissaves)

National Saving

- Saving equals income minus spending in current needs

- **National saving** equals private saving plus government saving

$$S = S_{pvt} + S_{govt}$$

Private Saving

- **Private saving** is the saving of the private sector, equal to PDI minus consumption

$$\begin{aligned} S_{pvt} &= PDI - C \\ &= Y + NFP + Tr + INT - T - C \end{aligned}$$

- Note that the private sector also spends resources with investment, but we do not subtract investment from private saving
- That is because investment is spending in future productive capacity and not spending to satisfy current needs
- The **saving rate** is private saving over private disposable income

$$s_{pvt} = \frac{S_{pvt}}{PDI}$$

Government Saving

- Similarly, **government saving** is net government income minus government purchases

$$\begin{aligned} S_{govt} &= NGI - G \\ &= T - Tr - INT - G \end{aligned}$$

- Recall that government investment (spending on capital goods) is typically included in G, which may induce some mismeasurement
- Government saving can alternatively be called the **budget surplus**
- When the budget surplus is negative (outlays exceed revenues), it is called **budget deficit**

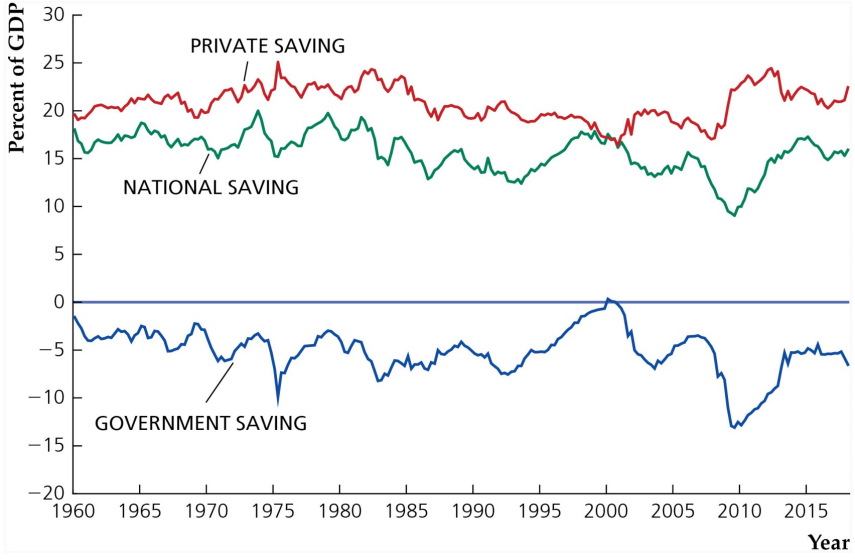
National Saving

- Let's return to the national saving and replace for S_{pvt} and S_{govt}:

$$\begin{aligned} S &= S_{pvt} + S_{govt} \\ &= Y + NFP + Tr + INT - T - C + T - Tr - INT - G \\ &= Y + NFP - C - G \\ &= GNP - C - G \end{aligned}$$

- National saving is equal to GNP minus private consumption and government consumption

National Saving, 1960Q1-2018Q1



Uses of Private Saving

Private saving is used to

1. Fund new investment
2. Fund government budget deficits
3. Acquire assets from/lend to foreigners

Recall that

$$S = Y + NFP - C - G$$

Replace Y with the income-expenditure identity to get

$$\begin{aligned} S &= C + I + G + NX + NFP - C - G \\ &= I + NX + NFP \\ &= I + CA \end{aligned}$$

$CA \equiv NX + NFP$ is called the **Current Account balance**

Uses of Private Saving

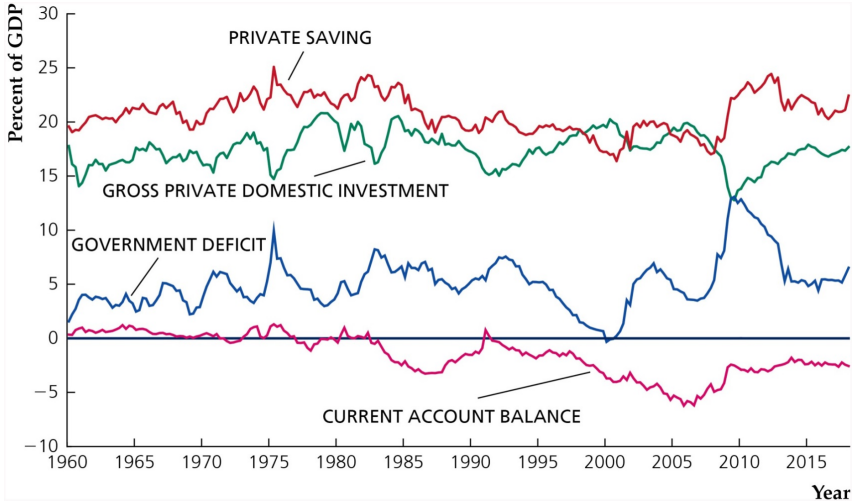
Note also that

$$\begin{aligned} S_{pvt} &= S - S_{govt} \\ &= I + CA - S_{govt} \end{aligned}$$

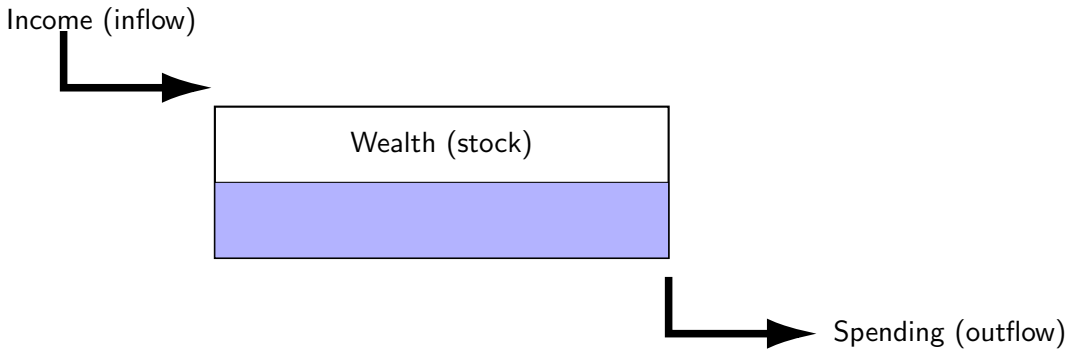
This is the **uses of saving identity**, stating that private saving can be used for

1. Investment, I
2. Fund government deficits, $-S_{govt}$
3. Lend to foreigners, CA

Uses of Saving, 1960Q1-2018Q1



Saving and Wealth: Stocks and Flows



Saving and Wealth: Stocks and Flows

- Saving is a **flow variable**, while wealth is a **stock variable**

$$W_{t+1} = S_t + W_t \Rightarrow \Delta W_{t+1} = S_t$$

- Current wealth W_t reflects all past savings S_i for $i \leq t$
- Positive saving adds to wealth, while negative saving reduces wealth
- Flow variables are measured in dollars *per unit of time*
  - Ex: US GDP was $ 20.94 trillion in 2020. This means that $20.94 trillion worth of goods and services were produced *during* 2020.
- Stock variables are measured in dollars *at a point in time*.
  - Ex: US government debt was $28.5 trillion in 2021Q2. This reflects past deficits (flow variable).

National Wealth

- National wealth consists of
  1. Domestic assets, such as physical capital, land, and intellectual property.
  2. Net foreign assets, the stock of foreign assets minus foreign liabilities
- Recall the use of saving identity

$$S = I + CA$$

- An increase in savings raises national wealth either by:
  1. Investment, which increases the stock of domestic assets
  2. Positive current account balances, which increases net foreign assets

4. Real GDP, Price Indexes, and Inflation

Real and Nominal Variables

- So far we have discussed the measurement of **nominal variables**
- These are variables that are measured in contemporary or **current** dollars
- GDP is measured in nominal market values, which reflect *prices* and *quantities*

$$PY_t = \text{nominal GDP} = P_t \times Q_t = \text{current prices} \times \text{current quantities}$$

- But prices change over time, and the point of GDP is to measure quantities produced over time
- If nominal GDP grows by a lot, it is hard to tell whether this reflects
  1. An increase in quantities $Q_t \uparrow$, i.e. more stuff is actually being produced in the economy
  2. Or an increase in prices $P_t \uparrow$, in which case the same amount of goods and services are being produced, but are more expensive

Real and Nominal Variables

- **Real variables** measure the evolution of quantities, keeping prices fixed
- This is achieved by fixing the price level P to that of some **base year**
- **Real GDP** is GDP measured at the prices of a base year, also known as **constant dollars**

$$Y_t = \text{real GDP} = P_{\text{base year}} \times Q_t = \text{constant prices} \times \text{current quantities}$$

Real and Nominal GDP: Example

	Year 1	Year 2	Percent change from year 1 to year 2
Product (quantity)			
Computers	5	10	+100%
Bicycles	200	250	+25%
Price			
Computers	$1200/computer	$600/computer	−50%
Bicycles	$200/bicycle	$240/bicycle	+20%
Value			
Computers	$6000	$6000	0
Bicycles	$40,000	$60,000	+50%
Total	**$46,000**	**$66,000**	**+43.5%**

Real and Nominal GDP: Different Base Years

Calculation of real output with base year = Year 1

	Current quantities		Base-year prices		
Year 1					
Computers	5	×	$1200	=	$6000
Bicycles	200	×	$200	=	$40,000
				Total =	**$46,000**
Year 2					
Computers	10	×	$1200	=	$12,000
Bicycles	250	×	$200	=	$50,000
				Total =	**$62,000**

Percentage growth of real GDP = ($62,000 − $46,000)/$46,000 = 34.8%

Calculation of real output with base year = Year 2

	Current quantities		Base-year prices		
Year 1					
Computers	5	×	$600	=	$3000
Bicycles	200	×	$240	=	$48,000
				Total =	**$51,000**
Year 2					
Computers	10	×	$600	=	$6000
Bicycles	250	×	$240	=	$60,000
				Total =	**$66,000**

Percentage growth of real GDP = ($66,000 − $51,000)/$51,000 = 29.4%

GDP Growth

- You often hear more about the *growth* of GDP rather than the *level* of GDP in the news, financial press, etc.
- When talking about GDP growth, most people implicitly mean **real GDP growth**
- (As we have seen before, nominal GDP growth is not a very useful concept)
- Note that if we know real GDP Y_t, we can compute its growth rate as

$$g_t^Y = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{Y_t}{Y_{t-1}} - 1$$

GDP Growth

- GDP growth is measured over a calendar quarter, and is often reported in **annualized form**
- "If GDP grew at this quarterly rate for the whole year, by how much would it grow?"

$$\text{annualized GDP growth} = (1 + g_t^Y)^4 - 1$$

- If we are dealing with annual GDP data, there is no need to annualize as GDP is a flow, not a stock
- Many other advanced economies do not publish annualized GDP numbers (i.e. Eurostat)
- US GDP releases are typically **seasonally adjusted**

GDP Growth

	Real GDP, bn of 2012 $	Quarterly growth rate	Annualized growth rate
2020Q1	4344.68	-8.48%	-29.86%
2020Q2	4685.93	7.85%	35.32%
2020Q3	4731.07	0.96%	3.91%
2020Q4	4804.06	1.54%	6.32%
2020, annual	*18565.73*		
2021Q1	4886.06	1.71%	7.00%
2021Q2	4918.15	2.37%	9.84%
2021Q3	5001.55	2.36%	9.79%
2021Q4	4981.02	1.28%	5.21%
2021, annual	*19786.78*		

Source: FRED, series name GDPC1

Price Indexes

Price Index

Measure of the average level of prices for some specified set of goods and services, relative to the prices in a specified base year.

- While real variables allow us to measure the growth of quantities, price indexes measure the growth of prices
- The three most commonly used price indexes are:
  - GDP deflator
  - Consumer Price Index (CPI)
  - Personal Consumption Expenditure price index (PCEPI, or just "PCE")

Price Indexes: GDP Deflator

- The **GDP deflator** is a special price index that allows us to convert nominal to real GDP, and vice-versa
- It is the average level of prices of all goods and services included in GDP
- Let P_t^y be the GDP deflator at quarter t, Y_t be real GDP, and PY_t be nominal GDP, then

$$Y_t = \frac{PY_t}{P_t^y/100}$$

- Similarly, if we know real GDP we can compute the GDP deflator as

$$P_t^y = 100 \times \frac{PY_t}{Y_t}$$

- The deflator is defined with respect to a **base year**, the year for which we are measuring real GDP at constant dollars

$$P^y_{\text{base year}} = 100$$

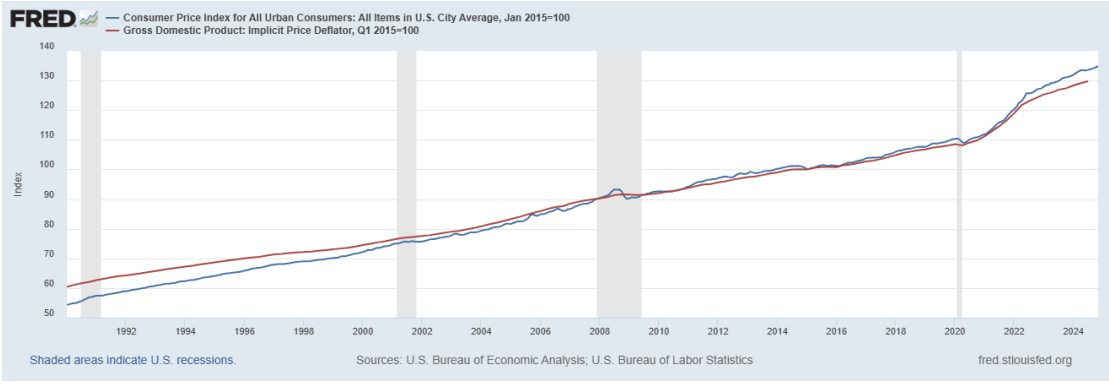
Price Indexes: CPI

- The **consumer price index** measures the prices of consumer goods and services
- The CPI is measured monthly by the BLS
- The idea is to fix a basket of goods and services, and measure their prices every month
- As an index, the CPI is expressed relative to some base period:

$$CPI_{2020} = 100 \times \frac{P^c_{2020}}{P^c_{2000}}$$

- In practice, the basket is not completely fixed and is updated every few years, in order to keep track with changes in consumption habits and patterns
- Technological innovation means that the CPI may overstate the cost of living
  - while an iPhone 13 may have a similar price tag as an iPhone 5, it is substantially more sophisticated and so it is effectively "cheaper"
  - The CPI fails to account automatically for this type of quality adjustments

GDP Deflator and CPI



The Inflation Rate

- Besides being used to convert nominal to real variables, price indexes are also useful to compute the inflation rate
- The inflation rate is the growth rate of a price index over a given period

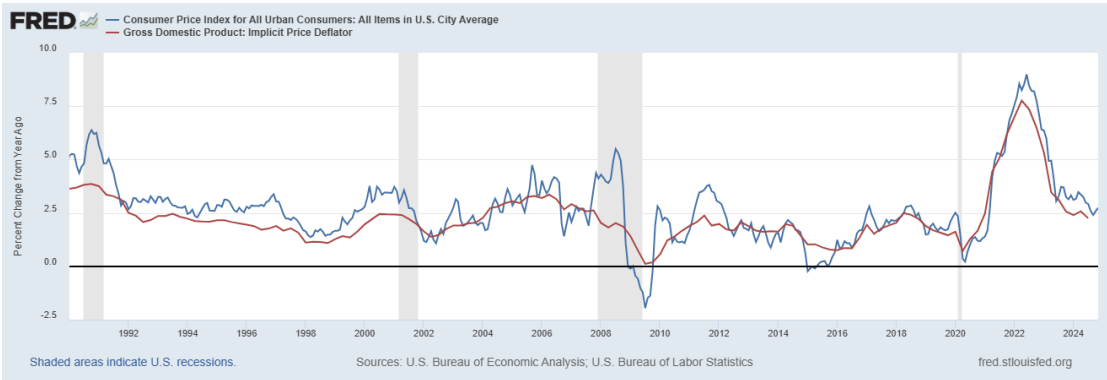
$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} (= g_t^P)$$

- Like GDP growth, the inflation rate is usually annualized
- It is also common to report **year-on-year inflation**, the change in the price index relative to its value in the same month of the previous year

$$\pi_t^{yoy} = \frac{P_t - P_{t-12}}{P_{t-12}}$$

- In this case, there is no need to annualize

Inflation: GDP Deflator vs CPI



5. Interest Rates

Interest Rates

Interest Rate

The rate of return promised by a borrower to a lender.

- An annual interest rate of 3% means that a \$100 loan involves a repayment of \$103 one year from now
- There are many interest rates in the economy, depending on who the borrower and the lender are, the maturity of the loan, etc.
- Most interest rates tend to more or less closely a reference or policy rate that is set by the Federal Reserve (more on this later)

Nominal vs. Real Interest Rates

- Nominal interest rates measure returns in terms of current dollars
- In the previous example, a 3% nominal rate promises a repayment of \$103 one year from now
- This could be a good deal if inflation is zero!
- But what if annual inflation is equal to 5%? Taking today as the base period, we need to deflate those \$103 to today's dollars
- In this case, the price level is equal to 100 today and 105 tomorrow. Thus the real value of \$103 tomorrow is

$$\frac{\$103}{105} \times 100 = \$98.1$$

Nominal vs. Real Interest Rates

- While the nominal interest rate is positive, the real return is actually negative!

$$\text{real return} = \frac{\text{real repayment tomorrow}}{\text{investment today}} - 1 = \frac{\$98.1}{\$100} - 1 = -1.9\%$$

  In real terms, this loan is a bad investment!

- The **real interest rate** measures the return on a loan while taking account the effect of inflation

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t}$$

- This is usually approximated as

$$r_t \simeq i_t - \pi_t$$

- In our example,

$$r_t = 3\% - 5\% = -2\% \simeq -1.9\%$$

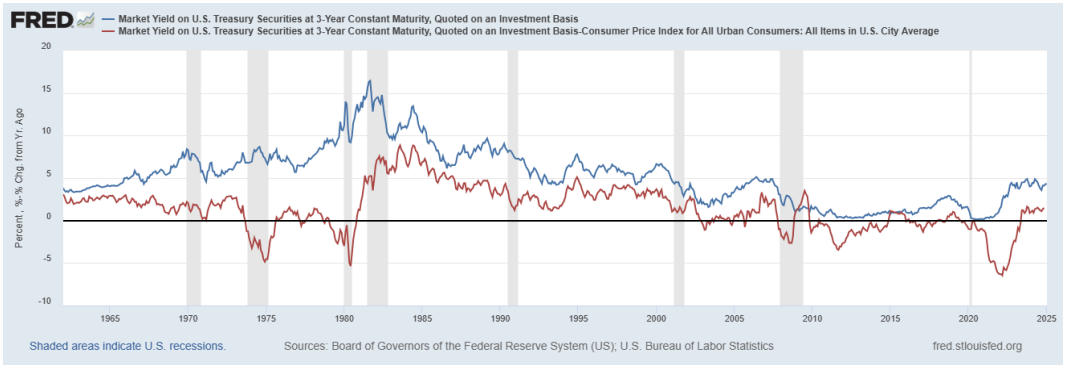
Expected Real Interest Rate

- In practice, when you take a car loan or a mortgage, you specify and fix a nominal interest rate for the length of the contract
- However, you do not know beforehand what inflation is going to be while you repay the loan
- Since $r_t = i_t - \pi_t$, you do not know what the real interest rate is either
- For this reason, it is useful to define the **expected real interest rate**

$$r_t^e = i_t - \pi_t^e$$

- This is the real interest rate implied by a given nominal interest rate and an expected rate of inflation
- Since no one knows inflation in advance, this is the relevant interest rate for agents when making economic decisions

Nominal and Real Interest Rates



- Nominal rate approximated as 3 year yield on treasury securities (FRED: DGS3)
- Real rate is approximated as the difference between DGS3 and the annual growth rate of the CPI