

Intermediate Macroeconomics

Measuring the Macroeconomy

ECON 3311 – Spring 2025

UT Dallas

Introduction

- In this lecture we will examine:
 - The importance of gross domestic product (GDP) – the overall level of goods and services that an economy produces
 - Relevant to determine when economic intervention may be warranted
 - National Income Accounting began with the Great Depression and the need to quantify economic downturns
 - Composition of GDP and how it has changed over time
 - How we can use GDP to track and explain the evolution of living standards over time and the differences in living standards across countries
 - We will examine important measures that are missed by the traditional GDP calculation
 - The difference between nominal GDP and real GDP and how GDP can be compared between two countries

Gross Domestic Product

Gross domestic product (GDP):

Market value of the final goods and services produced in an economy over a certain period

↳ Prices × Quantities

↳ Annual (2022, 2024, ...)
Quarterly (2019-3; 2021-4)

We need to distinguish between real GDP (which takes into account inflation) and nominal GDP (which does not take inflation into account) $\text{Nominal GDP}_t = \text{Prices}_t \times \text{Quantities}_t$

Real
Nominal $\text{GDP}_t = \text{Prices}_t \times \text{Quantities}_t$

↳ base year

↳ Global Financial Crisis

Q Recessions



Three ways to measure GDP

1) **Expenditure** measure of GDP:

- The total purchases in the economy by the different sectors of the economy

2) **Income** measure of GDP:

- All the income earned in the economy

3) **Production** measure of GDP:

- The value of goods produced in the economy

↑
Market ↑
Final ↗ and services

*All three approaches give (nearly) identical measures of GDP

We will be using the three different approaches for different applications

Expenditure measure

The national income accounting identity states:

$$Y = C + I + G + \underbrace{NX}_{\substack{\text{Exports} - \text{Imports} \\ (\text{Net exports})}}$$

Where:

- Y = GDP (in dollars)
- C = Consumption
- I = Investment
- G = Government purchases
- $NX = X - M = \text{Exports} - \text{Imports}$

\hookrightarrow Include products produced both
domestically and abroad.

All goods and services have to be **consumed/invested/purchased** by one of these categories

Different components of expenditure

Consumption (C): Goods and services purchased by individuals and families

- Restaurant meals, cars, medical care, law services, etc.

Households

Investment (I): Investments made by the private sector

Firms

- Business investment - office buildings, factories, machines, tools, construction of new homes (residential investment)
- Residential investment – construction of new homes and apartment buildings
- Inventory investment – changes in inventory

Different components of expenditure

Government purchases (G): Purchases of goods and services made by the government

Fiscal budget / Fiscal Sector

- Public schools, highways, national defense, etc.
- There is a difference between government purchases and government spending
- Government spending includes transfer payments (i.e. social security payments), but it is not included in government purchases and GDP because nothing is produced

Net exports (NX): Net exports are equal to exports minus imports

- Exports: Goods and services produced domestically and sold abroad
- Imports: Goods and services produced abroad but purchased domestically
- Net exports can be positive or negative

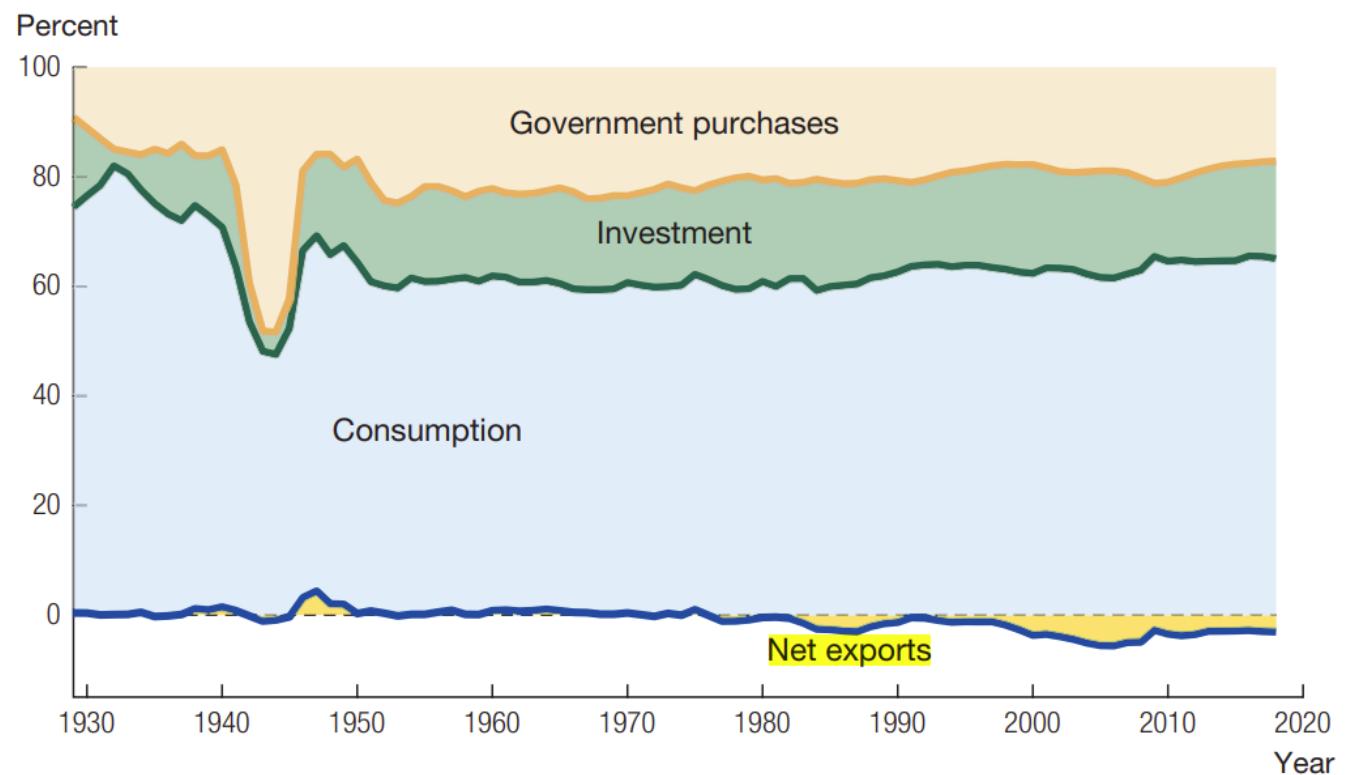
Composition of U.S. GDP

Expenditure-side decomposition of GDP shows the general stability of the shares over much of the twentieth century.

$$\frac{Y}{Y} = \frac{C}{Y} + \frac{I}{Y} + \frac{G}{Y} + \frac{NX}{Y}$$
$$1 = \frac{C}{Y} + \frac{I}{Y} + \frac{G}{Y} + \frac{NX}{Y}$$

$\approx 0.68 \text{ in 2020}$

Composition of U.S. GDP



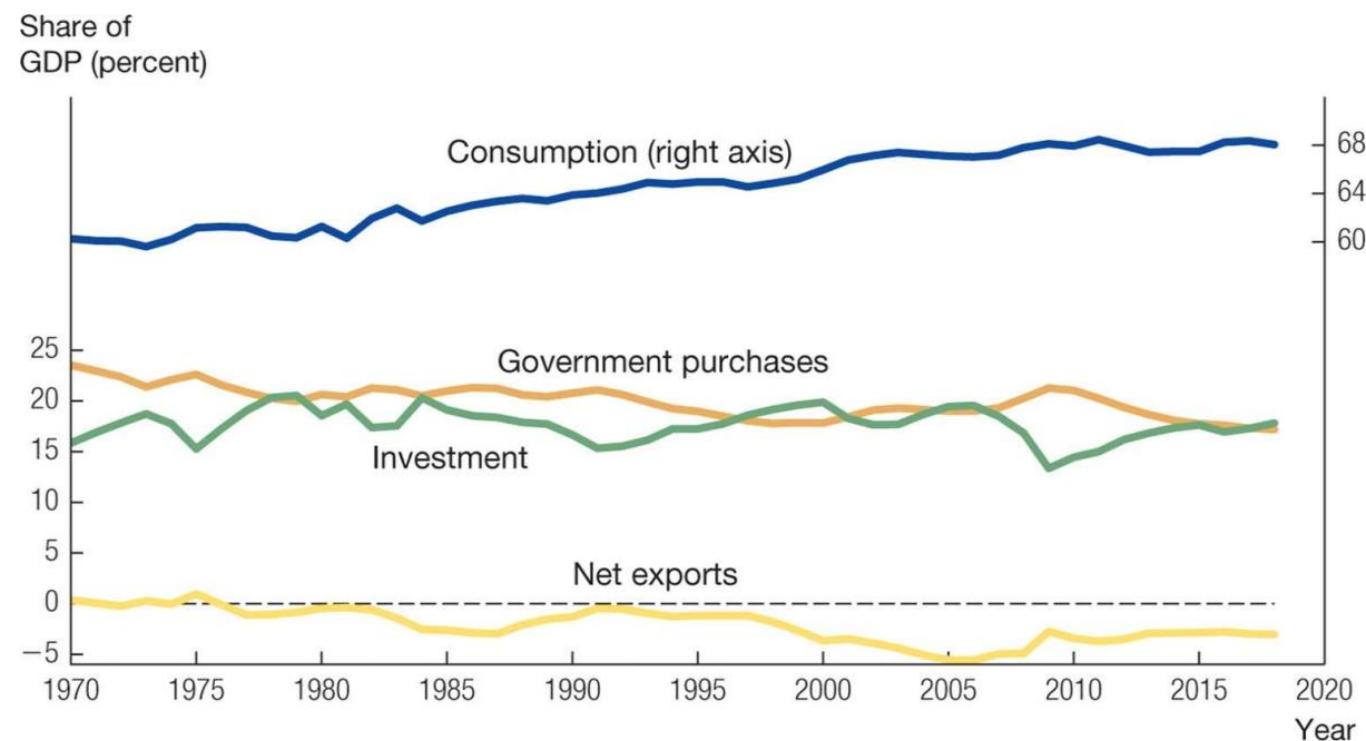
Source: U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov.

Share of different categories of GDP

Note that while the shares seem relatively constant, out of a GDP of 23 trillion, even a small change can represent hundreds of billions of dollars

For instance, consumption was 63 percent of GDP in 1970 and 68 percent in 2014

The US has had a trade deficit since around 1980



Source: U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov.
Copyright © 2021 W.W. Norton & Company

Income approach to GDP

The income approach measures the sum of all income earned in the economy – the idea is that every dollar of product sold is a dollar of income earned.

The different types of income includes:

- Wages
- Salaries
- Employee benefits
- Rental income
- Profits of firms
- Interest earned by individuals

Income approach to GDP

For example, suppose you buy \$1000 worth of flour from a flour mill and sell bread for \$2000

- Through the expenditure approach, GDP is \$2000 (the amount of money spent on bread)
- The income of the flour mill is the \$1000 it received from the person who sells bread
- Your income is \$1000 (the \$2000 you received for the bread minus the \$1000 you paid the flour mill)
- Overall income is \$2000, which is the same as the amount of money spent on the bread

GDP calculation example

Item	Amount (billions)		Item	Amount (billions)
Gross Domestic Product (GDP)	23,315		Gross Domestic Product (GDP)	23,315
Consumption	15,902		Wages and salaries	10,290
Investment	4,113		Benefits	2,248
Government	4,160		Proprietors income	1,753
Exports	2,539		Rental income	723.8
Imports	— (3,401)		Corporate profits	2,771.1
			Net interest	644.1
			Taxes less subsidies	1,181.5
			Business transfer	171.0
			Depreciation	3,831

We can see how the GDP yields the same amount via expenditure or income

(Depreciation: Wear and tear of capital equipment)

Production approach to GDP

GDP represents the **value of final goods and services produced** in an economy during a given period

Final goods: When using this approach, we have to make sure there is no double-counting.

For instance, if \$1 million worth of apples are sold to a factory that sells \$3 million worth of apple sauce, we only count the \$3 million and not the \$1 million.

The value of the apples is already counted when selling the apple sauce

Some examples of what is not included in GDP are:

- Transfer payments
- Climate change
- Tasks done at home
- Babysitting services (if not reported)
- Illegal activities

What Is Included in GDP and What's Not?

- Market Transactions Only
-

Not included:

- Health and Life Expectancy
- Environmental Resources

GDP review questions

Which of the following is/are not included in the expenditure approach to national income accounting?

- a. Software
- b. Taxes
- c. Defense Expenditures
- d. Health care expenditures
- e. Software investment

Which of the following counts toward changes in the current GDP?

- a. You find \$10 on the sidewalk
- b. You purchase a used stereo from a friend
- c. The government builds a new highway
- d. You fix your own sink
- e. None of the answers above are correct

Beyond GDP

Due to the many aspects of our well-being that the GDP measure misses, other measures have been looked at to complement GDP when determining the welfare of individuals in a country

One study by Jones and Klenow (2016) incorporates life expectancy, leisure per adult, and inequality

For instance, suppose we look at the United States and France:

Item/Country	Per capita GDP	Life expectancy	Consumption share of GDP	Leisure	Inequality	Overall Welfare Index
United States	100	77.8	0.845	836	0.658	100
France	70.3	80.8	0.776	629	0.471	91.1

While per capita GDP is lower for France, the higher life expectancy, less hours worked (more leisure), and lower inequality leads their welfare index to be much closer to that of the United States

Measuring Changes in GDP over Time

*When examining GDP over time, we need to take into account changes in prices

- This is especially true in periods like the past year when inflation has been high

Nominal GDP:

- A measure of GDP using current - year prices

What year to use as base?

Real GDP:

- A measure of GDP using base year prices so that only the actual quantity of goods and services produced can change GDP

$$\text{Nominal GDP} = \text{price level} \times \text{Real GDP}$$

$$\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{price level}}$$

In 2010, nominal GDP was \$15.05 trillion in the US and in 2022, nominal GDP was \$23.30 trillion in the US – does this mean that production went up by 55%?

→ No

Measuring Changes in GDP over Time

To compute GDP over time, we must use a certain year's prices

base year

For instance, suppose the economy only produces apples and its GDP increased from \$200 to \$300

*Suppose the GDP of \$200 was based on 200 apples being sold for \$1 each

- The increase to \$300 may be due to the price still being \$1 and more apples being produced – production has increased
- The increase to \$300 may be due to the price now being \$1.50 and the same amount of apples are being produced – production has not changed
- **Real GDP** (the actual amount of goods and services being produced) is different than nominal GDP (the value of the goods and services produced using the prices of that year) because prices are (almost) always changing

Measuring Changes in GDP over Time

- Nominal GDP:

$$Y_t = P_{1t} Q_{1t} + P_{2t} Q_{2t} + P_{3t} Q_{3t} + \dots + P_{Nt} Q_{Nt}$$

apples *Peaches* *Cars* *...*

good variety
Period time index

- where N is the total number of goods and services in the economy, and P_{1t} represents the prices in year t and Q_{1t} represents the quantity in year t of good '1'
- To calculate real GDP, we keep the prices the same for every year
- For instance, if our base year is 2015, then real GDP for 2022 will be

$$Y_{2022} = P_{1,2015} \underbrace{Q_{1,2022}}_{\text{Base year}} + P_{2,2015} \underbrace{Q_{2,2022}}_{\text{Base year}} + P_{3,2015} \underbrace{Q_{3,2022}}_{\text{Current year}} + \dots + P_{N,2015} \underbrace{Q_{N,2022}}_{\text{Current year}}$$

- Real GDP in 2023 would be:

$$Y_{2023} = P_{1,2015} \cancel{Q_{1,2022}}_3 + P_{2,2015} \cancel{Q_{2,2022}}_3 + P_{3,2015} \cancel{Q_{3,2022}}_3 + \dots + P_{N,2015} \cancel{Q_{N,2022}}_3$$

Real GDP can only change between 2022 and 2023 if the quantities produced change

GDP calculation example

What is real GDP in 2021 (using 2021 prices)?

What is real GDP in 2022 (using 2021 prices)?

Suppose you are given that nominal GDP in 2023 is the same as nominal GDP in 2021.

Does this mean that real GDP increased, decreased, stayed the same, or is there not enough information to determine?

$$N\text{GDP}_{23} = R\text{GDP}_{21}$$

$$N\text{GDP}_{21} = R\text{GDP}_{21} \text{ base=21}$$

	2021	2022
Quantity of pistachios	1,000	1,100
Quantity of video games	500	500
Price of pistachios	\$1.00	\$1.50
Price of video games	\$15.00	\$14.75

} Cannot say whether changes come from quantities (production) or prices (valuations)

$$R\text{GDP}_{2021} = 1.100 + 15.500 = 8500$$

$$R\text{GDP}_{2022} = 1.1100 + 15.500 = 8600$$

Different indexes for measuring GDP

One factor that needs to be taken into account when measuring real GDP is what year will be used for base year prices

- Laspeyres index
 - Calculates changes in real GDP using the initial prices
- Paasche index
 - Calculates changes in real GDP using the final year prices

Over long time intervals the two indexes can result in substantial differences when calculating the GDP growth rates (next slide)

Therefore, the method most commonly used is an average of the Laspeyres and Paasche indices and is called the Fisher index (chain weighting)

- Can be applied on a year-by-year basis if we compute real GDP each year

*For example, if calculating the growth rate of GDP using the Laspeyres index is 16% and using the Paasche index is 17%, then using the Fisher index the growth rate is 16.5%

Advantage of using the Fisher index

*Suppose we are comparing GDP in 1990 to 2010

- Over this time period, there was great technological progress, especially with regard to computers, leading to lower prices for the same quality computer
- As a result, a computer would be much more expensive relative to other goods in 1990 versus 2010
- The increase in the use of computers would lead to much higher GDP growth using 1990 prices (Laspeyres index) than 2010 prices (Paasche index)
- Using the Fisher index (an average of both) bypasses the latter problem

Calculating the inflation rate

The relationship between real and nominal GDP is given by the following equation:

$$\text{nominal GDP} = \text{price level} \times \text{real GDP}$$

The price level is called the GDP deflator

Because the percentage change in a product is approximately equal to the sum of the percentage changes, we can write the equation above as:

$$(\text{per\% change in nominal GDP}) = (\text{per\% change in price level}) \times (\text{per\% change in real GDP})$$

The **inflation rate is the percentage change in the price level**

$$\hookrightarrow \frac{\text{Price level}_{2021}}{\text{Price level}_{2020}} - 1 = \pi_{2021}$$

Reminder: for $z = x \cdot y$
rate of growth $g_z \approx g_x + g_y$
(g_x, g_y : rates of growth of x and y)

When not to use chain-weighting

The equation $Y = C + I + G + NX$ holds for nominal measures of consumption, investment, government purchases, and net exports

However, the equation will not hold for the real chain-weighted values of these variables

- This is because different prices are used in constructing the different components

Therefore, when calculating the shares that certain components make up of GDP, then nominal measures are used, while when calculating economic growth then chain-weights (Fisher index) is used

for { - Knowing GDP share of consumption ($\frac{C}{Y}$): use nominal quantities
- Knowing real GDP growth: use chain weights

Comparing GDP between countries

*When comparing GDP across countries, we need to take into account that different countries use **different currencies**.

The **exchange rate** between two currencies determines the rate at which one currency can be exchanged for the other

For example, in 2021 US GDP was \$23.32 trillion and UK GDP was £2.28 trillion

Can we conclude that US GDP was about 10 times that of the UK?

We need to take into account the exchange rate, as a pound is worth more than a US dollar (the average exchange rate in 2021 was \$1.38/£)

Therefore, UK GDP in 2021 can also be given as:

$$2.28 \text{ trillion pounds} \times \frac{\$1.38}{\text{pound}} = \$3.15 \text{ trillion}$$

Comparing GDP between countries - 2

We also need to take into account that there are **different prices in the countries**.

For instance, cars and gasoline are cheaper in the US, while healthcare services and internet/phone plans are cheaper in the UK

Therefore, if one country is much less expensive than the other, then their GDP is understated relative to the more expensive country

For instance, suppose that prices in the UK are 80% of the prices in the US

Then, we need to take the GDP of the UK in dollars (calculated in the previous slide) and adjust it for the lower prices:

$$\text{Price}_{US} \times \frac{\text{Price}_{UK}}{\cancel{\text{Price}_{UK}}} \times Y_{UK}^{\text{nom}}$$

$$UK \text{ real GDP (US prices)} = \frac{\text{price level US}}{\text{price level UK}} \times UK \text{ nominal GDP in dollars}$$

$$UK \text{ real GDP (US prices)} = \frac{1}{0.80} \times \$3.15 \text{ trillion} = \underline{\underline{\$3.94 \text{ trillion}}}$$

In general, higher income countries have higher wages and therefore the prices will be higher

Conclusion

- National income accounting allows us to gauge the economy's performance constantly
- GDP is the most important measure and can be calculated using the expenditure approach, income approach, or production approach
- Nominal GDP is the value of GDP in the prices of the current year, while real GDP is the comparison of GDP in two different years using the same prices → Base year prices
- There are different ways to set base year prices, with chain-weighting being the most commonly used

For comparisons between two countries, two conversions need to be made:

1. Use the exchange rate to convert to a common currency
2. Adjust the real GDP by considering the different price levels in the two countries

Practice exercises

1. Real and Nominal GDP

Calculate real GDP in 2022 and 2023

Calculate real GDP in 2022 and 2023 (using 2022 prices)

	2022	2023
Quantity peaches	1000	1200
Quantity of Pepsi (units)	800	600
Price of peaches	\$1.00	\$1.50
Price of Pepsi	\$5.00	\$4.50

2. Comparing GDP between countries

The table on the right depicts information on the Eurozone and US economies in 2015. Try and answer the following:

- The value of Eurozone nominal GDP in U.S. dollars is _____ billion.
- The value of the Eurozone nominal GDP in U.S. dollars adjusted for price differences is _____ billion.
- When we convert the Eurozone's nominal GDP into dollars and adjust for price differences, the U.S. economy is about _____ times the size of the Eurozone economy

	2015
Eurozone nominal GDP (€ billions)	€11,548
U.S. nominal GDP (\$ billions)	\$20,580
Dollar/euro exchange rate	\$1.10/€1
P_{EZ}/P_{US}	0.85