# 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

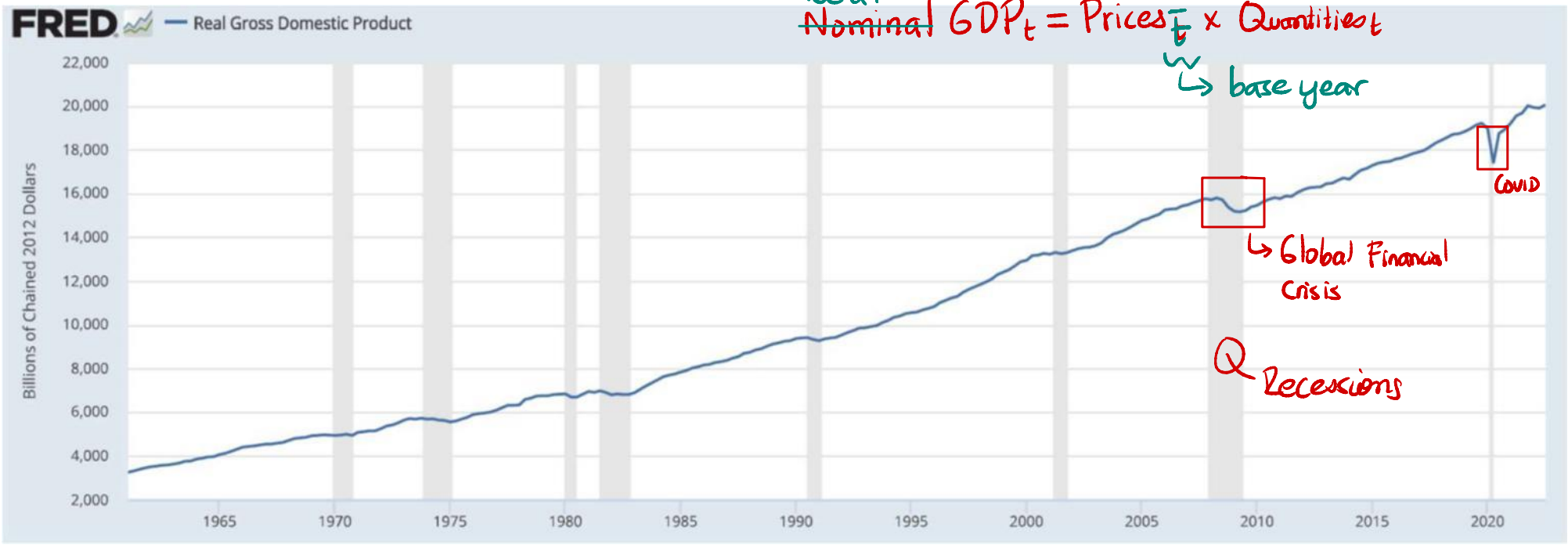
↳ annual (2022, 2024, ...)
Quarterly (2019-3; 2021-4)

We need to distinguish between real GDP (which takes into account inflation) and nominal GDP (which does not take inflation into account)

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

$\text{Real GDP}_t = \text{Prices}_{\bar{t}} \times \text{Quantities}_t$

↳ base year



# 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:

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

Exports – Imports (Net exports)

Include products produced both domestically and abroad

Where:

- Y = GDP (in dollars)
- C = Consumption
- I = Investment
- G = Government purchases
- NX = X – M = Exports – Imports

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

Households

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

**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

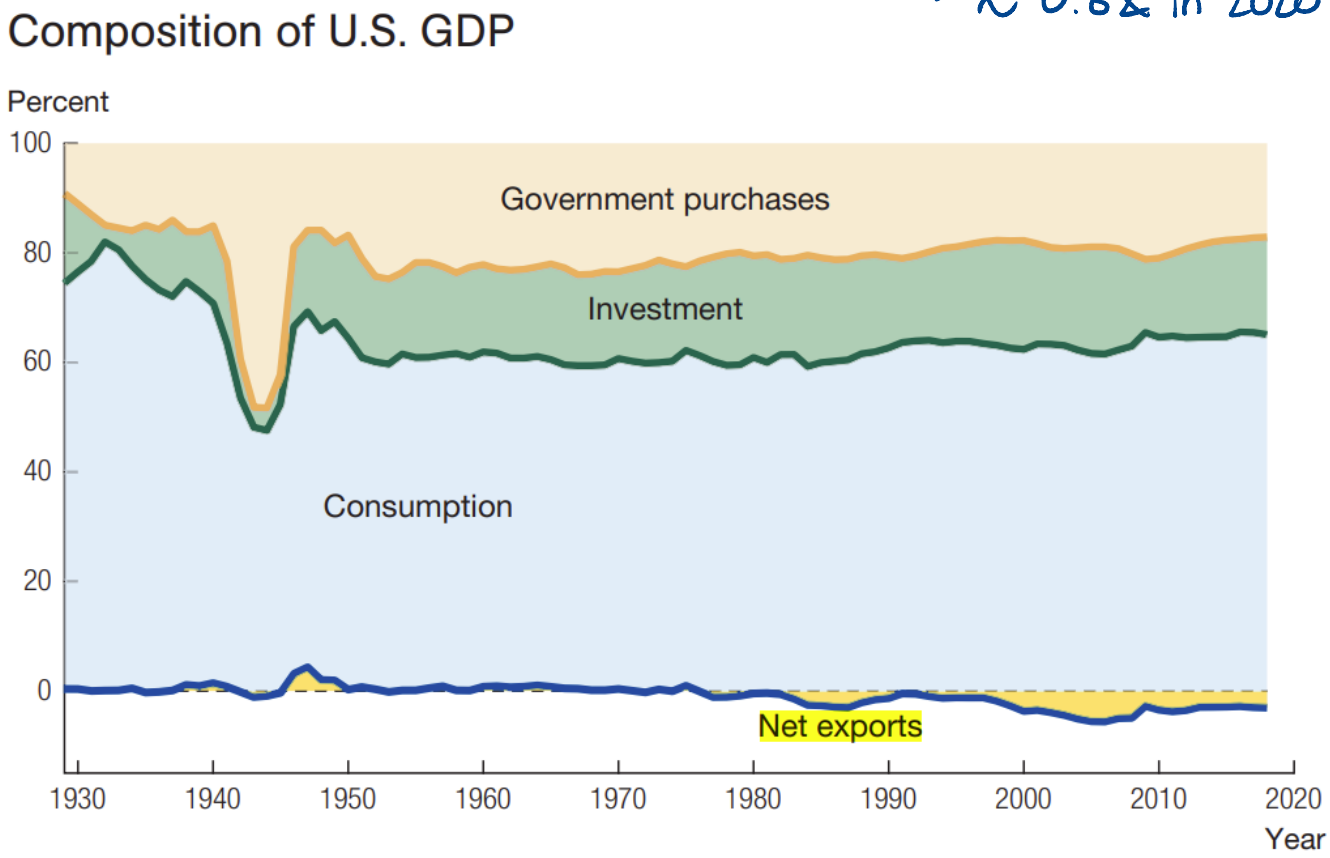
# Composition of U.S. GDP

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

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

$\frac{C}{Y} \approx 0.68$ in 2020

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



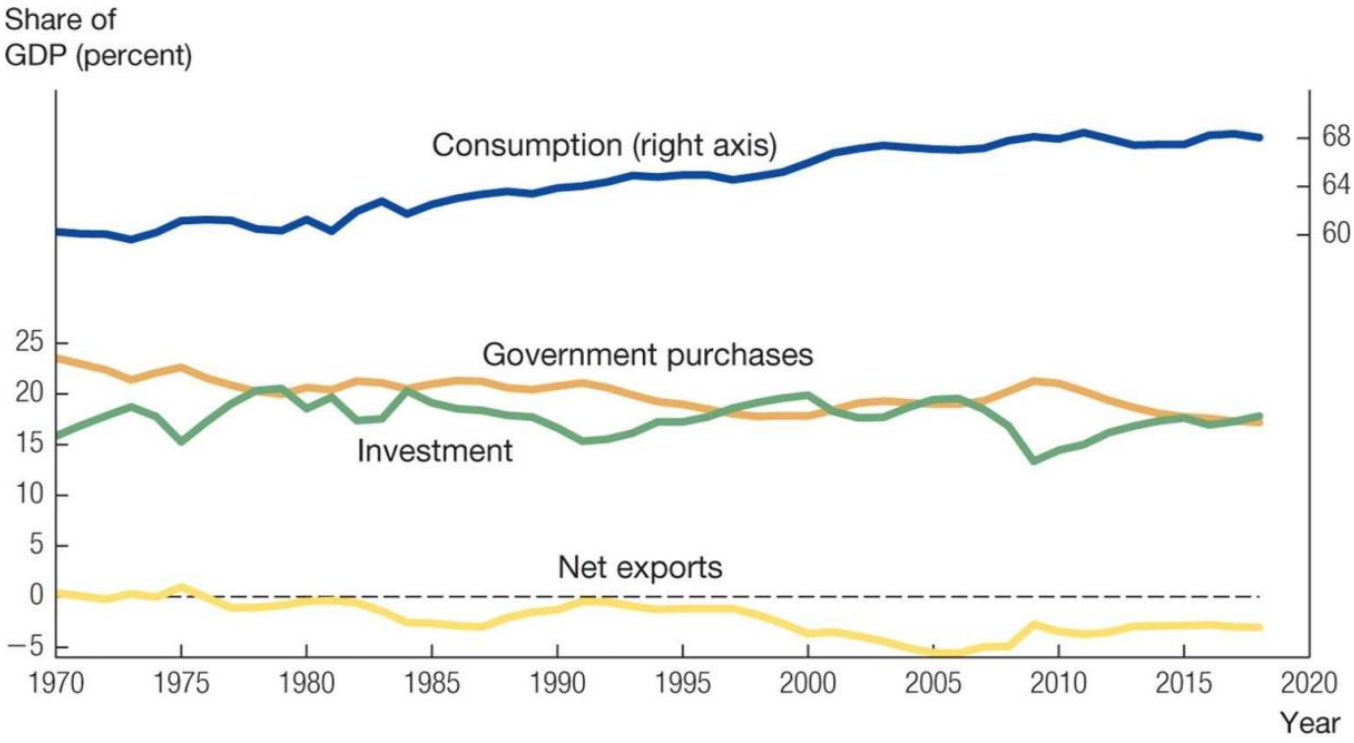

*Source:* U.S. Department of Commerce, Bureau of Economic Analysis, www.bea.gov.

# 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.

# 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

**Real GDP:**

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

What year to use as base?

$$Nominal\ GDP = price\ level \times Real\ GDP$$

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

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:

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

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

$$Y_{2022} = P_{1,2015}Q_{1,2022} + P_{2,2015}Q_{2,2022} + P_{3,2015}Q_{3,2022} + \cdots + P_{N,2015}Q_{N,2022}$$

Base year; Current year

- Real GDP in 2023 would be:

$$Y_{2023} = P_{1,2015}Q_{1,2023} + P_{2,2015}Q_{2,2023} + P_{3,2015}Q_{3,2023} + \cdots + P_{N,2015}Q_{N,2023}$$

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

# GDP calculation example

$NGDP_{23} = rGDP_{21}$

$NGDP_{21} = RGDP_{21}$ base=21

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?

| | 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 variations

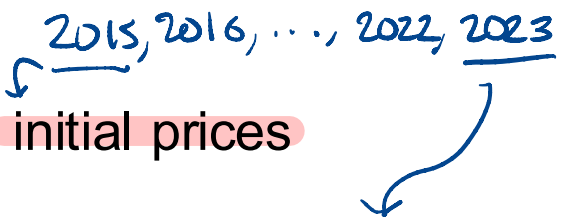
$rGDP_{2021} = 1.1000 + 15.500 = 8500$

$rGDP_{2022} = 1.1100 + 15.500 = 8600$

# 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:

*nominal GDP = price level x 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:

*(per· change in nominal GDP) = (per.change in price level) x (per· change in real GDP)*

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

$$\rightarrow \frac{\text{Price level}_{2021}}{\text{Price level}_{2020}} - 1 = \Pi_{2021}$$

Reminder: for $z = x.y$

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 $\left(\frac{C}{Y}\right)$: 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:

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

# 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:

$$Price_{US} \times \frac{Price_{UK}}{Price_{UK}} \times Y^{nom}_{UK}$$

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

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

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
- 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

$y_{22}^{nom} = (1)(1000) + (5)(800) = 5000$

$y_{23}^{nom} = (1.5)(1200) + (4.5)(600) = 4500$

## 1. Real and Nominal GDP

$y_{22}^{real} = (1)(1000) + (5)(800) = y_{22}^{nom}$

Calculate ~~real~~ Nominal GDP in 2022 and 2023

$y_{23}^{real} = (1)(1200) + (5)(600) = 4200$

Calculate real GDP in 2022 and 2023 (using 2022 prices) → Prices of base year (2022)

| | 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 |

$NGDP^{\$}_{EZ,15} = €11548 \times 1.10\ \$/€ = \$12702.8$

$NGDP^{\$,adj}_{EZ,15} = \frac{P_{US}}{P_{EZ}} \cdot \$12702.8 = \left(\frac{1}{0.85}\right)\$12702.8 = \$14944.5$

# 2. Comparing GDP between countries

$\frac{NGDP^{\$}_{US,15}}{NGDP^{\$,Adjust}_{EZ,15}} = \frac{\$20580}{\$14944.5} = 1.38$

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 $12702.8 billion.
- The value of the Eurozone nominal GDP in U.S. dollars adjusted for price differences is $14944.5 billion.
- When we convert the Eurozone's nominal GDP into dollars and adjust for price differences, the U.S. economy is about 1.38 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 |

↳ $\frac{P_{US}}{P_{EZ}} = \frac{1}{0.85} = 1.18$