Principles of Macroeconomics: Real GDP and CPI

Class 2

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Overview

- Announcements:
  - You should be able to access your homework on Achieve (due September 12th at 11:59pm)
  - Make sure you have read the syllabus – if something is in the syllabus, don't email me about it
- Topics:
  - National Accounts recap
  - Nominal vs Real
  - Real GDP
  - Consumer Price Index
- Readings:
  - Chapter 7.2 (Real GDP), chapter 7.3 (Price Indices), chapter 9.1 (Comparing Economies)

National Accounting Recap

- Production: GDP (Y)
- Spending: $C + I + G + (x - i)$
- Income: Wages + Rent + Interest + Profits
- These all come from the circular flow diagrams

- Production = Spending = Income
- $Y = C + I + G + (x - i)$
- We can measure production using Value Added, spending using the national accounts data, and income using the GNI accounts data

Nominal vs. Real

- Suppose we want to know the value of a good sold – say Labubu toys (if you don't know what these are, neither do I).
- Then we can multiply the price times the quantity:

$$Value_{Labubu} = P_{Labubu} \times Q_{Labubu}$$

- Extend this logic to the full economy:

$$V_{US} = P_{US} \times Q_{US}$$

- We call P_{US} the price level, and Q_{US} real GDP (RGDP).
- Nominal GDP (NGDP) is then the value of goods and services produced in the US.

Well, what is the Quantity of GDP?

- We can easily measure NGDP by just computing the value for each item (like Labubu toys) and adding them up.
- But what does it mean to add quantities?
  - Suppose the economy consists of Labubu toys and Squishmallows. Suppose 7 Labubu toys were sold and 10 Squishmallows were sold. Then:

$$? = 7 \text{ Labubu} + 10 \text{ Squishmallows}$$

Calculating RGDP

- In practice, we do the following:
  1. Pick a "base year."
  2. Collect prices from that base year.
  3. Collect quantities for all years you are interest in.
  4. Compute the value of GDP in each year using base year prices.
- This way, we have a value still, but we keep prices fixed over time.

An Example

	Year 1	Year 2
Quantities (billions)		
Labubu	2	2.2
Squishmallows	1	1.2
Prices (dollars)		
Labubu	45	54
Squishmallows	15	21
NGDP (billions of dollars)		
RGDP (billions of Year 1 dollars)		

- Compute nominal GDP in each year
- Compute real GDP using year 1 prices
- What is the rate of change in the GDP price index?

Answers

- Compute nominal GDP
  - Year 1: $2 \times \$45 + 1 \times \$15 = \$105$
  - Year 2: $2.2 \times \$54 + 1.2 \times \$21 = \$144$
  - NGDP growth rate: $100\left(\frac{144-105}{105}\right) = 37.1\%$
- Compute real GDP
  - Year 1: $2 \times \$45 + 1 \times \$15 = \$105$
  - Year 2: $2.2 \times \$45 + 1.2 \times \$15 = \$117$
  - RGDP growth rate: $100\left(\frac{117-105}{105}\right) = 11.4\%$
- What is the rate of change in the GDP price index?
  - $\frac{NGDP_2}{NGDP_1} = \frac{P_2}{P_1} \times \frac{RGDP_2}{RGDP_1}$
  - $\frac{P_2}{P_1} = \frac{NGDP_2}{NGDP_1} \times \frac{RGDP_1}{RGDP_2} = \frac{144}{105} \times \frac{105}{117} = 1.23$
  - So: $100\left(\frac{P_2-P_1}{P_1}\right) = 23\%$

- We can simplify the price index:

$$\begin{aligned}\frac{P_2}{P_1} &= \frac{NGDP_2}{NGDP_1} \times \frac{RGDP_1}{RGDP_2} \\ &= \frac{NGDP_2}{NGDP_1} \times \frac{NGDP_1}{RGDP_2} \\ &= \frac{NGDP_2}{RGDP_2}\end{aligned}$$

- We call this the "Paasche Price Index"
- It only uses period 2 quantities to add up prices in each year.

But...

- Which year do we choose as a base year?
- Let's choose period 2 as our base year now:
  - Year 1: $2 \times \$54 + 1 \times \$21 = \$129$
  - Year 2: $2.2 \times \$54 + 1.2 \times \$21 = \$144$
  - Real GDP growth: $100\left(\frac{144-129}{129}\right) = 11.6\%$
- But before we got real GDP growth of 11.4%
- So how do we solve this?

The BEA Solution

- The BEA uses what is called a "geometric mean" to calculate real GDP:

$$\frac{RGDP_2}{RGDP_1} = \left(\frac{GDP_2 \text{ at year 1 prices}}{GDP_1 \text{ at year 1 prices}}\right)^{\frac{1}{2}} \left(\frac{GDP_2 \text{ at year 2 prices}}{GDP_1 \text{ at year 2 prices}}\right)^{\frac{1}{2}}$$

- This is called the "Fisher Index"
- Going back to Labubu and Squishmallows:

$$\begin{aligned}\frac{RGDP_2}{RGDP_1} &= \left(\frac{117}{105}\right)^{\frac{1}{2}} \left(\frac{144}{129}\right)^{\frac{1}{2}} \\ &= 1.1152\end{aligned}$$

- So we get a growth rate of 11.52%

Consumer Prices

- Just like GDP, consumption can be real and nominal as well.
  - Nominal consumption $\equiv$ dollars spend on consumption
  - Real consumption $\equiv$ quantity of goods consumed
- We call the price index for consumption the "Consumer Price Index" (CPI).
- The idea: measure how the price a "typical" basket of consumer goods changes over time.

CPI Example

- Suppose we have a basket of goods: 10 Labubu, 12 Squishmallows, and 6 Tamagotchi, with prices given below:

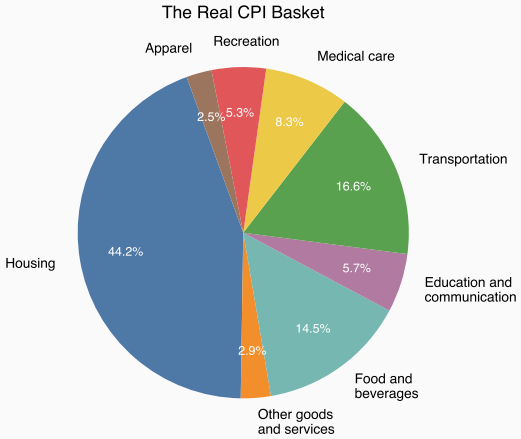
	Year 1	Year 2
Prices (dollars)		
Labubu	45	54
Squishmallows	15	21
Tamagotchi	20	36
Cost of Basket		

- Calculate CPI using: $100 \times \frac{P_2^{basket}}{P_1^{basket}}$
- Calculate CPI inflation

Answers

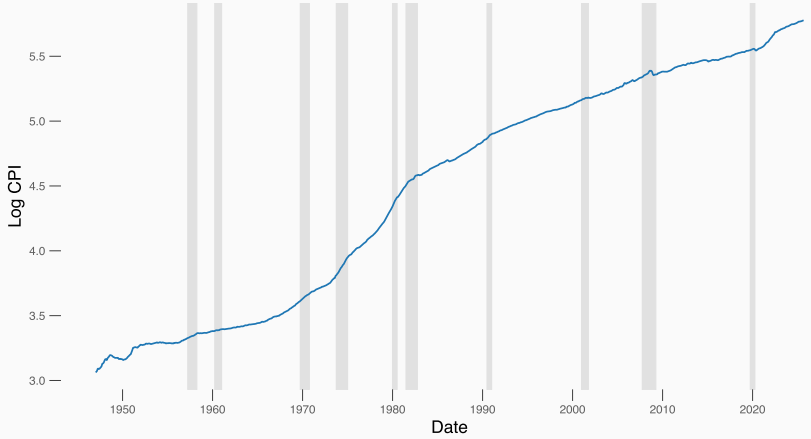
- The Cost of Basket:
  - Year 1: $10 \times \$45 + 12 \times \$15 + 6 \times \$20 = \$750$
  - Year 2: $10 \times \$54 + 12 \times \$21 + 6 \times \$36 = \$1008$
- So CPI is: $100 \times \frac{1008}{750} = 134.4$
- Therefore CPI inflation is 34.4%

The Basket (2023)



- To calculate the CPI, the BLS needs to decide on a basket. Is this the price index ALL people face?

Log CPI Time Series - Slope is Inflation



- Average inflation rate: 3.4% year-over-year from 1947M1 to 2025M7

Summary

- Real GDP vs. Nominal GDP
- GDP Deflator
- CPI
- There are other price indices – producer price index (PPI), personal consumption expenditure price index (PCEPI).
  - The Federal Reserve tends to look at PCEPI for their inflation gauge.
  - Go read about them.
- Next week: Long run growth
  - Read chapter 9.1