

MACROECONOMICS

73-240

LECTURE 3

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Last Class Recap

In the last class:

- ① We learnt the 3 ways of calculating GDP
- ② We saw that the different ways of calculating GDP allows us to answer different questions
- ③ We also learnt the difference between GNP and GDP.

Plan for today

Today we will:

- ① Talk about Real Quantities and Nominal Quantities
- ② and Discuss Measuring Prices

Real and Nominal Quantities

Real and Nominal GDP

- US GDP in 2018: 20.6 trillion, US GDP in 1998: 9.1 trillion
 - How much richer were we in 2018 compared to 1998?
- We need to measure how much quantities grew,
 - ... and separate that from the growth of prices

Real and Nominal GDP

- For I different goods and services, GDP as measured at market value is:

$$\text{GDP}_t = \sum_{i=1}^I p_{it} q_{it}$$

- Same unit of measurement
- But difficult to compare across time
- Current dollar GDP could increase due to changes in p or changes in q

Some Definitions

- A nominal quantity: denotes the market value of a quantity with price level defined at the time of production
- A real quantity: denotes the market value of a quantity with a common price level

Keeping Prices Fixed

Question: How do we compute growth of quantities only?

Answer: compute GDP and keep prices fixed (choose a **base year**)

Two options:

- Fix all the prices at year 2000
- Fix all the prices at year 2001
- Calculate Real GDP using those fixed base year prices.

Keeping Prices Fixed

- Nominal GDP is calculated as:

$$NGDP_t = \sum_{x \in X} P_{x,t} Q_{x,t}$$

where x denotes a particular good, and t denotes the period of interest

- Denote the base year price of good x as $P_{x,b}$
- Real GDP is calculated as:

$$RGDP_t = \sum_{x \in X} P_{x,b} Q_{x,t}$$

A 1 good economy

Example economy lasts for 2 periods and 1 good is produced: Apples
The data:

Quantities/Time	Year 1	Year 2
Apples	5	10
Prices		
Apples	0.2 \$	0.6 \$
Values		
Apples	1 \$	6 \$
Nominal GDP	1 \$	6 \$

Nominal GDP growth= 600%. But both quantities **and** prices are changing!

Base Year: $t = 1$

Quantities/Time	Year 1	Year 2
Apples	5	10
Prices	Base year	
Apples	0.2 \$	0.6 0.2 \$
Values		
Apples	1 \$	2 \$
Real GDP t	1 \$	2 \$

Real GDP growth = 100%

Real GDP controls for changes in prices

- Changes in nominal GDP can be due to:
 - Changes in overall level of prices
 - Changes in quantities of output produced
- Changes in real GDP can only be due to changes in quantities
 - because real GDP is constructed using constant base year prices

The importance of real vs. nominal

In the news:

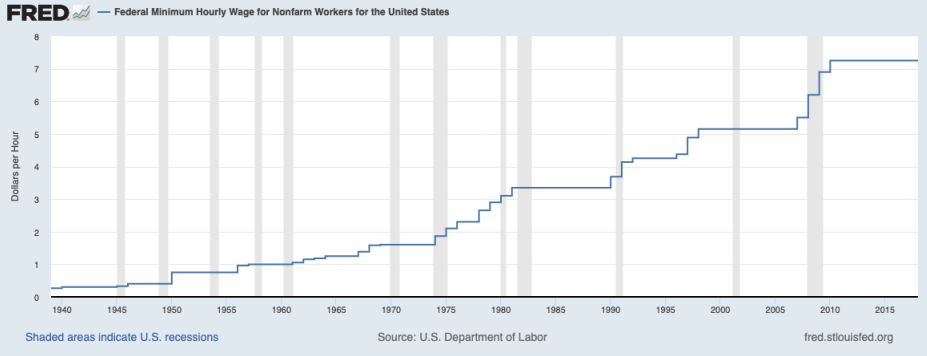
- US House passed a bill on July 18 2019, the details of which would be implemented incrementally over 6 years.
- It could boost the income of 17 million people
- It could result in 1.3 million jobs lost.

What is this legislation?

The Federal Minimum Wage

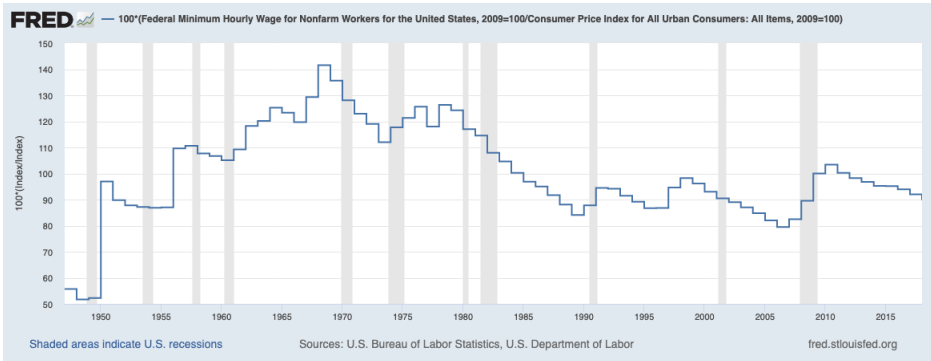


Nominal Federal Minimum Wage



Federal Minimum Wage

If we adjust for inflation, what stands out?



Minimum wage normalized to 100 in year 2009

Question

Back to Nominal vs. Real GDP

- Does the Base Year Matter?

Eg: The Economy of As and Bs

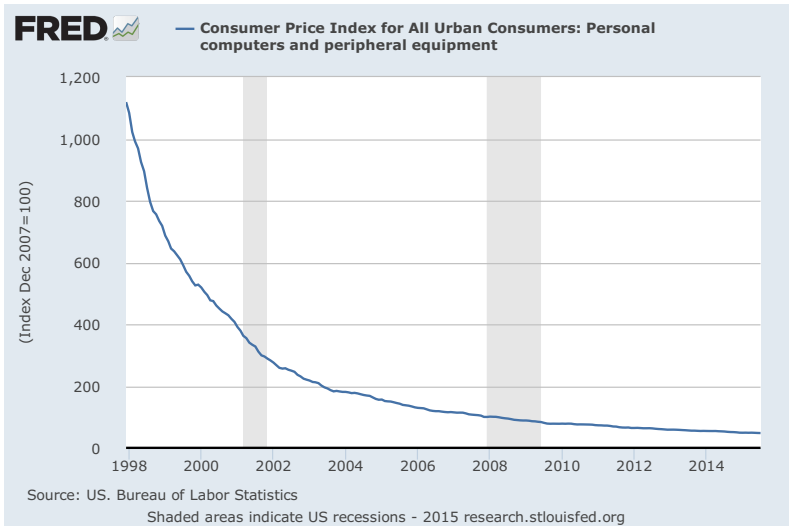
Suppose we have an economy that produces good A and B. What's Real GDP growth if the base year is year 1? if the base year is year 2?

Quantity/Time	Year 1	Year 2
A	1000	2000
B	1	3
Prices		
A	\$1	\$2
B	\$5000	\$1000

Does the Base Year Matter?

- In a single good economy, no.
- But most economies produce more than one good
- Choice of the base year is arbitrary, and matters to the extent that relative prices of goods change over time
- Growth will vary depending on base year chosen
- Rapidly growing sectors with declining relative prices will be overly weighted as base year gets further and further in the past.
- Which industry has been growing while its relative price has been declining?

Price Index for Computers



Prices then and now

Prices of Apple personal computers



Price tag in 1984: 2,495
Inflation Adjusted Price: 5,694



Price tag in 2018: 1099

Fixed vs Chained weights?

- Want to compare GDP this year vs. GDP in past year
- But we know the base year affects the weighting of different sectors/components of GDP
- Solution: use a rolling base year

Chained weighted GDP

- BEA provides *chain-weighted GDP* :

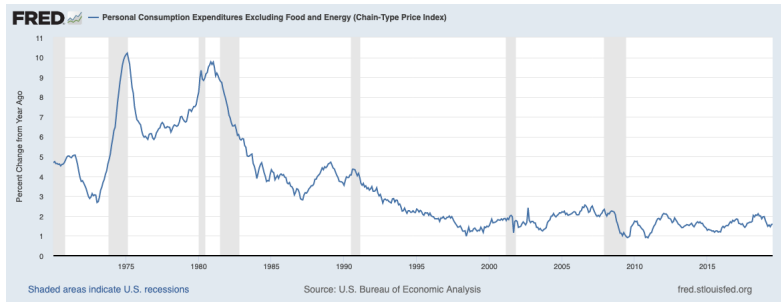
$$\Delta \text{GDP chain-weighted} = \sqrt{(\Delta \text{Real GDP}_{\text{year1}}) \times (\Delta \text{Real GDP}_{\text{year2}})}$$

- Chain-weighted GDP: updates weights every period
 - This means to compare growth between 2017 and 2018: use prices in 2017 and 2018
 - To compare growth between 2018 and 2019: use prices in 2018 and 2019
- What's the trade-off from using a Chain-weighted index?

PRICES AND INFLATION:
WHICH MEASURE SHOULD WE USE?

Whither inflation?

- (Aug 30 2019): In July, Fed's preferred measure to gauge inflation, the Personal Consumption Expenditure Price Index excluding food and energy (core PCEPI) rose 1.6% year-on-year
- Below Fed's inflation target of 2%



- Why is the core PCEPI the Fed's preferred index for measuring inflation? Why not CPI?

Some Definitions

- A price level is a weighted average of prices at a given time
- A price index is the ratio of two price levels.

Price Indexes

- A value of a basket of goods (V) is given by: $V = \sum_i P_i X_i$
(P=prices, X=goods)
- We can measure the cost of the entire basket of goods in two ways
 - ① GDP deflator
 - ② CPI (consumer price index)
- A price index is constructed by doing a ratio of GDP at two different times keeping prices OR quantities fixed

GDP Deflator

- Consider GDP in two different years 2017 and 2018
- Key feature: **keep prices fixed at the base year**

$$\text{GDP Deflator}(2018) = \frac{\sum_{i \in US} P_i^{2018} X_i^{2018}}{\sum_{i \in US} P_i^{2017} X_i^{2018}} = \frac{\text{Nominal GDP in 2018}}{\text{Real GDP in 2018}}$$

Note: using 2017 as reference (base) year

- Note : idea of GDP deflator is to see how much prices changed in the economy over time

Understanding the GDP deflator

- Suppose there are only three goods in an economy. We call them $i = 1, 2, 3$

P_{it} : market price of good i in year t

Q_{it} : quantity of good i produced in year t

$NGDP_t$: Nominal GDP in year t

$RGDP_t$: Real GDP in year t

- GDP deflator is

$$\begin{aligned}\text{GDP Deflator}_t &= \frac{NGDP_t}{RGDP_t} = \frac{P_{1t}Q_{1t} + P_{2t}Q_{2t} + P_{3t}Q_{3t}}{RGDP_t} \\ &= \left(\frac{Q_{1t}}{RGDP_t} \right) P_{1t} + \left(\frac{Q_{2t}}{RGDP_t} \right) P_{2t} + \left(\frac{Q_{3t}}{RGDP_t} \right) P_{3t}\end{aligned}$$

Understanding the GDP deflator

$$\text{GDP Deflator}_t = \left(\frac{Q_{1t}}{RGDP_t} \right) P_{1t} + \left(\frac{Q_{2t}}{RGDP_t} \right) P_{2t} + \left(\frac{Q_{3t}}{RGDP_t} \right) P_{3t}$$

- The GDP deflator is a weighted average of prices.
- The weight on each price reflects that good's relative importance in GDP.
- Note that the weights change over time.
- GDP deflator is a Paasche Index: price index with a **changing** basket (changing weights)

Eg: The Economy of As and Bs

Suppose we have an economy that produces good A and B. What's the GDP deflator for each year if the base year is year 1?

Quantity/Time	Year 1	Year 2
A	1000	2000
B	1	3
Prices		
A	\$1	\$2
B	\$5000	\$1000

The GDP Deflator

But whose purchasing power do we care about?

- GDP Deflator shows us how much the price level of all final goods and services produced in the economy increased relative to its base year.
- Some of these goods don't pertain to household
- So if we want to understand cost of living, might want to restrict to goods and services the average household buys.

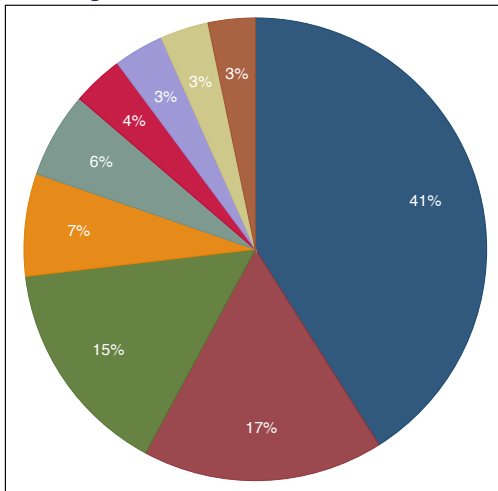
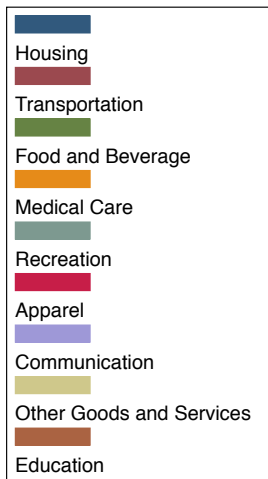
Consumer Price Index

- CPI is an alternative measure of *overall level of prices*
- CPI tracks changes in the *typical households* cost of living
- **Bureau of Labor Statistics (BLS)** survey consumers to determine composition of the typical consumer's basket of goods.
- Every month, collects data on prices of all items in the basket and computes cost of the basket
- Idea is to see how the total cost of consuming a fixed set of goods changes over time.
- CPI in any month equals

$$CPI = \frac{\text{Cost of basket in the month}}{\text{Cost of basket in the base month}} \times 100$$

The composition of the CPI's basket

Relative Importance of Components in CPI:
U.S. City Average, December 2012



Source: BLS, CPI Release, Table 1

- Key feature 1: keep quantities fixed at **base** year
- Key feature 2: **only** quantities purchased by consumers (C)

$$CPI(2008) = \frac{\sum_{i \in C} P_i^{2018} Q_i^{2017}}{\sum_{i \in C} P_i^{2017} Q_i^{2017}}$$

Note: using 2017 as reference (base) year

Understanding CPI

- Suppose there are only three goods in an economy. We call them $i = 1, 2, 3$

P_{it} : market price of good i in month t

Q_{ib} : amount of good i in CPI basket in base month

E_t : the cost of the CPI basket in month t

E_b : the cost of the CPI basket in base month

- CPI is

$$\begin{aligned}\text{CPI}_t &= \frac{E_t}{E_b} = \frac{P_{1t}Q_{1b} + P_{2t}Q_{2b} + P_{3t}Q_{3b}}{E_b} \\ &= \left(\frac{Q_{1b}}{E_b}\right) P_{1t} + \left(\frac{Q_{2b}}{E_b}\right) P_{2t} + \left(\frac{Q_{3b}}{E_b}\right) P_{3t}\end{aligned}$$

Understanding the CPI

$$\text{CPI}_t = \left(\frac{Q_{1b}}{E_b} \right) P_{1t} + \left(\frac{Q_{2b}}{E_b} \right) P_{2t} + \left(\frac{Q_{3b}}{E_b} \right) P_{3t}$$

- The CPI is a also weighted average of prices.
- The weight on each price reflects that goods relative importance in the CPI basket.
- Note that the weights remain fixed over time.
- CPI is a Laspeyres Index: price index with a **fixed** basket (fixed weights).

Eg: The Economy of As and Bs

Suppose we have an economy that produces good A and B. What's the CPI for each year if the base year is year 1?

Quantity/Time	Year 1	Year 2
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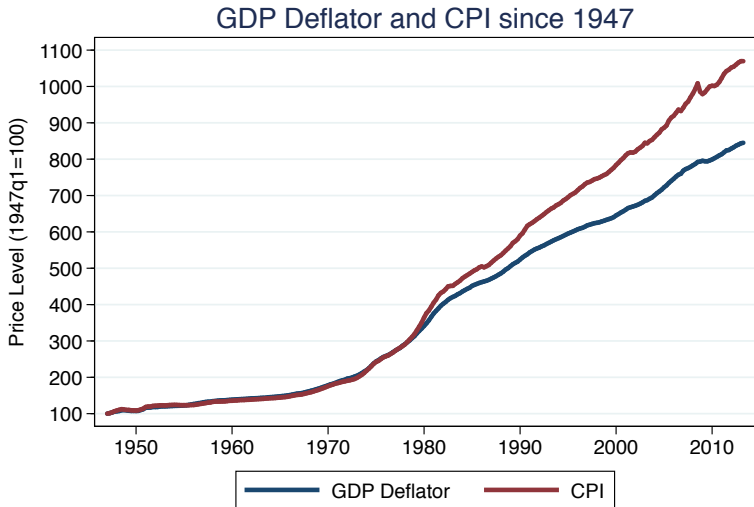
GDP Deflator vs. CPI

- Comparing Price Indices

- would you expect both price indices to be the same?

GDP Deflator vs. CPI

The two quantities differ over time!



Source: BEA and BLS

GDP Deflator vs. CPI

- Prices of capital goods
 - included in GDP deflator (if produced domestically)
 - excluded from CPI
- Prices of imported consumer goods
 - included in CPI
 - excluded from GDP deflator
- The basket of goods
 - CPI: fixed
 - GDP deflator: changes every year

Inflation

- **Inflation**: the growth rate of a price index

$$\text{Inflation} = \left(\frac{P_t - P_{t-1}}{P_{t-1}} \right) \times 100$$

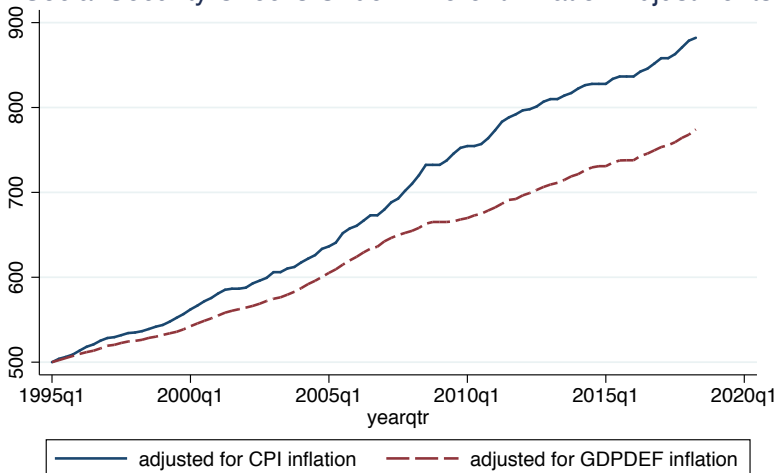
- With the two measures of the price index we can determine how overall prices change over time
- However, CPI inflation is usually used to determine changes in the cost of living
- Many contracts' term adjust for cost of living using CPI

Does it matter what price index we use?

- Many entitlement programs (e.g, Social Security) specify a nominal dollar amount of benefit
- The benefit that is actually paid is adjusted for cost of living using CPI
 - That means the benefit grows at the same rate CPI grows
 - Would the burden on government budget be lower if we had used the GDP deflator?
- An example: Tim retired in year 1995 and his Social Security check was \$500 in the first month.
- How much would he receive over time if we had pegged social security to GDP deflator vs. CPI?

Yes, it does!

Social Security Checks Under Different Inflation Adjustments



Source: BEA, BLS, Prof Wee's calculations

What's the right index?

- Burden on govt budget may be lower if use GDP deflator
- But CPI may be more appropriate because it captures the prices households pay for their consumption
- But Social security collected when old, does CPI capture inflation faced by the elderly? (come back to this later)

Is inflation as measured by CPI a good reflection of inflation faced by households?

Reasons why CPI may overstate inflation

- **Substitution bias:**

The CPI uses fixed weights, so it cannot reflect consumers' ability to substitute toward goods whose relative prices have fallen.

A fixed basket: no timely adjustment to changing consumption patterns

- **Introduction of new goods:**

The introduction of new goods makes consumers better off and, in effect, increases the real value of the dollar. But it does not reduce the CPI, because the CPI uses fixed weights.

- **Unmeasured changes in quality:**

Quality improvements increase the value of the dollar, but are often not fully measured.

PCEPI vs. CPI

- Why does the Fed prefer using core PCEPI?

The CPI uses fixed basket of goods and services. PCEPI adjusts to changing consumption patterns.

Since weights on goods can vary in PCEPI: sensitivity to price changes in various goods can be different.

Some notes: scope of goods different for the CPI vs. PCEPI.

- CPI counts out-of-pocket expenditures of average household.
PCEPI includes expenditures made by employers/govt on behalf of household.
- So medical expenditure made by employer on behalf of household is included in PCEPI

One basket for all

- It is possible for the CPI to overstate (or understate) the cost of living
- CPI is measured as the aggregate price of a basket of goods that a *representative* household would consume
- Do all households eat the same basket?

One basket for all

- Even if you consume the same basket, you may not pay the same price
- The price you pay for not shopping “enough”

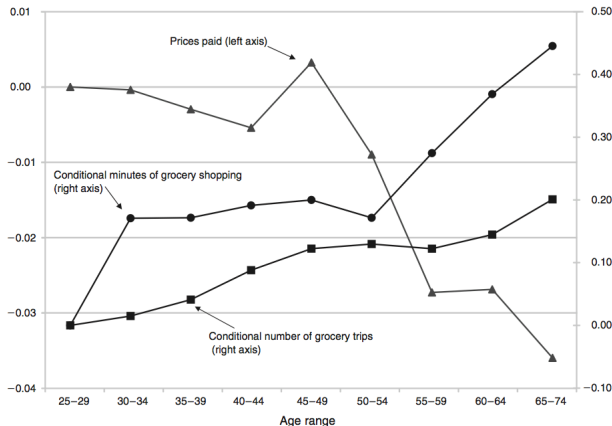


FIGURE 1. PRICE PAID AND SHOPPING FREQUENCY OVER THE LIFE CYCLE: LOG DEVIATION FROM 25- 29-YEAR-OLDS

Source: Aguiar & Hurst (2007)

One basket for all

- Lower price paid not stemming from shopping at different stores but from higher frequency of shopping amongst older

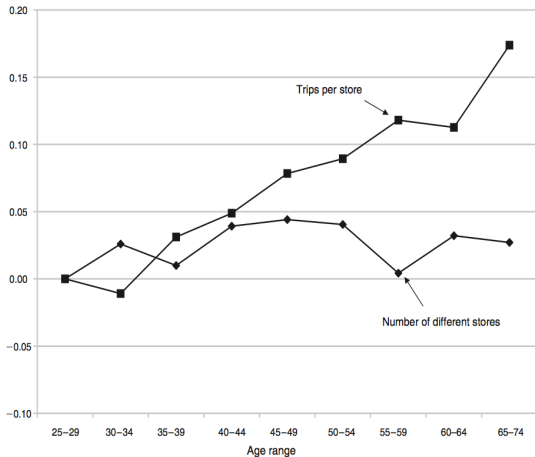
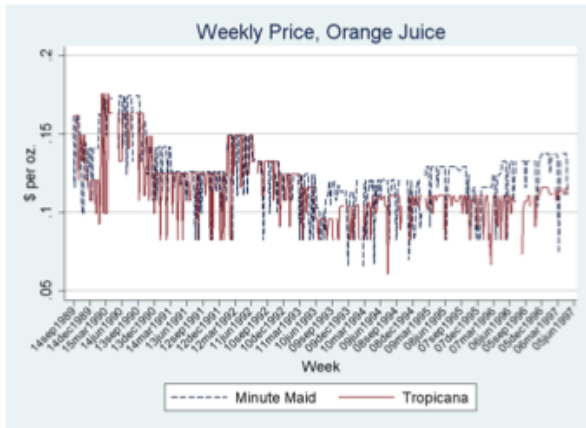


FIGURE 2. DECOMPOSITION OF SHOPPING FREQUENCY: LOG DEVIATION FROM 25- 29-YEAR-OLDS

Source: Aguiar & Hurst (2007)

Some goods follow a price plan

- Some goods have very volatile price paths that are marked by regular discounts



Source: Chevalier and Kashyap (2011)

One basket for all

- High frequency of shopping accompanied by taking advantage of sales

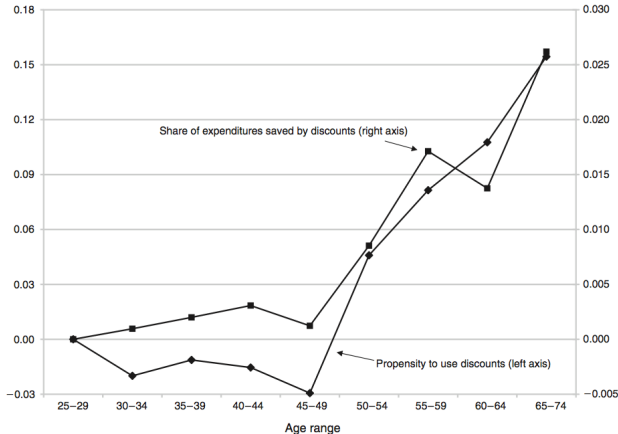


FIGURE 3. DISCOUNT USE OVER THE LIFE CYCLE: PERCENTAGE-POINT DEVIATION RELATIVE TO 25- 29-YEAR-OLDS

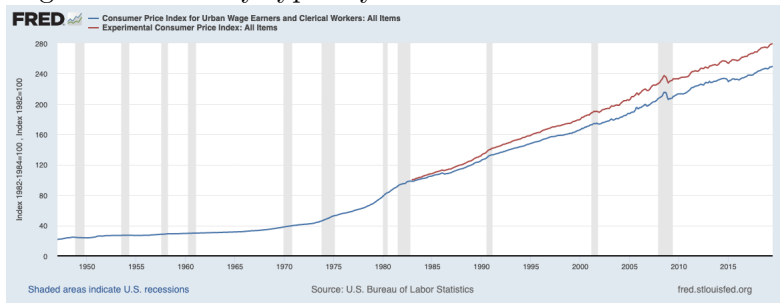
Source: Aguiar & Hurst (2007)

What's the right price index

- So far, it seems the elderly can pay less in terms of groceries
- But what forms a disproportionate cost for the elderly relative to the average household?

What's the right price index

- CPI-E (E for experimental): is a price index focused on the basket of goods the elderly typically consumes.



- Actually higher inflation recorded for CPI-E

Question

True or False:

Inflation is bad for the economy because goods and services are more expensive.

Thinking about Inflation

Is inflation bad for the economy since goods and services become more expensive?

- Prices are not the only economic variable that changes over time
- If prices double but income also doubles, then individuals are not worse off
- Concern: if prices rise faster than nominal income growth → falling real income

Roadmap

- Today \Rightarrow Real, and Nominal Quantities
- Next ... \Rightarrow Study the Consumer (Ch. 4!)
- After that... \Rightarrow Economic Model of the Firm (Ch. 4)