Inflation, Purchasing Power, and the Fed

Lecture 6

Rising prices

When I was your age, my hard-earned nickel would buy me a trolley ride down town, a ticket to the cinema, and enough ice cream to split with a friend!

In most modern economies, prices tend to rise over time. This phenomenon is known as **inflation** and an introduction to the effects it has on the consumer will be the subject of this part of the lecture.

Inflation

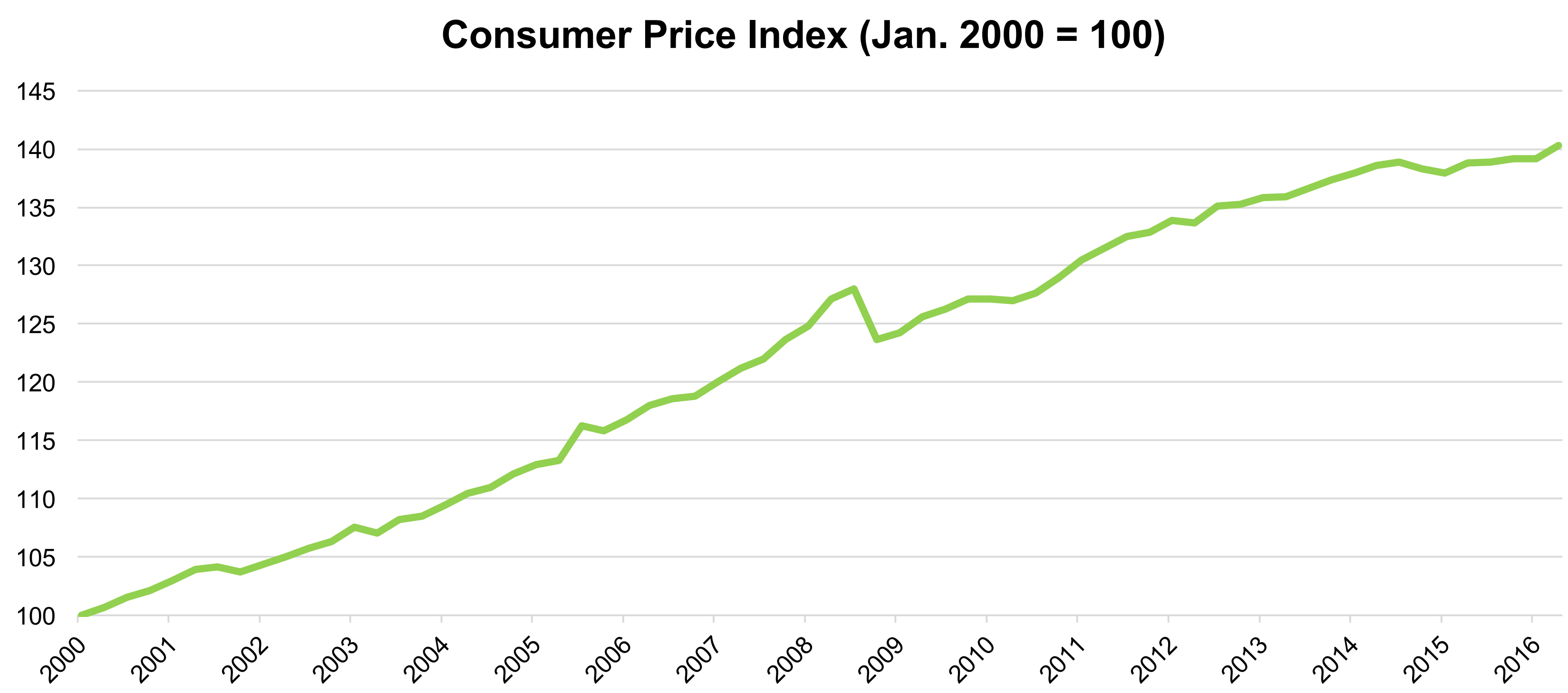
It's important to understand not only what inflation is, but what it isn't.

- Inflation is a technical term used by economists to describe the i**ncrease in the price level over time**.
- It does **not** make sense to talk about inflation in the price of a single, specific good, we buy many goods.
- While, over any given time period, the prices of some goods may rise, and others may fall, inflation describes the changes in the average price. If, on average, prices are increasing, inflation is positive. If, on average, prices are decreasing, inflation is negative (this is known as **deflation**).

Measuring Inflation

The Consumer Price Index

For one measure inflation, the US government publishes the **Consumer Price Index (CPI)**. To compute the CPI, the Bureau of Labor Statistics tracks the prices of a large basket of representative goods and computes the weighted average of the prices. This average is then indexed to some base year.



Source: Federal Reserve of Saint Louis Economic Data (FRED)

The Consumer Price Index

Because the level of the CPI measures the level of prices, changes in the level of the CPI can be used to estimate inflation.

Ex. In Country X, in December 2000, the CPI index was at 174.6 ; in December 2001, it was at 177.4; and in December 2005, it was at 198.1. What was the annual rate of inflation between December 2000 and 2001? What was it between December 2000 and 2005?

Ans. To compute inflation, compute the annual growth rate in the level of the CPI. Between December 2000 and 2001, inflation was:

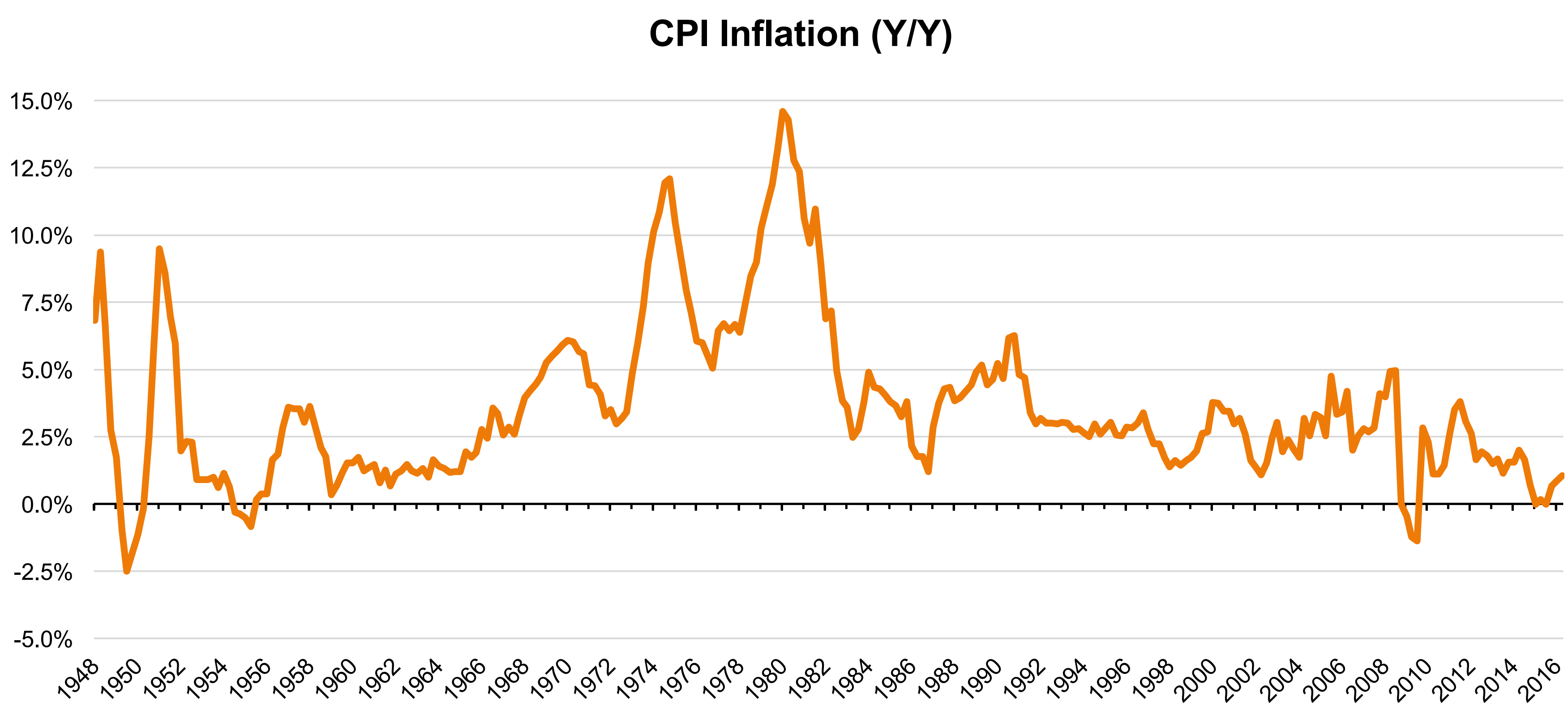
$$i = \frac{177.4}{174.6} - 1 = 1.6\%$$

Between December 2000 and 2005, average annual inflation was:

$$i = \left(\frac{198.1}{174.6}\right)^{\frac{1}{5}} - 1 = 2.6\%$$

The Consumer Price Index in the US

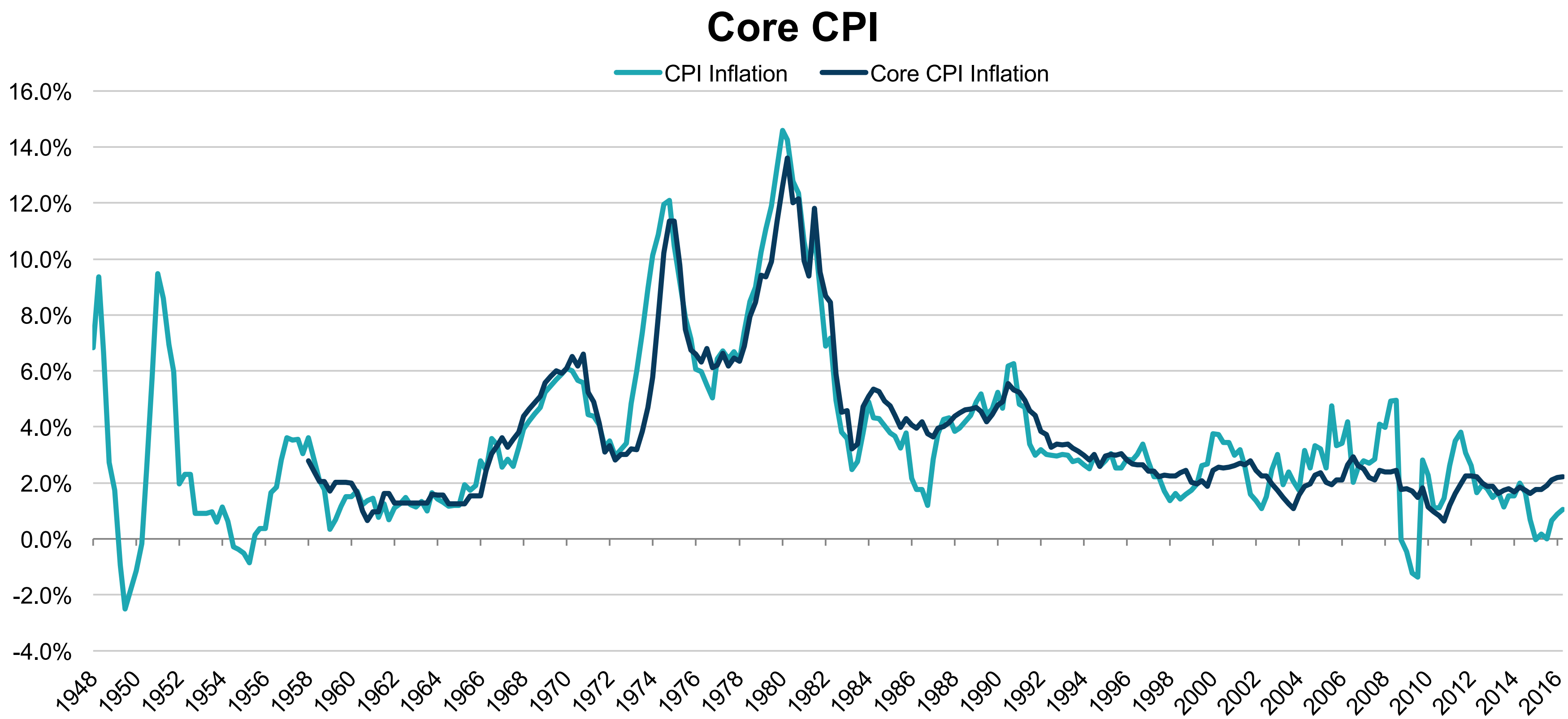
The chart below shows annual inflation rates from 1948 to 2012: Immediately following World War II, inflation was very volatile; the late 1970's was characterized by runaway inflation; and recently inflation was been low and stable around 2-3%, with a short period of deflation following the 2008 financial crises.



Source: Federal Reserve of Saint Louis Economic Data (FRED)

Core CPI

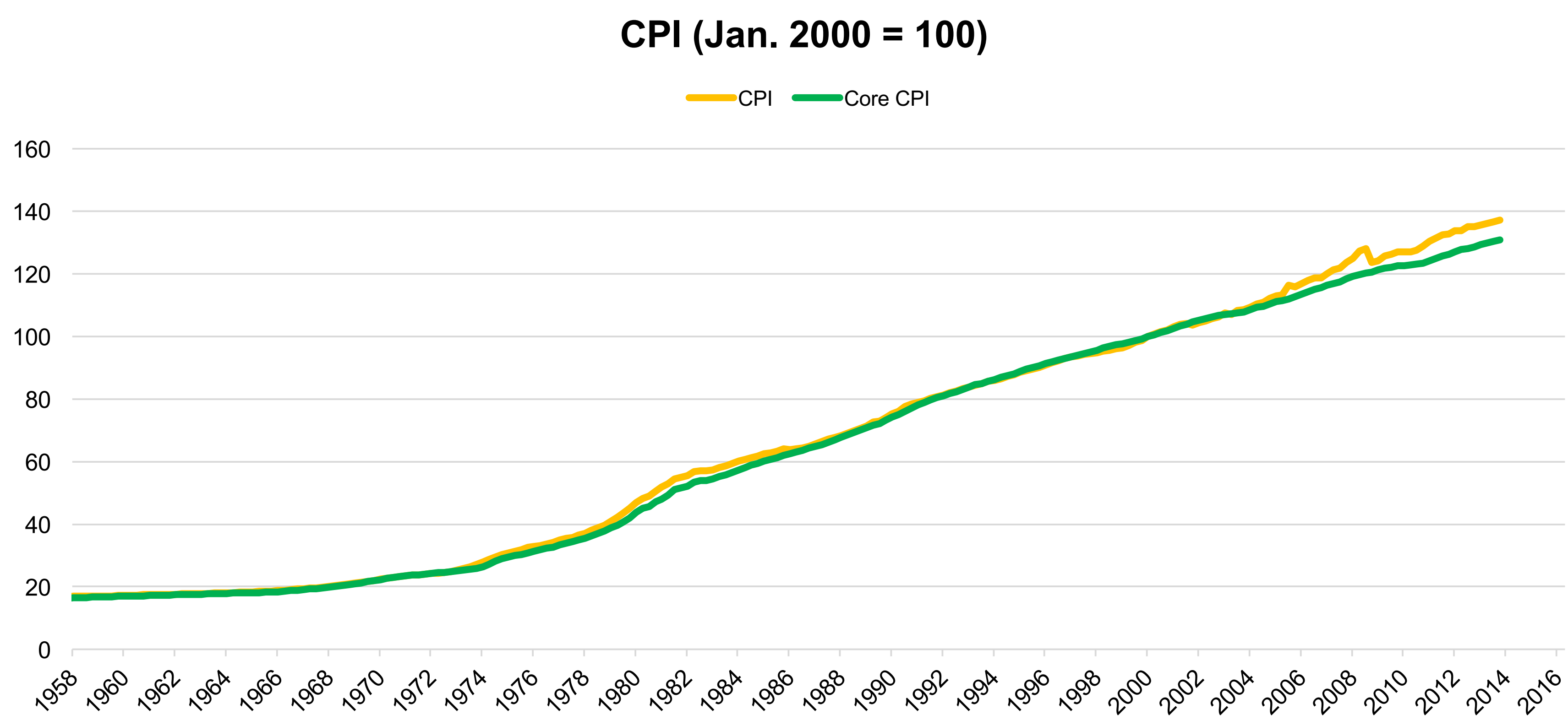
Some market observers pay more attention to **core CPI**. The core CPI is similar to the CPI, but it excludes food and energy prices. Because food and energy prices are highly volatile, **core CPI inflation** is less volatile than CPI inflation. (Note that the Federal Reserve traditionally monitors core inflation.)



Source: Federal Reserve of Saint Louis Economic Data (FRED)

Core CPI

Although core CPI excludes food and energy prices, long-term changes in the price level are similar whether measured with CPI or core CPI. Note that the CPI prices increase slightly more in the late 1970s (oil price shock) and in the 2000s (commodities boom and higher fuel costs).



Source: Federal Reserve of Saint Louis Economic Data (FRED)

Inflation and purchasing power

The most obvious effect of inflation is that it reduces the **purchasing power** of a dollar over time.

Ex. Today, a consumer spends an average of $150 per week on groceries for his family. If the inflation rate is 3% (per year), how much will it cost this consumer to purchase the same amount of groceries in 5 years?

Ans. Because prices are increasing by 3% per year, after five years, $150 worth of groceries today will cost:

$$\$150 * 1.03^5 = \$173.89$$

(Note that this assumes that the price of groceries changes with the average price level. Of course, the change in the price of groceries might differ from inflation due to supply and demand factors for groceries.)

Inflation and purchasing power

When there is inflation, **as time passes, it costs more money to purchase the same amount of goods**.

In general, the future price of a basket of goods can be found using the following formula:

$$P_T = P_0(1+i)^T$$

Where P_0 is the price of the goods today, i is the inflation rate, T is the number of years that pass, and P_T is the price of the basket of goods T years in the future.

Inflation and purchasing power

As a corollary, **as time passes, the same amount of money will buy less goods**.

Ex. If the inflation rate is 3% and the consumer described above continues to spend $150 per week on groceries, in five years will he be able to purchase more, less, or the same amount of groceries each week?

Ans. Because groceries are now more expensive, the consumer is not able to afford the same amount of groceries with the same amount of spending, and so he can only purchase less groceries per week with the same $150.

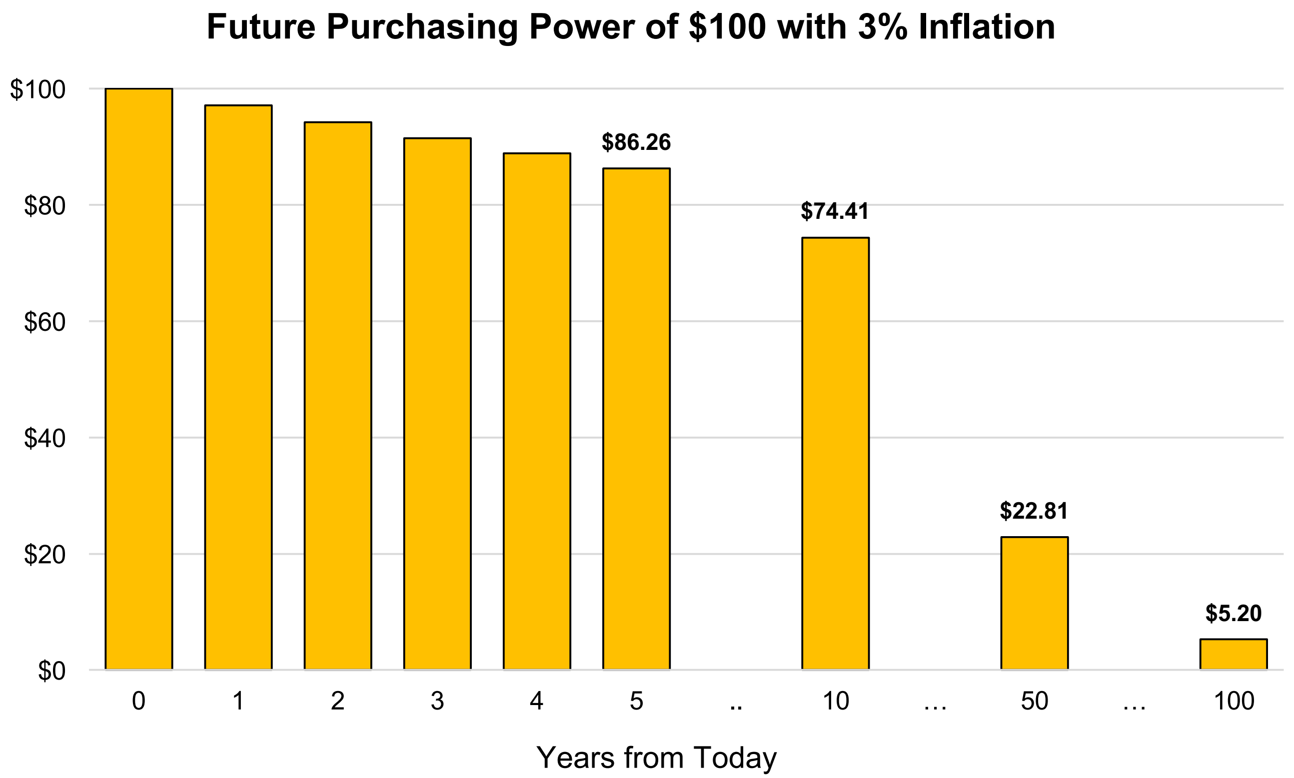
Using the inflation formula, we can see that:

$$P_T = P_0(1+i)^T \rightarrow \frac{P_0}{P_T} = \frac{1}{(1+i)^T} = \frac{1}{(1.03)^5} = 0.86$$

So, the same $150 in five years will buy 14% less groceries in five years.

Inflation and purchasing power

The more time passes, the further inflation erodes the purchasing power of a dollar:



Holding cash

Inflation is a tax on cash

- Holding cash over time is costly: the value of cash will decrease overtime
- Cash is not a “secure” investment, there is an inflation risk
- Cash cannot be “indexed” to inflation; when there is inflation the return to cash is negative

Nominal and Real Prices

Real versus nominal prices

To control for the effects of the changing purchasing power of the dollar on prices over time, economists distinguish between **real** and **nominal prices**.

- The **nominal price** of a good is the actual number of dollars that good costs (i.e., the sticker price). Because of inflation, this will change over time.

- The **real price** of a good is adjusted for inflation, and is indexed to the value of a dollar at some specified point in time. The real price of a good will not change with inflation (but may change due to supply and demand for that good).

The distinction between nominal and real prices is more easily demonstrated using an example…

Real versus nominal prices

Ex. A business man buys a new suit of the same brand and style every five years. In 1995, this suit cost the business man $400. In 2000, it cost him $440. In 2005, it cost him $525. Inflation has been steady at 2% each year over this time period. What is the nominal and real price of this suit in 1995, 2000, and 2005?

Ans. The nominal price of the suit is simply the sticker price and was $400, $440, and $525 in 1995, 2000, and 2005, respectively. The nominal price of the suit increased over this time period.

The real price of the suit can be found by adjusting the prices for inflation in terms of some index year. Taking the index year to be 1995, the suit in 2000 still cost the business man about $400 in 1995 dollars:

$$Price_{2000,\$1995} = \frac{Price_{2000}}{(1+i)^{2000-1995}} = \frac{\$440}{(1.02)^5} = \$399$$

Thus, the **real price of the suit did not increase between 1995 and 2000**.

Real versus nominal prices

Ans. (continued)

Again taking the index year to be 1995, the suit in 2005 cost the business man $431 in 1995 dollars:

$$Price_{2005,\$1995} = \frac{Price_{2005}}{(1+i)^{2005-1995}} = \frac{\$525}{(1.02)^{10}} = \$431$$

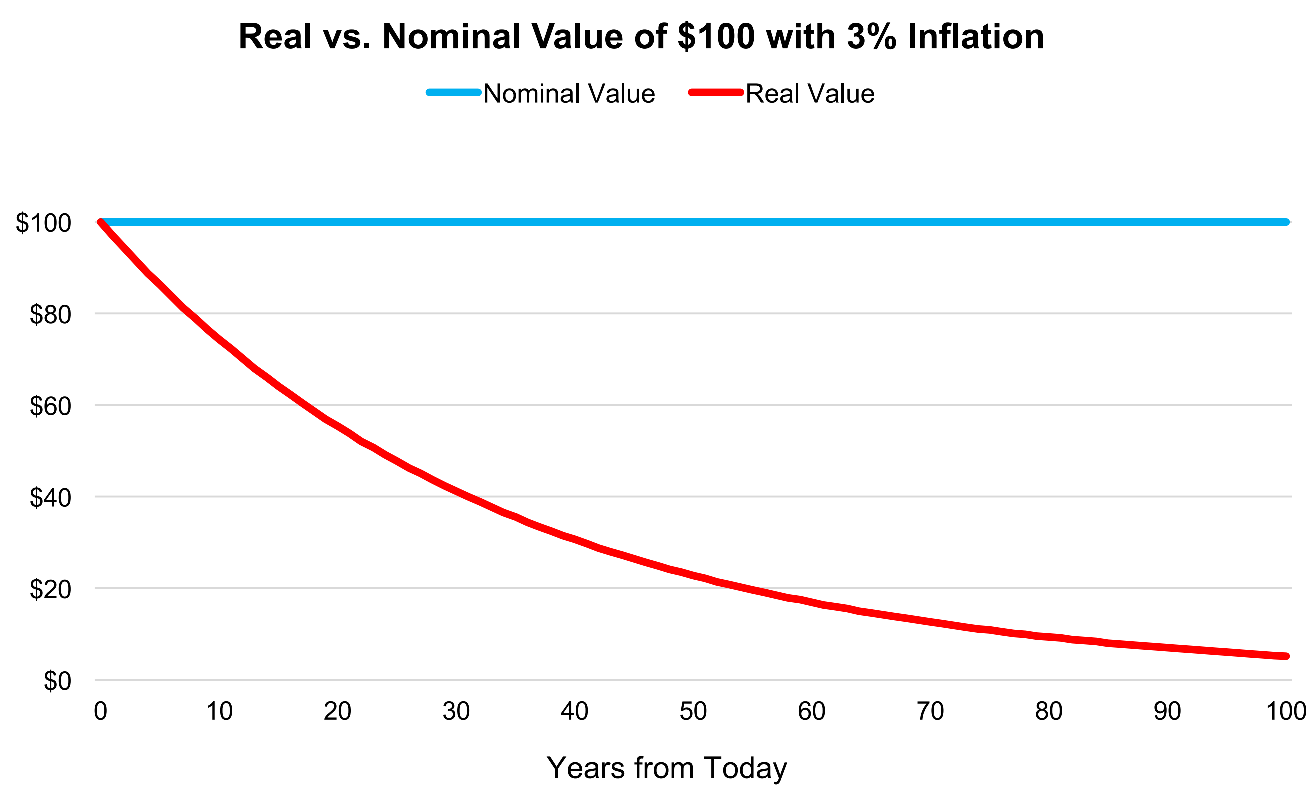
Thus, the **real price of the suit increased between 1995 and 2005.**

In other words, the price of the suit increased at a rate faster than inflation over this time period. The rate of in the price of the suit over those ten years was about 2.8%:

$$\left(\frac{\$525}{\$400}\right)^{\frac{1}{10}} - 1 = 2.8\%$$

Real versus nominal prices

So while the nominal value of $100 may stay the same, its real value declines with inflation:



Inflation and Wages

Inflation and wages

When I was your age, it took me a full day's work to mow three lawns and paint one side of a fence, and all I got was a quarter!

Prices may increase over time, but so do wages. So while inflation may reduce the purchasing power of a dollar over time, the purchasing power of a day's work may not be effected…

Inflation and wages

Ex. Today, a consumer earns a salary of $65,000 per year and spends an average of $150 per week, or $7,800 per year, on groceries for his family. What proportion of his budget is spent on groceries per each week? If inflation is 3% per year and the consumer's income raises by the same 3% per year, how much of his weekly budget will be spent on groceries in 5 years? What if his salary does not rise at all?

Ans. Today, groceries take up 12% of the consumer's annual budget:

$$\frac{\$7{,}800}{\$65{,}000} = 12\%$$

If both the price of groceries and his wages increase by the same amount over the next 5 years, groceries will continue to cost 12% of his annual income:

$$\frac{\$7{,}800 * 1.03^5}{\$65{,}000 * 1.03^5} = 12\%$$

Inflation and wages

Ans. (continued)

However, if his salary increases less rapidly than the price of groceries, groceries will cost a larger share of his annual budget. If his salary does not increase at all, groceries will cost 13.9% of his annual budget:

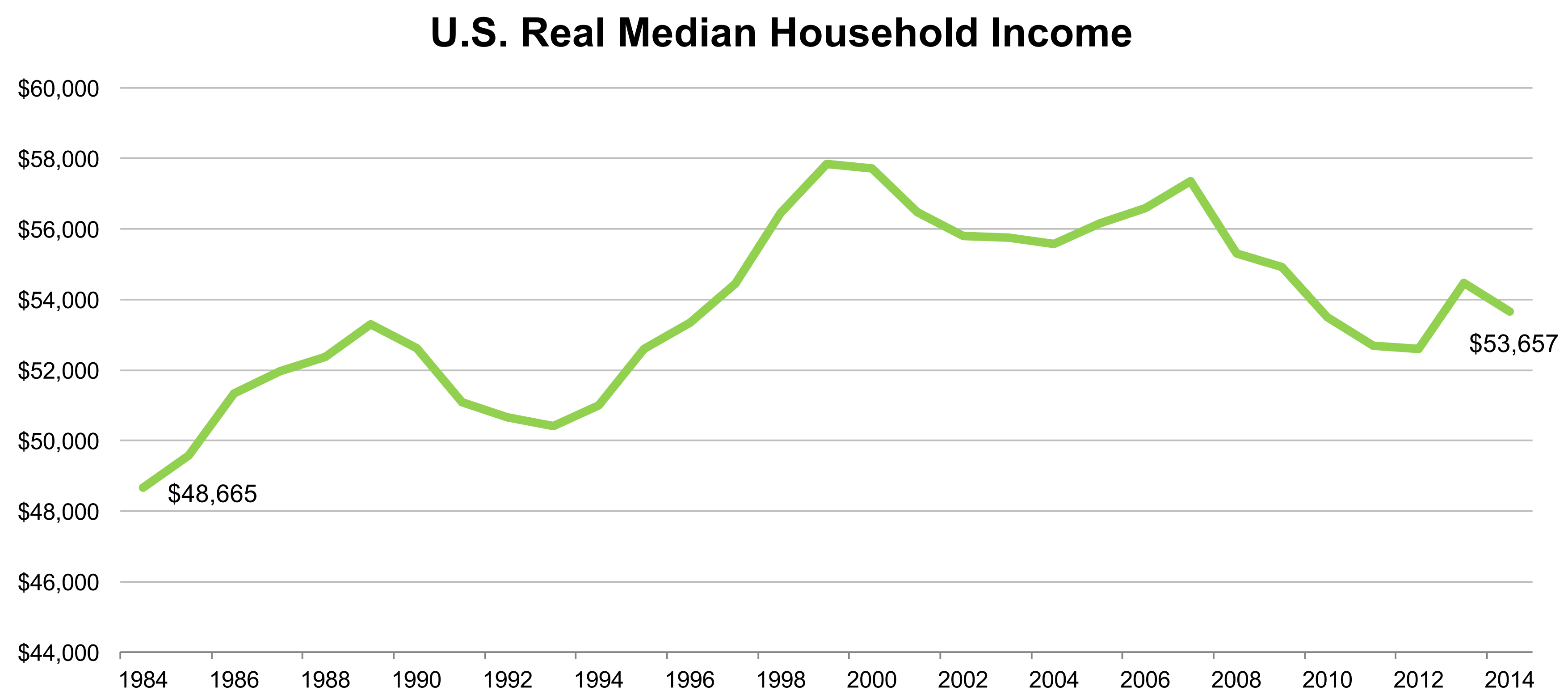
$$\frac{\$7{,}800 * 1.03^5}{\$65{,}000} = 13.9\%$$

Because the price of groceries, in this example, increased at the rate of inflation, the **real cost** of groceries did not increase at all. In the first case, the consumer's **real wages** were also constant, and so groceries were no more or less expensive to him.

In the second, the consumer's **real wages** declined, and so groceries became more expensive; but, **in real terms, this was not because the price of groceries went up, but because his salary went down**…

Real wages

Generally, wages increase over time, and often do so more rapidly than inflation. As a result, **real wages tend to increase over time** (because of improved productivity), though there are periods of time where this is not the case…



Source: Federal Reserve of Saint Louis Economic Data (FRED)

Inflation and Savings

Inflation and wealth

While incomes may not be effected by inflation in the long-run, wealth is. If wealth is stored in cash, its purchasing power is reduced with the purchasing power of the dollar…

Ex. In 1973, when Bob graduated from high school, his grandfather, who lost all of his boyhood savings from a bank failure during the Great Depression, gave him **$500 dollars in cash** with strict instructions to keep it safely hidden under his mattress. Bob obliged and kept the cash safely stored under his mattress, including through the highly inflationary period through the 1970's. It's **40 years later in 2013, and inflation has averaged 4.3%** annually since Bob received the $500 in 1973. By how much was the purchasing power of the gift reduced over the 40 years? How much was it originally worth in real terms (indexed to 2013 dollars)?

Inflation and wealth

Ans.

At 4.3% inflation per year over 40 years, the purchasing power of a dollar will be reduced a lot:

$$P_T = P_0(1+i)^T \rightarrow \frac{P_0}{P_T} = \frac{1}{(1+i)^T} = \frac{1}{(1.043)^{40}} = 0.186$$

In other words, the real value of the $500 gift was reduced by 81.4%!

In 2013 terms, the gift was originally worth $500/0.186 = $2,688. That is, it could buy as much in 1973 as $2,688 can buy today. Now, it can only purchase a fraction of that amount…

This is one reason why it's a bad idea to keep your money stored under your mattress. Not only will you forego the interest you would earn if you kept it in a bank account or more productive investments, but you will allow inflation to eat away at its value…

Inflation and savings

Even if your savings earn interest, however, **inflation will reduce the gains in purchasing power** that you would otherwise realize.

Ex. Bob, realizing the error of his ways, gave his own son, Bobby, $10,000 with specific instructions to invest them in high-yielding stock mutual funds.

During the first year, the mutual fund returned 12%. Over the first ten years, it yielded an average annual return of 10%. Inflation was a constant and stable 2% per year over those ten years.

By how much did the real value of Bobby's $10,000 increase after the first year? At what rate did the real value increase over the first 10 years?

Inflation and savings

Ans.

After the first year, Bobby’s $10,000 will earn 12% and increase to:

$$\$10{,}000 * 1.12 = \$11{,}200$$

However, after adjusting for the 2% inflation, the real value only increased to:

$$\frac{\$11{,}200}{1.02} = \$10{,}980$$

In other words, in real terms, the value only increased by:

$$\frac{\$10{,}980}{\$10{,}000} - 1 = 9.8\%$$

Inflation and savings

Ans. (continued)
After the first ten years, the nominal value of Bobby's account will increase to:

$$\$10{,}000 * 1.10^{10} = \$25{,}937$$

But, the real value only increased to:

$$\frac{\$25{,}937}{1.02^{10}} = \$21{,}277$$

This implies **real growth** of:

$$\left(\frac{\$21{,}277}{\$10{,}000}\right)^{\frac{1}{10}} - 1 = 7.84\%$$

In other words, the purchasing power of Bobby's mutual fund investment increased by 7.8% per year. This is 2.2% less than the nominal return of 10%.

Real versus nominal interest rates

In general, in the presence of inflation, the real value of an investment will grow according to the formula:

$$V_T = P_0 \frac{(1+n)^T}{(1+i)^T}$$

Where P_0 is nominal value of the investment today, n is the **nominal return** on the investment, i is the inflation rate, T is the number of years that pass, and V_T is the **real** value of the investment T years in the future (stated in terms of today's dollars).

Real versus nominal interest rates

This can be rewritten as:

$$V_T = P_0(1+r)^T$$

Where ***r*** is defined as:

$$r = \frac{1+n}{1+i} - 1 \approx n - i$$

Because ***r*** is the rate of increase of the real value of the investment, it is known as the **real rate of return** (or **real interest rate**), while ***n*** is referred to as the **nominal rate of return** (or **nominal interest rate**).

Real versus nominal interest rates

Ex. Using the real interest rate, calculate the real value of Bobby's $10,000 in ten years if he receives an annual nominal return of 10% and inflation is 2% per year.

Ans. With a nominal return of 10% and inflation of 2%, the real return is:

$$r = \frac{1+n}{1+i} - 1 = \frac{1.10}{1.02} - 1 = 7.84\%$$

Naturally, this is equal to the 7.8% real growth we found earlier. The real return may also be estimated as:

$$r \approx n - i = 10\% - 2\% = 8\%$$

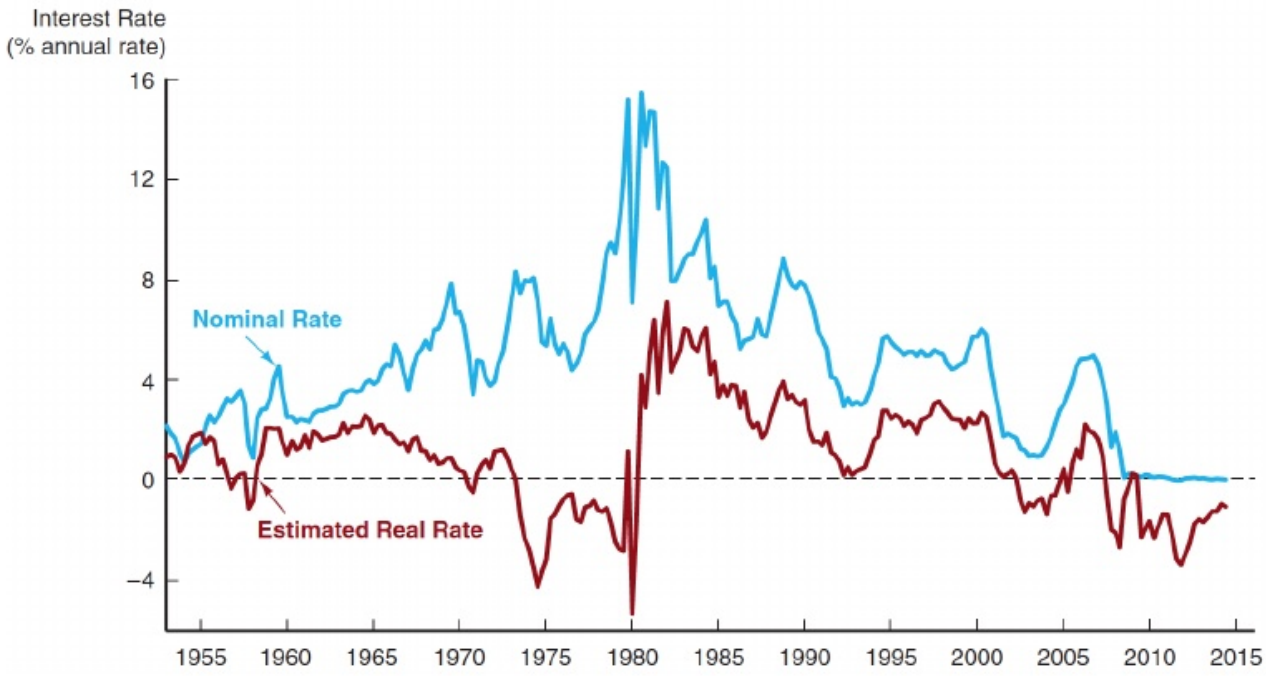
And it can be used to find the real value of the $10,000 investment ten years from today:

$$V_T = P_0(1+r)^T = \$10{,}000(1.0784)^{10} = \$21{,}272$$

Real versus nominal interest rates

Because of inflation, real interest rates are generally lower than nominal rates (and sometimes negative!):

T-Bill Returns (1953-2015)



Source: Nominal rates from Federal Reserve Bank of St. Louis (FRED). Real rates from Frederic S. Mishkin, "The Real Interest Rate: An Empirical Investigation," *Carnegie-Rochester Conference Series on Public Policy*,15 (1981): 151-200: 151-200.

Measuring knowledge of inflation

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

a) More than today
b) Exactly the same
c) Less than today
d) I do not know
e) Refuse to answer

Source: 2015 National Financial Capability Study

National Financial Capability Study

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

a) More than today
b) Exactly the same
c) **Less than today**
d) I do not know
e) Refuse to answer

64% answered correctly.

Source: 2015 National Financial Capability Study

The Effects of Inflation

The effects of inflation

To summarize, the effects of inflation are:

- Inflation **decreases the purchasing power of a dollar** over long periods of time.
- Real wages are set based on the supply and demand of labor. If real wages remain constant, nominal wages must increase with inflation. In this case, inflation does not reduce income.
- Inflation **decreases real wealth** if it is not invested to earn interest. And if it is invested, inflation **reduces the interest rate on savings to a lower, real interest rate**.

The effects of unexpected inflation

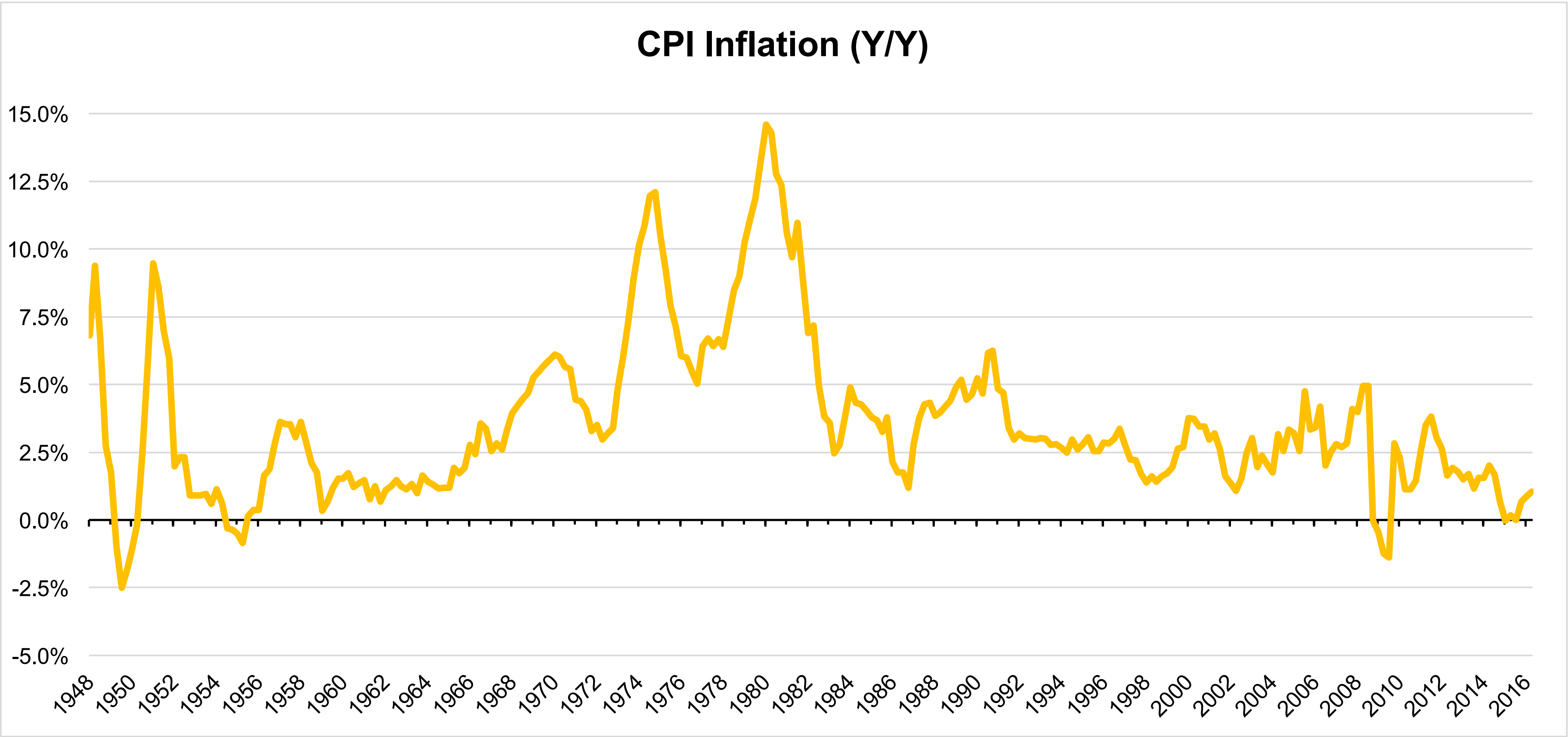
Inflation can be incorporated into financial planning but is itself uncertain. **Unexpected inflation** has particularly important consequences for borrowing and lending:

- Lenders are aware of inflation, and set nominal interest rates such that they **receive a real return based on their inflation expectations**.
- If inflation increases, however, the real interest rate declines and the lender receives payments with a lower real value than they expected. This helps the consumer by reducing their debt burden, but hurts the lender by decreasing their real return.
- If inflation decreases, the real interest rate increases, and the borrower must make higher than anticipated real payments. This increases the consumer's debt burden and the lender's return.

This is one of the reasons it is important to maintain a low and stable rate of inflation.

The potential severe consequences of deflation

Note the short period of deflation following the 2008 financial crisis.



Source: Federal Reserve of Saint Louis Data (FRED)

Inflation

Video about inflation

“How Inflation Diminishes Savings”

http://gflec.org/education/educational-videos/

Inflation and the Fed

Money supply and inflation

To understand inflation, we need to understand money and the money supply…

"*Inflation is always and everywhere a monetary phenomenon.*"

Milton Friedman

Examples of What Has Been Used as Money

- Cigarettes (POW camps)
- Fish teeth (New Caledonia)
- Bread grain (Egypt)
- Pepper corns (Peru)
- Rice (Korea)
- Salt (Abyssinia)
- Silk (China)
- Tea (Mongolia)
- Mahogany wood (Honduras)
- Onions (Sudan)

Stone Money on the Island of Yap

Measuring Money (Monetary Aggregates)

M1 = Currency +

Traveler's checks +

Demand Deposits + Other checkable deposits

M2 = M1 +

Savings Deposits including MMDAs +

Time Deposits (small denomination) +

MMMFs (noninstitutional)

U.S. Monetary Aggregates (January 2016)

M1	**3,092.6**
Currency	1,339.3
Traveler's checks	2.5
Transaction Accounts (Demand deposits)	1,233.3
M2	**12,437.2**
Components of M1	3,092.6
Savings deposits, including MMDAs	8,222.6
Small-denomination time deposits	405.0
MMMFs (noninstitutional)	717.0

The Supply of Money

Only the Central Bank (the Fed in the US) can print money.

The Fed controls the monetary base (MB)

Monetary base (MB) = Currency + Reserves

Money Supply (M) = Currency + Deposits

$$M = m_m * MB$$

where m_m is the money multiplier

The Fed's Balance Sheet

Balance Sheet of the Federal Reserve System

Assets	Liabilities
U.S. government securities	**Currency in circulation**
Discount loans to banks	**Reserves**
Gold + other assets	

TABLE 14.2

The Balance Sheet of the Federal Reserve System (Billions of Dollars)

Assets		**Liabilities**		
Gold	$11.0	Currency		$1370.8
Loans to depository institutions	202.0	Vault cash	67.3	
U.S. Treasury securities	2461.5	Held by nonbank public	1303.5	
Federal agency debt	35.1	Deposits of depository institutions		2624.6
Mortgage-backed securities	1743.2			
Other assets	86.6	Other liabilities and net worth		544.0
Total	**$4539.4**	**Total**		**$4539.4**

Addenda

Reserves = deposits of depository institutions + vault cash = $2691.9 billion.

Monetary base = currency held by the nonbank public + reserves = $3995.4 billion.

Note: Numbers may not add to totals shown owing to rounding.

Source: Federal Reserve Statistical Releases H.4.1 and H.3. Data are for the week ending July 22, 2015.

Changing the Monetary Base

- The Fed changes the monetary base by changing the levels of its assets.

- In an open market purchase the Fed buys government bonds and increases the monetary base.

- In an open market sale the Fed sells government bonds and decreases the monetary base.

- The Fed can also change reserves and the monetary base through changes in discount loans.

Notes on Central Banks

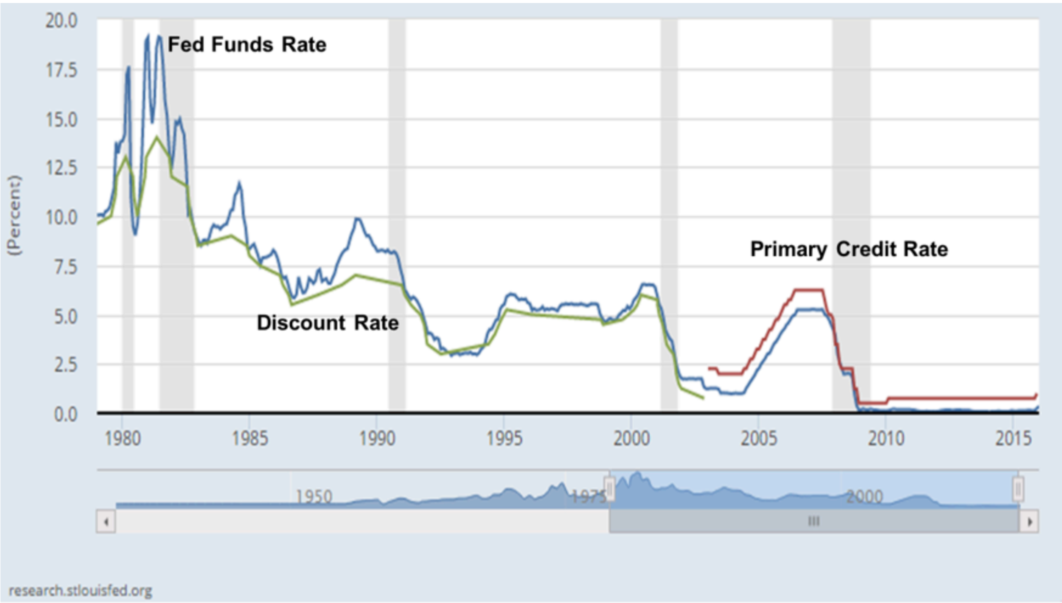
The Central Bank is *The Banks' Bank*. The Central Bank operates a clearinghouse for bank checks. Each member bank has an account with the Central Bank. In the U.S. the deposits that banks have with the Fed are called *federal funds*. A check written against private bank B and deposited with private bank C reduces bank B's federal funds and increases bank C's federal funds. Thus banks *want* federal funds so they can honor check withdrawals.

Neither the Fed nor other major Central Banks target growth rates of the *money supply* (This was done in previous periods but the Fed has shifted to a different target). The Fed targets the federal funds rate.

The Federal Funds Rate vs. the Discount Rate

The Fed targets the *federal funds rate*. This target changes over time. The Fed carries out open market operations to keep the actual rate near the target rate. This is the heart of Fed policy.

The *discount rate* is the interest rate on loans from the Fed to banks. The Fed sets the discount rate. Discount window loans have normally played a minor role in Fed policy.



Source: **Economic Research St. Louis FED (FRED). H.15 Series**

Federal funds

- Federal funds are the deposits of private banks with the Fed.

- The federal funds market consists of private banks borrowing and lending their federal funds amongst each other overnight.

- The federal funds rate is the interest rate on these overnight loans. It is set by supply and demand.

- The Fed can change the supply of federal funds through open market operations, exerting an effect on the fed funds rate.

A Fed Purchase of Government Securities …

- Raises the supply of federal funds. More federal funds means they are cheaper to borrow, so a lower federal funds rate.

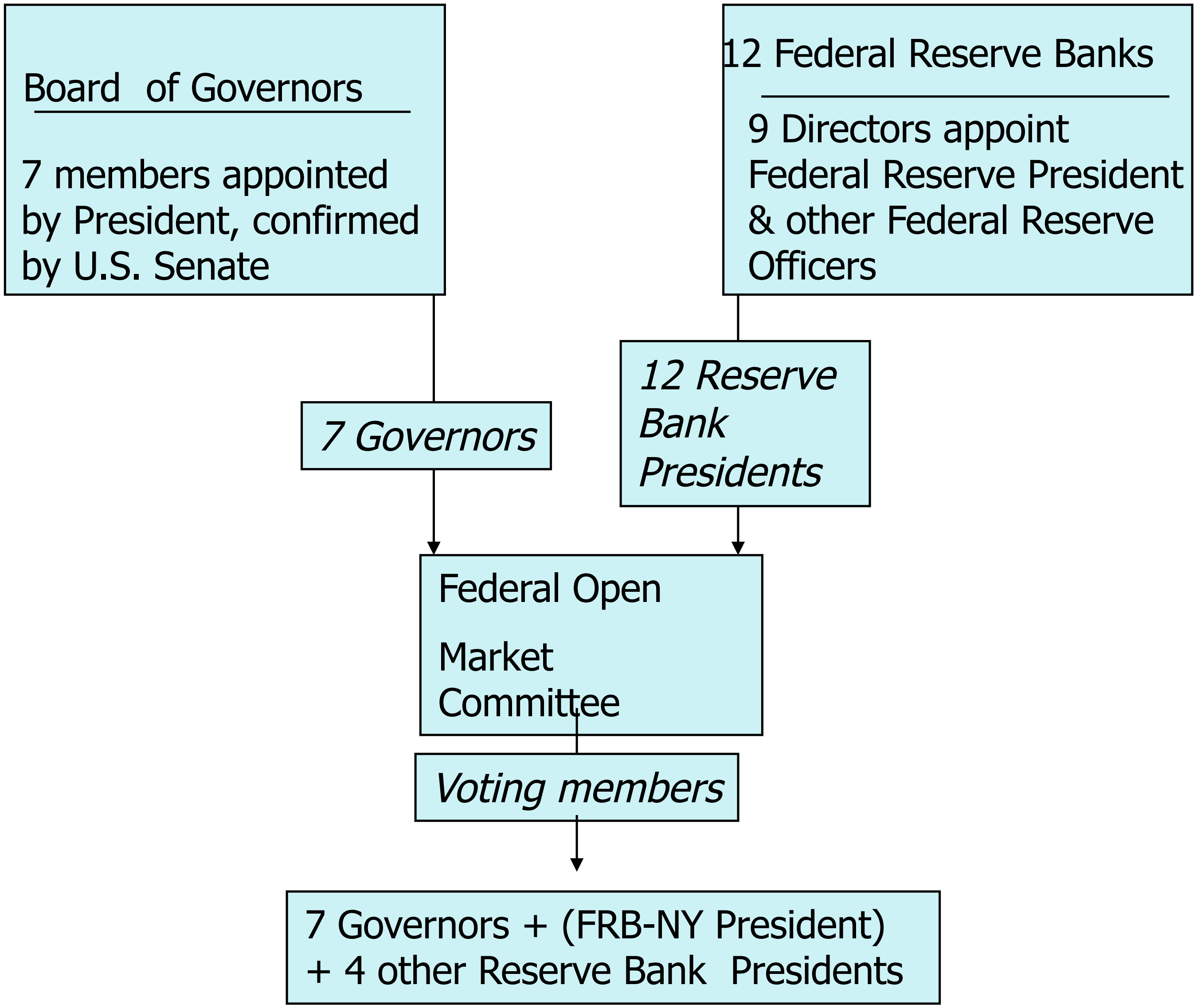
- Leaves banks flush with reserves. Banks find it profitable to convert some of their new reserves into loans (which in turn creates more deposits, raising the money supply). To get people/firms to borrow more (take the new loans they are offering), banks lower the interest rate on the loans.

Bottom Line: A Fed purchase of government securities lowers r

The Federal Open Market Committee (FOMC)

- Seven Governors from the Board
- Twelve Presidents from District Banks
  - All participate; five vote (NY Fed + four)
- Meet 8 times a year in Washington, DC
- Purpose: Formulate monetary policy
  - Set federal funds rate target to promote price stability and “maximum sustainable growth”
  - Contain systemic financial risk

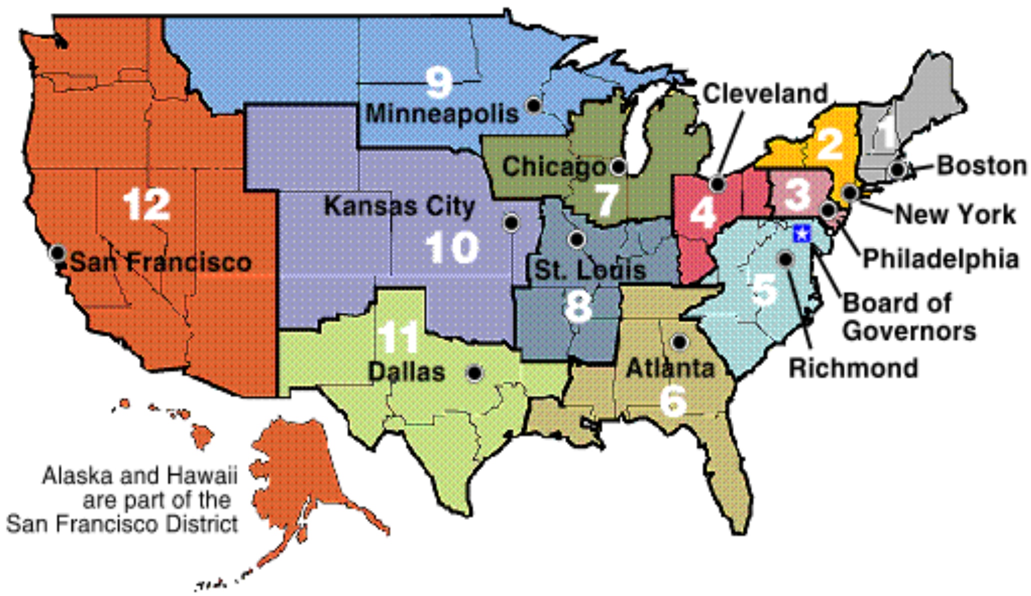
Federal Reserve Governance



The Federal Reserve System

The Federal Reserve System

- The leadership of the Fed is provided by the Board of Governors in Washington, D.C.
  - There are seven governors, who are appointed by the president of the United States, and have fourteen-year terms
  - The chairman of the Board of Governors has considerable power, and has a term of four years



FOMC Meetings (past and new)

BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM

The Fisher Equation and the Quantity Theory of Money

$$M * V = P * Y$$

M = money supply, P = Price level (GDP Deflator), Y = real GDP.

V = velocity of money = PY/M. We define V in this way.

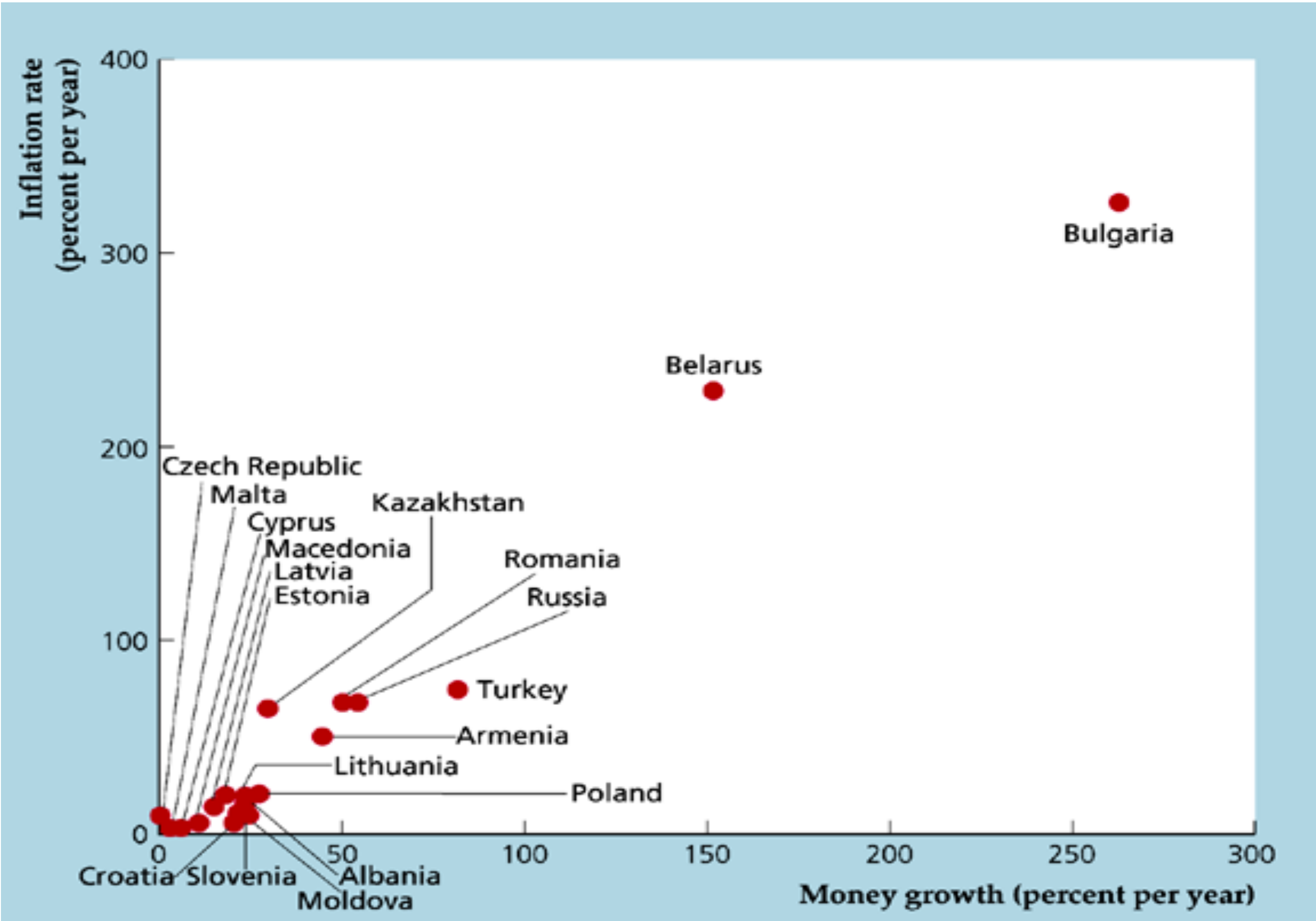
If V and Y are constant, when the Central Bank doubles M, the result is a doubling of P.

"Inflation is always and everywhere a monetary phenomenon"

This Friedman quote is not literally correct because of Y and V movements, but it is approximately correct.

Inflation and Money Growth

Eastern Europe from 1995 to 1998



Source: *Macroeconomics* – Abel, Bernanke, and Croushore (2014), page 270.
Money growth rates and consumer price inflation from International Financial Statistics, February 2003, International Monetary Fund)

Truly “Hyper”: 11.2 million %

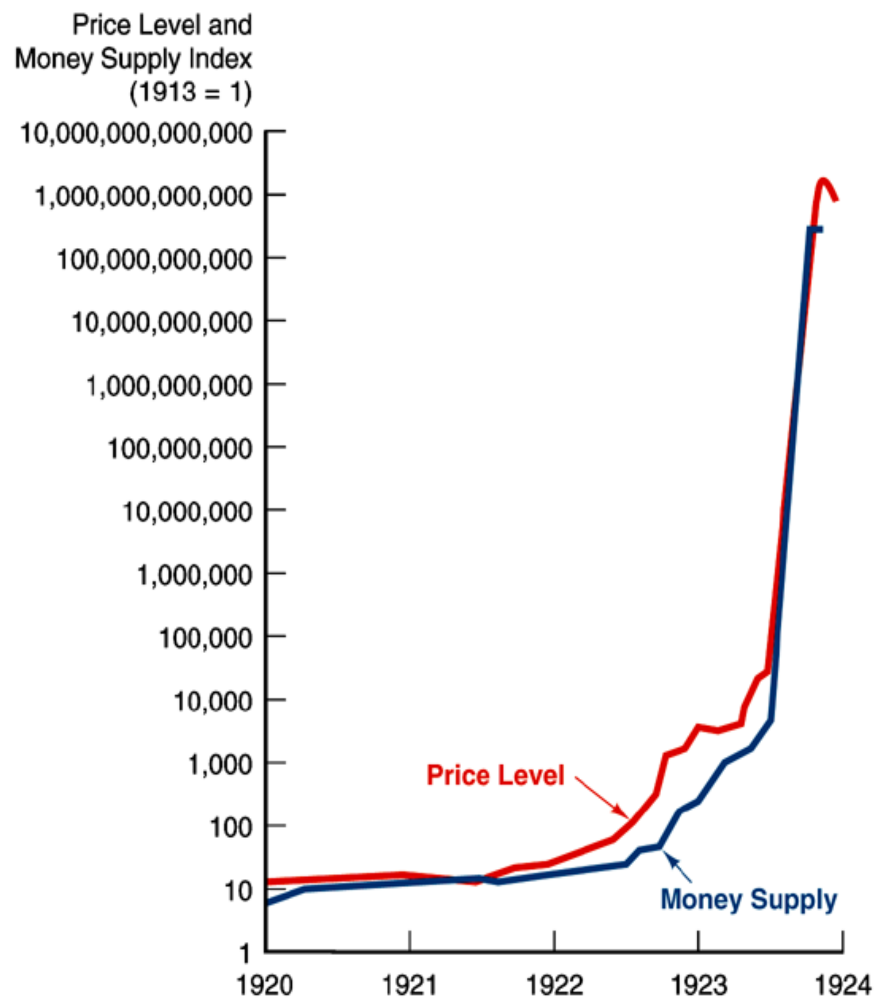
Buying a beer in Zimbabwe in 2008

A “small” note

- That’s $1 million Zimbabwe dollars, the price of a single beer purchased at a bar in Harare on November 24th, 2008

Hyperinflation in Germany in the 1920s

Date	Price of bread in marks
Dec 01, 1918	0.5
Dec 01, 1921	4
Dec 01, 1922	163
Jan 01, 1923	250
Mar 01, 1923	463
Jun 01, 1923	1,465
Jul 01, 1923	3,465
Aug 01, 1923	69,000
Sep 01, 1923	1,512,000
Oct 01, 1923	1,743,000,000
Nov 01, 1923	201,000,000,000



High Inflation Episodes

- Why does the central bank increase money supply so much?
- Periods of high inflation are often associated with large budget deficits.
- Countries with high inflation are also those with central banks that are not independent from the government.
- In these countries, when the government runs large deficits, it pushes the central bank to buy the bonds the government issues to finance its debt. When buying government bonds, the central bank increases the monetary base and thus the money supply.

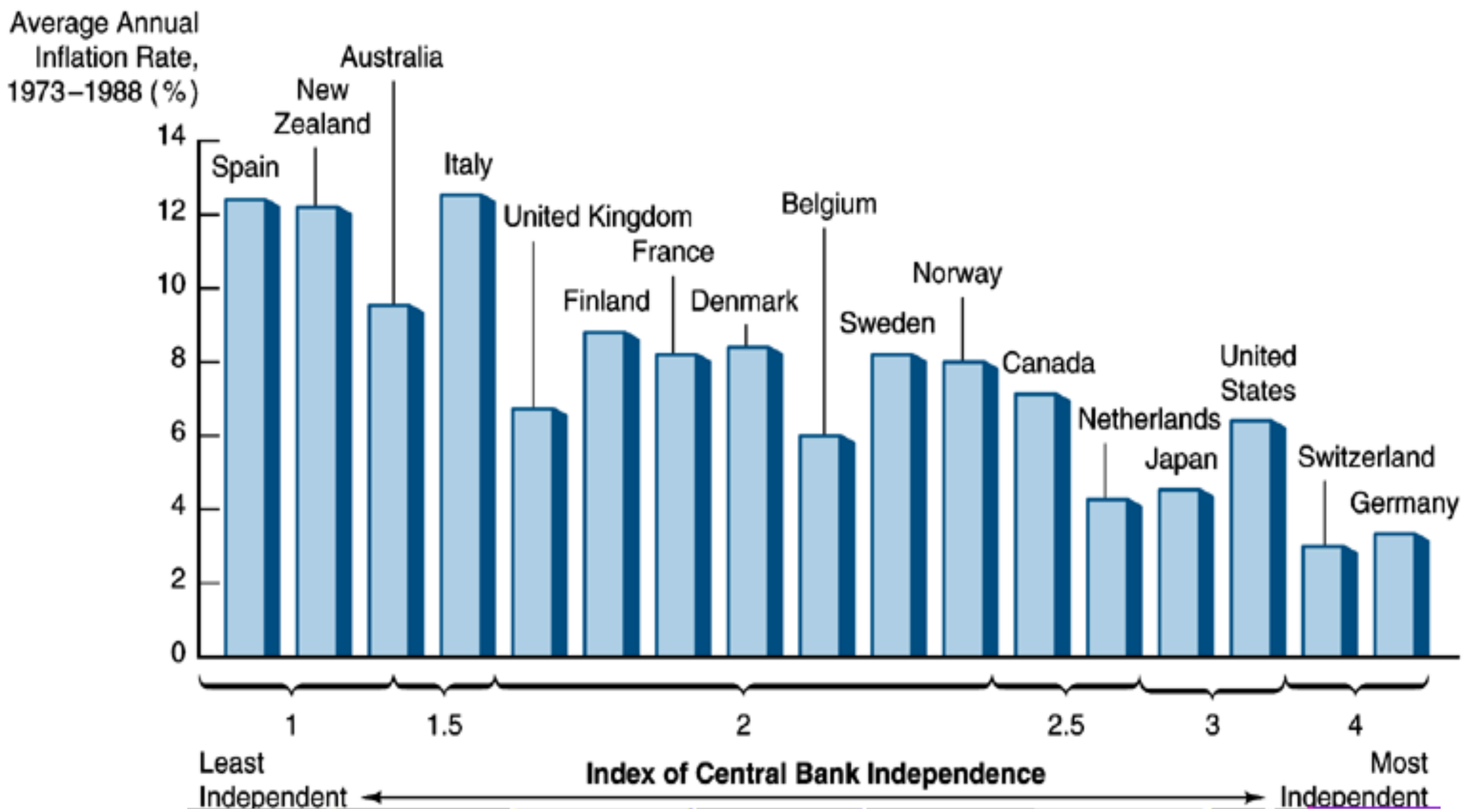
How to Fight Inflation

- Target money growth
- Appoint a “tough” central banker

  For example, in 1979 the appointment of Paul Volcker to be chairman of the Fed was designed to convince people that President Carter was serious about stopping inflation.

- Make central banks independent from the government
- Have a (low) inflation target

Central Bank Independence



The Economics of Money, Banking, and Financial Markets – Frederic S. Mishkin (2003), page 388
(Source: Alesina and Summers, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit and Banking* 25 (1993): 151-162.)

Inflation Targeting

- Since 1989, several countries have adopted a system of inflation targeting.
- New Zealand was the pioneer, announcing explicit inflation targets that had to be met or else the central bank’s governor could be fired.
- Canada, the U.K., Sweden, Australia, Spain, and others followed with some version of inflation targeting.
- The European Central Bank uses a modified inflation targeting approach.

Inflation and Retirement Planning

Inflation and retirement planning

In the last lecture, we saw how to plan for retirement given a required retirement income and expected interest rates. In that lecture, we made no adjustment for inflation. But if you don't account for inflation when planning for retirement, you may not be able to enjoy the standard of living you expect.

Ex. A couple currently earns a combined salary of $70,000 per year. They plan to retire in 35 years at age 65, at which point they hope to maintain their current standard of living, and plan to save enough to do so for 30 years. During retirement, their account will earn 3.5% per year in interest. While saving, they expect to earn an average annual return of 7%. They live in an economy where inflation is consistently 2% per year.

If the couple ignores inflation and saves so that they can withdraw $70,000 per year while in retirement, what will the *real* value of their annual withdrawals be in retirement?

Inflation and retirement planning

Ans.

In the last lecture, we showed how to compute how much the couple must save each year.

The couple wants to withdraw $70,000 per year for 30 years in retirement. Assuming a 3.5% return on their savings while in retirement, the couple must save $1.29M.

Time Value of Money	
P/Y	1
PMT	$70,000
FV	$0
N	30
I/Y	3.5%
PV=	-$1,287,443

Time Value of Money	
P/Y	1
PV	$0
FV	$1,287,443
N	35
I/Y	7.0%
PV=	-$9,313

To save $1.29M over the next 35 years, the couple should make annual contributions of $9,313 assuming a return of 7.0% per year.

Inflation and retirement planning

Ans. (continued)

However, because of inflation (at 2% per year), the purchasing power of their $70,000 withdrawals will be much less then they planned for.

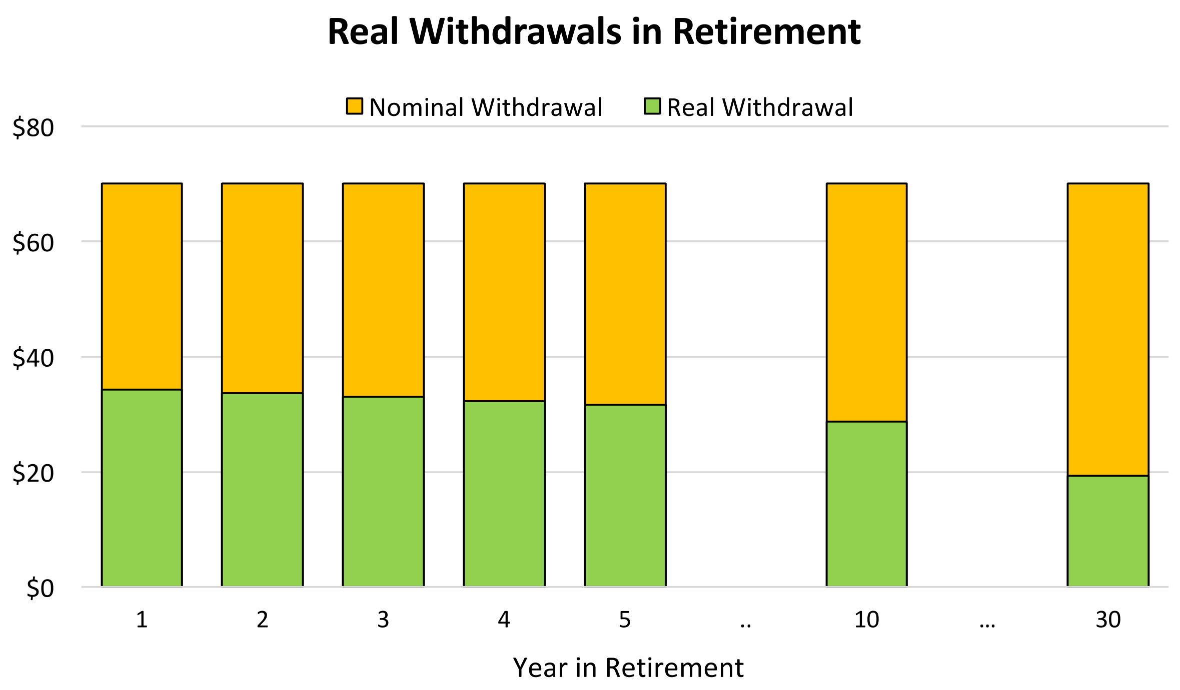
In the first year of retirement, 36 years from now, the *real* value of their $70,000 withdrawal will be cut in half to only $\frac{\$70{,}000}{1.02^{36}} = \$34{,}316$.

The real value of the $70,000 withdrawals will continue to decline throughout the 30 years of their retirement it reaches $\frac{\$70{,}000}{1.02^{65}} = \$19{,}323$ at the end of their planning horizon.

Inflation and retirement planning

Ans. (continued)

The following chart shows the real value of the couple's withdrawals throughout their retirement.



Inflation and retirement planning

Now, we show that it is easy to do consider inflation when making your retirement plans: **to adjust for inflation, simply plan using real interest rates and amounts.**

Ex. In the example above, a couple currently earns a combined salary of $70,000 per year. They plan to retire in 35 years at age 65, at which point they hope to maintain their current standard of living, and plan to save enough to do so for 30 years. During retirement, their account will earn 3.5% per year in interest. While saving, they expect to earn an average annual return of 7%. They live in an economy where inflation is consistently 2% per year.

How much must the couple withdraw each year in retirement to enjoy the same standard of living that $70,000 buys them today? And how much must they save each year to be able to do so?

Inflation and retirement planning

Ans.

To account for inflation, use **real interest rates** to find the **real target balance** and **real annual contributions**. Then, **convert** the annual contributions and retirement withdrawals to **nominal amounts**.

Step 1: Convert nominal rates to real interest rates

While saving for retirement, the couple expects to earn a nominal return of 7% on their investments. This corresponds to a *real* return of about 5%:

$$r = \frac{1+n}{1+i} - 1 = \frac{1.07}{1.02} - 1 = 4.90\%$$

And the 3.5% nominal return the couple expects to earn while in retirement corresponds to a real return of about 1.5%:

$$r = \frac{1+n}{1+i} - 1 = \frac{1.035}{1.02} - 1 = 1.47\%$$

Inflation and retirement planning

Ans. (continued)

Step 2: Compute real target balance
The couple wants to make *real* withdrawals of $70,000 per year for 30 years during their retirement while earning an expected 1.47% real return on their investment. To do so, they must accumulate a *real* balance of about $1.69M.

Time Value of Money	
P/Y	1
PMT	$70,000
FV	$0
N	30
I/Y	1.47%
PV=	-$1,688,280

Time Value of Money	
P/Y	1
PV	$0
FV	$1,688,280
N	35
I/Y	4.90%
PMT=	-$19,083

Step 3: Compute real contributions
To do so, the couple must make *real* contributions of $19,083 per year for the next 35 years, assuming a real return of 4.90%.

Inflation and retirement planning

Ans. (continued)

Step 4: Convert real amounts to nominal amounts

At the end of the first year, the couple should make a *nominal* contribution of $\$19{,}083 * 1.02 = \$19{,}465$.

They should increase this contribution by the 2% inflation rate each year until they make a final contribution of $\$19{,}083 * 1.02^{35} = \$38{,}164$.

At this point, they should have a *real* balance of $\$1.69M$, as we saw in the last slide. This corresponds to a *nominal* balance of $\$1.69M * 1.02^{35} = \$3.38M$.

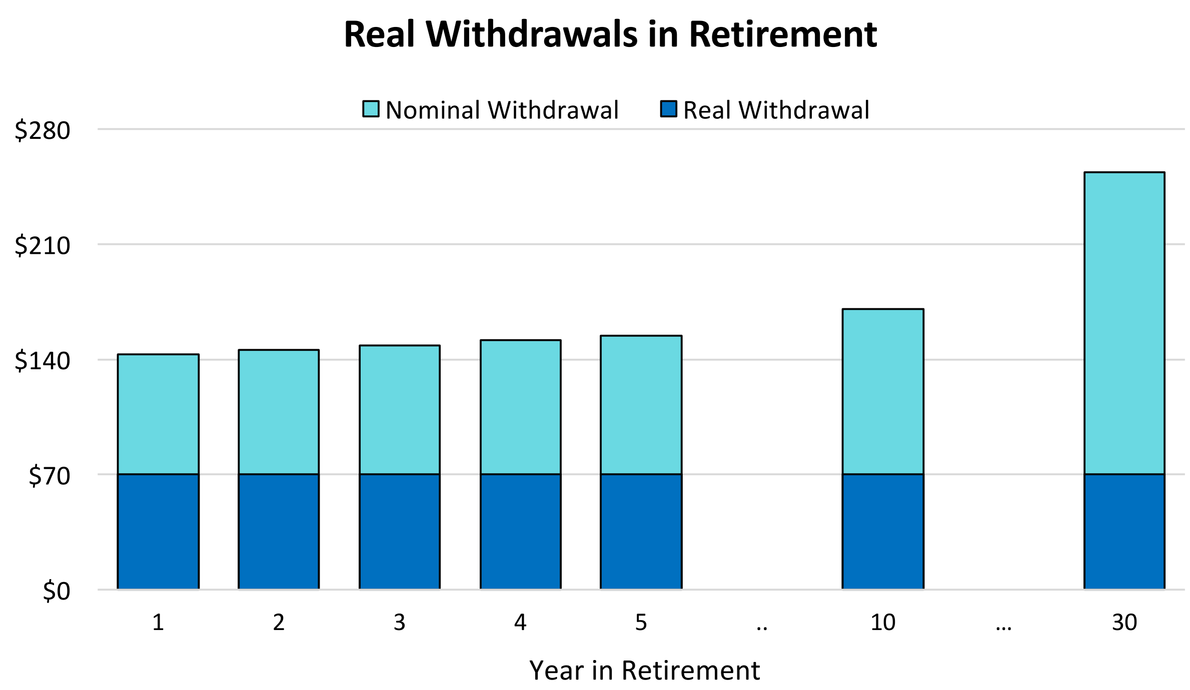
They should then withdraw $\$70{,}000 * 1.02^{36} = \$142{,}792$ in their first year of retirement.

They should increase their withdrawal by the 2% inflation rate per year until they withdraw $\$70{,}000 * 1.02^{65} = \$253{,}577$ at the end of their horizon.

Inflation and retirement planning

Ans. (continued)

The following chart shows the real and nominal withdrawals the couple should make during their retirement to maintain their pre-retirement standard of living.



Today we learned…

- ✓ Inflation and purchasing power
- ✓ Measuring inflation
- ✓ Nominal and real prices
- ✓ Inflation and wages
- ✓ Inflation and savings
- ✓ Effects of inflation
- ✓ Inflation and the Fed
- ✓ Inflation and retirement planning