ECON 2105 - Principles of Macroeconomics
Lecture 12: Inflation

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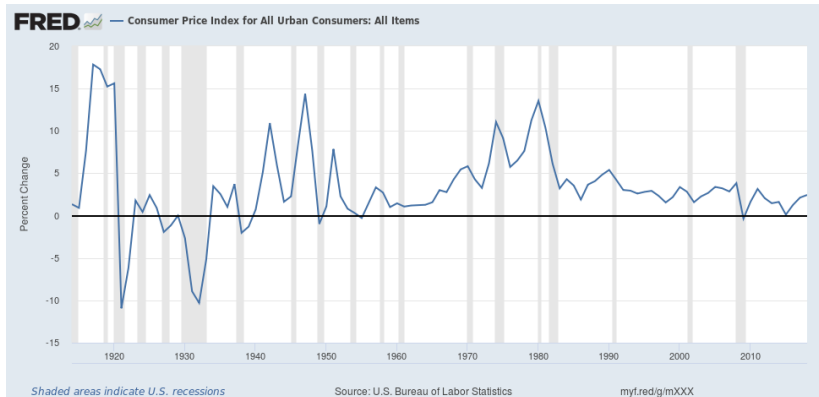Fall 2020
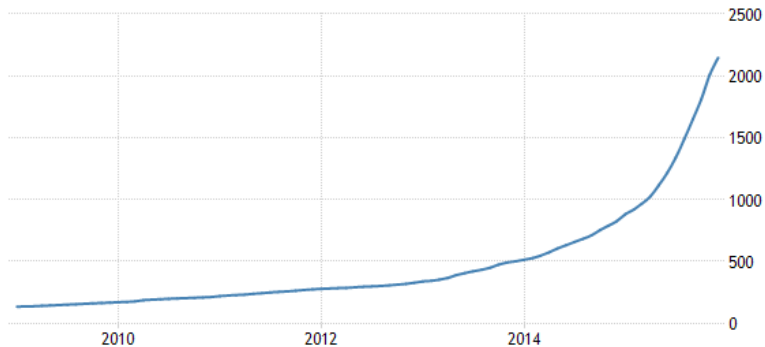
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Inflation in the US: 1914 – 2019

Inflation in Venezuela: 2009 – 2019

SOURCE: TRADINGECONOMICS.COM | BANCO CENTRAL DE VENEZUELA

Hyperinflation in Venezuela

A kilogram of carrots is pictured next to 3,000,000 bolivars, its price and the equivalent of 0.46 USD, at a mini-market in Caracas, Venezuela August 16, 2018.

This Lecture

- ▶ How does the money supply affect inflation and nominal interest rates?

- ▶ Does the money supply affect real variables like real GDP or the real interest rate?

- ▶ Is inflation a tax?

- ▶ What are the costs of inflation?

Introduction

- Recall one of Ten Principles from Lecture 1

    - Prices rise when the government prints too much money.

- This is sometimes referred to as quantity theory of money

- Most economists believe the quantity theory is a good explanation of the long run behavior of inflation.

The Value of Money

- $P =$ the price level (e.g., the CPI or GDP deflator)

- P is the price of a basket of goods, measured in money.

- $\frac{1}{P}$ is the value of \$1, measured in goods.

- Example: basket contains one potato

    - If $P = \$2$, value of \$1 is $\frac{1}{2}$ potato

    - If $P = \$3$, value of \$1 is $\frac{1}{3}$ potato

- Inflation drives up prices and drives down the value of money

The Quantity Theory of Money

- Developed by 18th century philosopher David Hume and the classical economists.

- Advocated more recently by Nobel Prize Laureate Milton Friedman.

- Asserts that the quantity of money determines the value of money.

- We study this theory using two approaches:
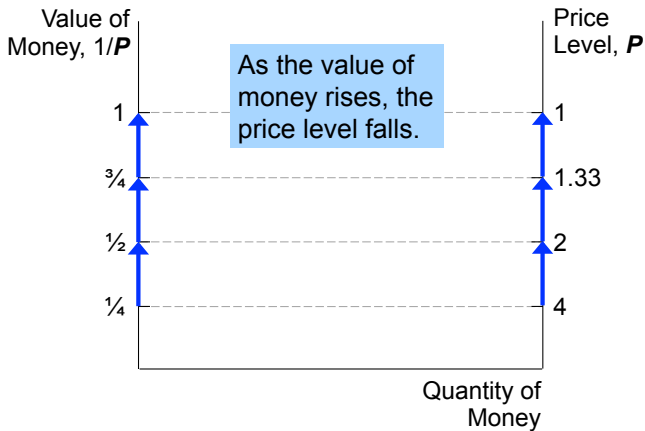
  - A supply-demand diagram

  - An equation

Money Supply (MS)

- In the real world, determined by the Fed, the banking system, and consumers.

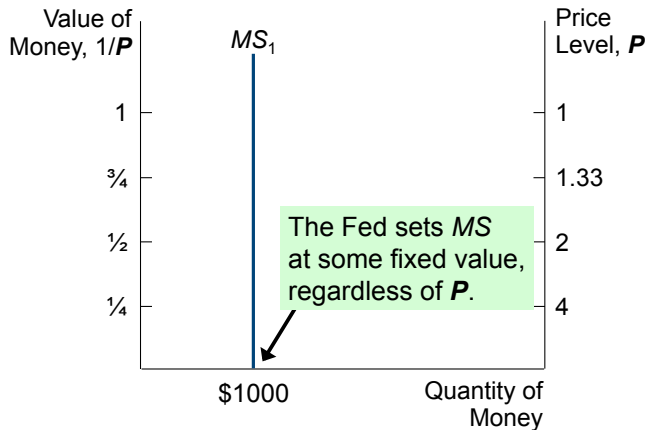- In this model, we assume the Fed precisely controls Money Supply and sets it at some fixed amount.

Money Demand (MD)

- Refers to how much wealth people want to hold in liquid form.

- Depends on P: An increase in P reduces the value of money, so more money is required to buy goods & services.

- Thus, quantity of money demanded is negatively related to the value of money and positively related to P, other things equal (These "other things" include real income, interest rates, availability of ATMs)

The Money Supply-Demand Diagram

As the value of money rises, the price level falls.

The Money Supply-Demand Diagram

The Money Supply-Demand Diagram

Value of Money, 1/**P**

A fall in value of money (or increase in **P**) increases the quantity of money demanded:

Price Level, **P**

1

¾

½

¼

MD_1

1

1.33

2

4

Quantity of Money
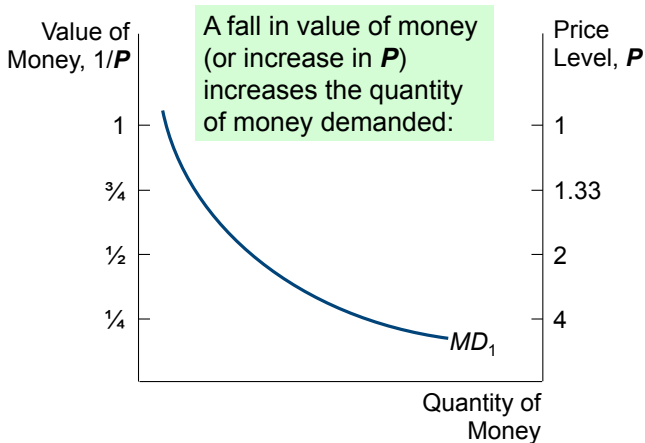
The Money Supply-Demand Diagram
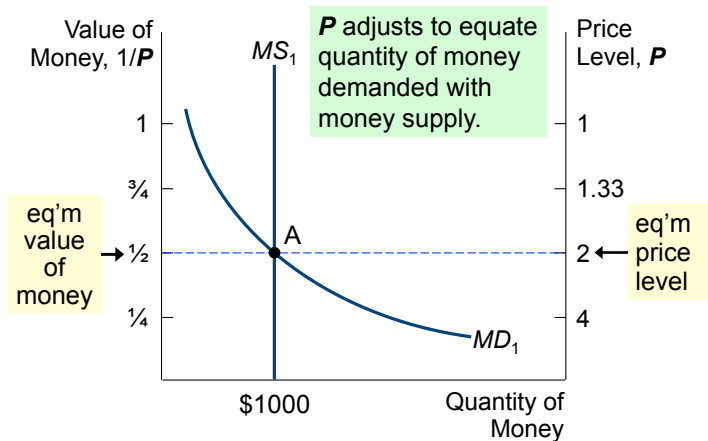
The Effects of a Monetary Injection

A Brief Look at the Adjustment Process
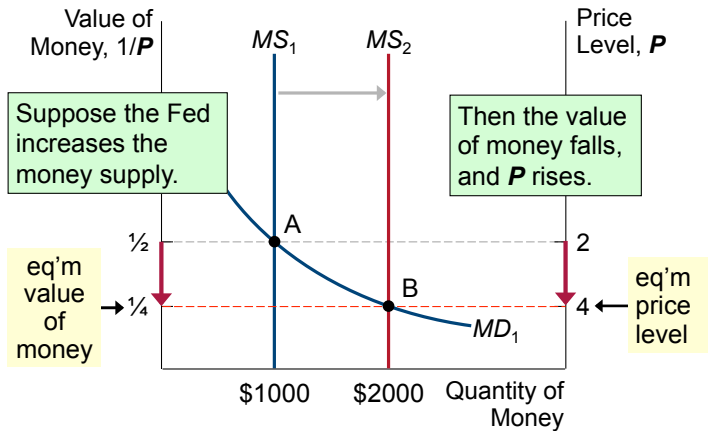
Result from graph: Increasing MS causes P to rise.

How does this work? Short version:

- ▶ At the initial P, an increase in MS causes an excess supply of money.

- ▶ People get rid of their excess money by spending it on goods & services or by loaning it to others, who spend it.

- ▶ Result: increased demand for goods.

- ▶ Suppose supply of goods does not increase, prices must rise.

▶ Note: our focus here is on the long run.

Real vs. Nominal Variables

- **Nominal variables** are measured in monetary units.

  Examples: nominal GDP, nominal interest rate (rate of return measured in $), nominal wage ($ per hour worked)

- **Real variables** are measured in physical units.

  Examples: real GDP, real interest rate (measured in output), real wage (measured in output)

Real vs. Nominal Variables

- Prices are normally measured in terms of money

  - Price of a compact disc: $15/cd

  - Price of a pepperoni pizza: $10/pizza

- A relative price is the price of one good relative to (divided by) another:

  - Relative price of CDs in terms of pizza:

  $$\frac{\text{price of cd}}{\text{price of pizza}} = \frac{\$15/\text{cd}}{\$10/\text{pizza}} = 1.5 \text{ pizzas per cd}$$

  Relative prices are measured in physical units, so they are real variables.

Real vs. Nominal Wage

An important relative price is the real wage:

W = nominal wage = price of labor, e.g., \$15/hour

P = price level = price of goods & services, e.g., \$5/unit of output

Real wage is the price of labor relative to the price of output:

$$\frac{W}{P} = \frac{\$15/\text{hour}}{\$5/\text{unit of output}} = 3 \text{ units output per hour}$$

The Classical Dichotomy

- **Classical dichotomy**: the theoretical separation of nominal and real variables

- Hume and the classical economists suggested that monetary developments affect nominal variables but not real variables.

- If central bank doubles the money supply, Hume & classical thinkers contend:

  - all nominal variables – including prices – will double.

  - all real variables – including relative prices – will remain unchanged.

The Neutrality of Money

- Monetary neutrality: the proposition that changes in the money supply do not affect real variables

- Doubling money supply causes all nominal prices to double; what happens to relative prices?

- Initially, relative price of cd in terms of pizza is

$$\frac{\text{price of cd}}{\text{price of pizza}} = \frac{\$15/\text{cd}}{\$10/\text{pizza}} = 1.5 \text{ pizzas per cd}$$

- After nominal prices double,

$$\frac{\text{price of cd}}{\text{price of pizza}} = \frac{\$30/\text{cd}}{\$20/\text{pizza}} = 1.5 \text{ pizzas per cd}$$

The relative price is unchanged.

The Neutrality of Money

- Monetary neutrality: the proposition that changes in the money supply do not affect real variables.

- Similarly, the real wage $\frac{W}{P}$ remains unchanged, so

  - quantity of labor supplied does not change.

  - quantity of labor demanded does not change.

  - total employment of labor does not change.

- The same applies to employment of capital and other resources.

- Since employment of all resources is unchanged, total output is also unchanged by the money supply.

The Neutrality of Money

- ► Most economists believe the classical dichotomy and neutrality of money describe the economy in the long run.

- ► In later chapters, we will see that monetary changes can have important short-run (1-2 years) effects on real variables.

The Velocity of Money

▶ **Velocity of money**: the frequency at which the average unit of currency is used to purchase newly domestically-produced goods and services within a given time period (the rate at which money changes hands).

▶ Notation:

$$
\begin{aligned}
P \times Y &= \text{nominal GDP} \\
&= (\text{price level}) \times (\text{real GDP}) \\
M &= \text{money supply} \\
V &= \text{velocity}
\end{aligned}
$$

▶ Velocity formula: $V = \frac{P \times Y}{M}$

The Velocity of Money

Velocity formula

$$V = \frac{P \times Y}{M}$$

▶ Example with one good: pizza In 2012,

$$
\begin{aligned}
Y &= \text{real GDP} = 3000 \text{ pizzas} \\
P &= \text{price level} = \text{price of pizza} = \$10 \\
P \times Y &= \text{nominal GDP} = \text{value of pizzas} = \$30000 \\
M &= \text{money supply} = \$10000 \\
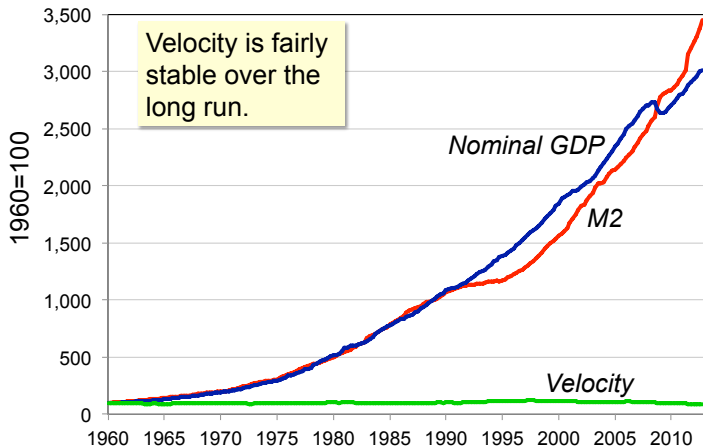V &= \text{velocity} = \frac{\$30000}{\$10000} = 3
\end{aligned}
$$

The average dollar was used in 3 transactions.

Exercise

There is only one good, potato. The economy has enough labor, capital, and land to produce $Y = 800$ bags of potato. Velocity V is constant. In 2008, Money Supply is \$2000 and price of potato is $P = \$5/\text{bag}$.

Compute nominal GDP and velocity in 2008.

U.S. Nominal GDP, M2, and Velocity, 1960-2013

The Quantity Equation

Velocity formula

$$V = \frac{P \times Y}{M}$$

▶ Multiply both sides by M

$$M \times V = P \times Y$$

▶ This equation is called quantity equation.

The Quantity Theory in 5 Steps

Start with quantity equation $M \times V = P \times Y$

1. V is stable – almost constant

2. So, a change in M causes nominal GDP $(P \times Y)$ to change by the same percentage.

3. A change in M does not affect Y: money is neutral, Y is determined by technology & resources

4. So, P must change by the same percentage as $P \times Y$ and M.

5. Rapid money supply growth causes rapid inflation.

Miltone Friedman: "inflation is always and everywhere a monetary phenomenon."

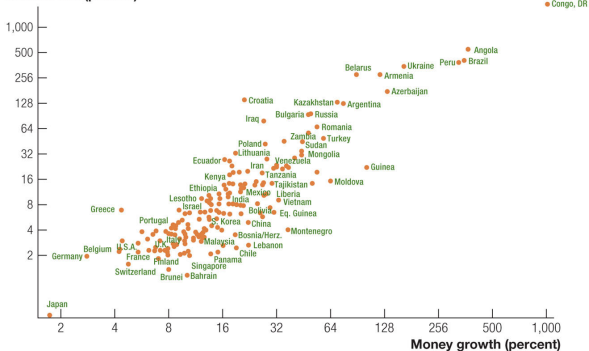# Money Growth and Inflation in the U.S., 1970 – 2012

FIGURE 8.2

Money Growth and Inflation in the United States, 1870–2012
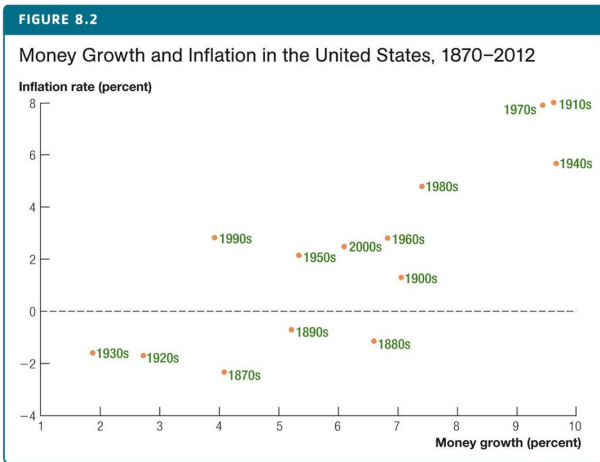
Money Growth and Inflation, World, 1990 − 2011

FIGURE 8.3

Money Growth and Inflation around the World, 1990−2011

Exercise

There is only one good, potato. The economy has enough labor, capital, and land to produce $Y = 800$ bags of potato. Velocity V is constant. In 2008, Money Supply is \$2000 and price of potato is $P = \$5/\text{bag}$.

For 2009, the Fed increases M by 5%, to \$2100.

A Compute the 2009 values of nominal GDP and P. Compute the inflation rate for 2008-2009.

Exercise

There is only one good, potato. The economy has enough labor, capital, and land to produce $Y = 800$ bags of potato. Velocity V is constant. In 2008, Money Supply is \$2000 and price of potato is $P = \$5/\text{bag}$.

For 2009, the Fed increases M by 5%, to \$2100.

B Suppose tech. progress causes Y to increase by 3% to 824 in 2009. Compute 2008-2009 inflation rate.

Summary

- If real GDP is constant, then inflation rate $=$ money growth rate

- If real GDP is growing, then inflation rate $<$ money growth rate.

$$\text{inlfation} = \text{money grwoth rate} - \text{real GDP growth}$$

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- The bottom line:

  - Economic growth increases $\#$ of transactions.

  - Some money growth is needed for these extra transactions.

  - Excessive money growth causes inflation.

Hyperinflation

- Hyperinflation is generally defined as inflation exceeding 50% per month.

- Recall one of the Ten Principles from Lecture 1:

  Prices rise when the government prints too much money

- Excessive growth in the money supply always causes hyperinflation

Hyperinflation in Zimbabwe

▶ Large government budget deficits led to the creation of large
quantities of money and high inflation rates

date	Zim$ per US$
Aug 2007	245
Apr 2008	29401
May 2008	207209688
June 2008	4470828401
July 2008	26421447043
Feb 2009	37410030
Sept 2009	355

Tom Sargent: "Persistent high inflation is always and
everywhere a fiscal phenomenon"

The End of Hyperinflations?

- ▶ How do episodes of high inflation or hyperinflation end?

The End of Hyperinflations?

- ▶ How do episodes of high inflation or hyperinflation end?

- ▶ Fundamentally difficult: much harder than just putting away the printing press.

  - ▶ Must fix the source of the problem: the government budget constraint

  - ▶ Fiscal reforms: find ways to cut spending and raise taxes and restore borrowing

  - ▶ These difficulties explain why hyperinflations tend to recur

- ▶ Coordination problem: convincing everyone in a frenzy of rising prices that they should stop raising their own prices.

The Inflation Tax

- When tax revenue is inadequate and ability to borrow is limited, government may print money to pay for its spending.

- Almost all hyperinflations start this way.

- The revenue from printing money is the inflation tax: printing money causes inflation, which is like a tax on everyone who holds money.

- In the U.S., the inflation tax today accounts for less than 3% of total revenue.

The Fisher Effect

▶ Recall the definition of real interest rate

$$\text{real interest rate} = \text{nominal interest rate} - \text{inflation}$$

The Fisher Effect

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real interest rate $=$ nominal interest rate $-$ inflation

- Rearrange the definition of the real interest rate:

nominal interest rate $=$ real interest rate $+$ inflation

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- The real interest rate is determined by saving & investment in the loanable funds market.

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- Money supply growth determines inflation rate.

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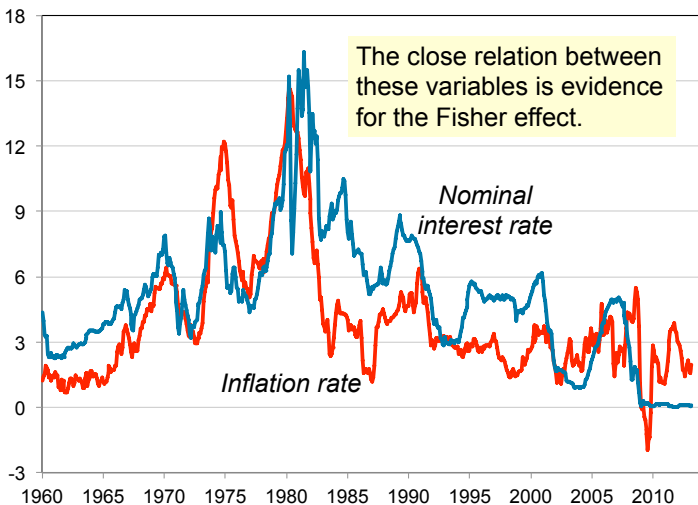
  nominal interest rate = real interest rate + inflation

- The real interest rate is determined by saving & investment in the loanable funds market.

- Money supply growth determines inflation rate.

- So, this equation shows how the nominal interest rate is related.

The Fisher Effect

nominal interest rate = real interest rate + inflation

- In the long run, money is neutral: a change in the money growth rate affects the inflation rate but not the real interest rate.

- So, the nominal interest rate adjusts one-for-one with changes in the inflation rate.

- This relationship is called the Fisher effect after Irving Fisher, who studied it.

U.S. Nominal Interest & Inflation Rates, 1960-2013

The close relation between these variables is evidence for the Fisher effect.

Nominal interest rate
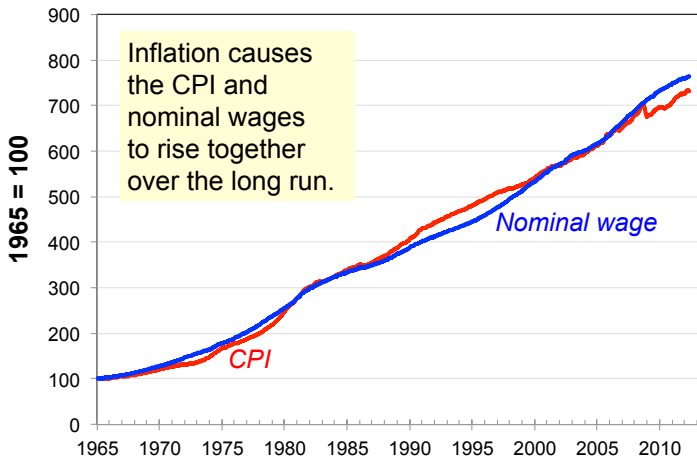
Inflation rate

The Fisher Effect & the Inflation Tax

$$\text{nominal interest rate} = \text{real interest rate} + \text{inflation}$$

- The inflation tax applies to people's holdings of money, not their holdings of wealth.

- The Fisher effect: an increase in inflation causes an equal increase in the nominal interest rate, so the real interest rate (on wealth) is unchanged

The Costs of Inflation

- The inflation fallacy: most people think inflation erodes real incomes.

- But inflation is a general increase in prices of the things people buy <u>and</u> the things they sell (e.g., their labor).

- In the long run, real incomes are determined by real variables, not the inflation rate.

U.S. Average Hourly Earnings & the CPI

Inflation causes the CPI and nominal wages to rise together over the long run.

The Costs of Inflation

▶ Shoeleather costs: the resources wasted when inflation encourages people to reduce their money holdings

The Costs of Inflation

- **Shoeleather costs**: the resources wasted when inflation encourages people to reduce their money holdings

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- **Misallocation of resources from relative-price variability**: Firms don't all raise prices at the same time, so relative prices can vary, which distorts the allocation of resources.

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- **Misallocation of resources from relative-price variability**: Firms don't all raise prices at the same time, so relative prices can vary, which distorts the allocation of resources.

- **Confusion & inconvenience**: Inflation changes the yardstick we use to measure transactions. Complicates long-range planning and the comparison of dollar amounts over time

The Costs of Inflation – continued

- ▶ Surprise inflation redistributes wealth from creditors to debtors

    - ▶ Loss of wealth for people on fixed incomes/annuities (retirees)

    - ▶ Banks, financial institutions, lenders, creditors lose (why?)

- ▶ U.S. tax system in the 1970s taxed nominal not real income

    - ▶ Bracket creep in the income tax system

The Costs of Inflation – continued

- ► Tax distortions:

  Inflation makes nominal income grow faster than real income

  Taxes are based on nominal income, and some are not adjusted for inflation

  So, inflation causes people to pay more taxes even when their real incomes don't increase

Tax Distortions: Exercise

You deposit $1000 in the bank for one year

Case 1: inflation = 0%, nominal interest rate = 10%

Case 2: inflation = 10%, nominal interest rate = 20%

A In which case does the real value of your deposit grow the most?

Tax Distortions: Exercise

You deposit $1000 in the bank for one year

Case 1: inflation = 0%, nominal interest rate = 10%

Case 2: inflation = 10%, nominal interest rate = 20%

Assume the tax rate is 25%.

B In which case do you pay the most taxes?

Tax Distortions: Exercise

You deposit $1000 in the bank for one year

Case 1: inflation = 0%, nominal interest rate = 10%

Case 2: inflation = 10%, nominal interest rate = 20%

Assume the tax rate is 25%.

C Compute the after-tax nominal interest rate, then subtract inflation to get the after-tax real interest rate for both cases

Summary

deposit=$1000, tax rate $= 25\%$

Case 1: inflation $= 0\%$, nominal interest rate $= 10\%$

Case 2: inflation $= 10\%$, nominal interest rate $= 20\%$

Inflation

- raises nominal interest rates (Fisher effect) but not real interest rates

- increases savers' tax burdens

- lowers the after-tax real interest rate

A Special Cost of Unexpected Inflation

▶ Arbitrary redistributions of wealth

Higher-than-expected inflation transfers purchasing power from creditors to debtors: Debtors get to repay their debt with dollars that aren't worth as much.

Lower-than-expected inflation transfers purchasing power from debtors to creditors.

High inflation is more variable and less predictable than low inflation.

So, these arbitrary redistributions are frequent when inflation is high.

The Costs of Inflation

- All these costs are quite high for economies experiencing hyperinflation.

- For economies with low inflation (less than 10% per year), these costs are probably much smaller, though their exact size is open to debate.