In this chapter, look for the answers to these questions:

- 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?
- How is inflation like a tax?
- What are the costs of inflation? How serious are they?

Introduction

This chapter introduces the **quantity theory of money** to explain one of the Ten Principles of Economics from Chapter 1:

*Prices rise when the govt prints too much money.*

Most economists believe the quantity theory is
The Value of Money

- $P$ = the price level
  (e.g., the CPI or GDP deflator)
- $\frac{1}{P}$ is
- Example: basket contains one candy bar.
  - If $P = $2, value of $1$ is $\frac{1}{2}$ candy bar
  - If $P = $3, value of $1$ is $\frac{1}{3}$ candy bar

Inflation drives up prices and

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
- We study this theory using two approaches:
  1. A supply-demand diagram
  2. An equation

Money Supply ($M_S$)

- In real world, determined by Federal Reserve, the banking system, consumers.
- In this model, we assume
Money Demand (MD)

- Refers to
- Depends on

Thus, quantity of money demanded is __________ related to the value of money and __________ related to \( P \), other things equal.
(These “other things” include real income, interest rates, availability of ATMs.)

The Money Supply-Demand Diagram

<table>
<thead>
<tr>
<th>Value of Money, ( 1/P )</th>
<th>Quantity of Money</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4%</td>
<td>1.33</td>
</tr>
<tr>
<td>2%</td>
<td>2</td>
</tr>
<tr>
<td>1%</td>
<td>4</td>
</tr>
<tr>
<td>1/4</td>
<td>1000</td>
</tr>
</tbody>
</table>

The Fed sets \( MS \) at some fixed value, regardless of \( P \).
A fall in value of money (or increase in $P$) increases the quantity of money demanded:

The Money Supply-Demand Diagram

The Effects of a Monetary Injection

Suppose the Fed increases the money supply.
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
  - People get rid of their excess money by spending it on g&s or by loaning it to others, who spend it.
  - Result:
  - But supply of goods

(Other things happen in the short run, which we will study in later chapters.)

Real vs. Nominal Variables

Nominal variables

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

Real variables

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

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

- Relative price of CDs in terms of pizza:

Relative prices are measured in _______________, so they are real variables.
**Real vs. Nominal Wage**

An important relative price is the real wage:

\[ W = \text{nominal wage} = \text{price of labor}, \ e.g., \$15/\text{hour} \]

\[ P = \text{price level} = \text{price of g&s}, \ e.g., \$5/\text{unit of output} \]

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

**The Classical Dichotomy**

- Classical dichotomy:

- Hume and the classical economists suggested that

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

- all nominal variables

- all real variables

**The Neutrality of Money**

- Monetary neutrality: the proposition that

- 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, relative price of cd in terms of pizza is

\[ \frac{\text{price of cd}}{\text{price of pizza}} = \frac{30/\text{cd}}{20/\text{pizza}} = \text{ pizzas per cd} \]
The Neutrality of Money

- Similarly, the real wage $W/P$
- quantity of labor supplied
- quantity of labor demanded
- total employment of labor
- The same applies to employment of capital and other resources.
- Since employment of all resources is ____________, 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 effects on real variables.

The Velocity of Money

- Velocity of money:

- Notation:
  $P \times Y = \text{nominal GDP}$
  $= (\text{price level}) \times (\text{real GDP})$
  $M = \text{money supply}$
  $V = \text{velocity}$

- Velocity formula:
### The Velocity of Money

Example with one good: pizza.

In 2008,
- \( Y \) = real GDP = 3000 pizzas
- \( P \) = price level = price of pizza = $10
- \( P \times Y \) = nominal GDP = value of pizzas = $30,000
- \( M \) = money supply = $10,000
- \( V \) = velocity =

### Active Learning 1

#### Exercise

One good: corn.

The economy has enough labor, capital, and land to produce \( Y = 800 \) bushels of corn.

\( V \) is constant.

In 2008, \( MS = \$2000, \ P = \$5 \) bushel.

Compute nominal GDP and velocity in 2008.

#### Answers
The Quantity Equation

Velocity formula: \[ V = \frac{P \times Y}{M} \]

- Multiply both sides of formula by \( M \):

- Called the quantity equation

The Quantity Theory in 5 Steps

Start with quantity equation: \( M \times V = P \times Y \)

1. \( V \) is stable.
2. So, a change in \( M \) causes

3. A change in \( M \)
   money is neutral,
   \( Y \) is determined by

4. So, \( P \) changes by

5. Rapid money supply growth causes rapid inflation.
**Exercise**

One good: corn. The economy has enough labor, capital, and land to produce $Y = 800$ bushels of corn. $V$ is constant. In 2008, $MS = $2000, $P = $5/bushel.

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


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**Answers**

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**Summary and Lessons about the Quantity Theory of Money**

- If real GDP is constant, then
- If real GDP is growing, then
- The bottom line:
  - Economic growth increases # of transactions.
Hyperinflation

- Hyperinflation is generally defined as

- Recall one of the Ten Principles from Chapter 1: *Prices rise when the government prints too much money.*

The Inflation Tax

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

- Almost all hyperinflations start this way.

- Inflation tax:

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

The Fisher Effect

- Rearrange the definition of the real interest rate:

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

  - So, this equation shows how the nominal interest rate is determined.
The Fisher Effect

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

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


The Fisher Effect & the Inflation Tax

- 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:

But inflation is a general increase in prices of the things people buy and

In the long run,

U.S. Average Hourly Earnings & the CPI

Nominal wage (right scale)

CPI (left scale)

The Costs of Inflation

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

Menu costs:
The Costs of Inflation

- 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.

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The Costs of Inflation

- Tax distortions:

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ACTIVE LEARNING 3

Tax distortions

You deposit $1000 in the bank for one year.

CASE 1: inflation = 0%, nom. interest rate = 10%
CASE 2: inflation = 10%, nom. interest rate = 20%

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

Assume the tax rate is 25%.

b. In which case do you pay the most taxes?

c. Compute the after-tax nominal interest rate, then subtract off inflation to get the after-tax real interest rate for both cases.
A Special Cost of Unexpected Inflation

- **Arbitrary redistributions of wealth**
  - Higher-than-expected inflation
    - Debtors get to repay their debt with dollars that aren’t worth as much.
    - Lower-than-expected inflation
  - High 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 (< 10% per year), these costs are probably much smaller, though their exact size is open to debate.
CONCLUSION

This chapter explains one of the Ten Principles of economics:

*Prices rise when the govt prints too much money.*

We saw that

In later chapters, we will see that money has important effects in the short run on real variables like output and employment.