IN THIS CHAPTER, YOU WILL LEARN:

- The classical theory of inflation
  - causes
  - effects
  - social costs
- “Classical”—assumes prices are flexible & markets clear
- Applies to the long run
U.S. inflation and its trend, 1960-2014

% change from 12 mos. earlier

% change in GDP deflator
U.S. inflation and its trend, 1960-2014
The quantity theory of money

- A simple theory linking the inflation rate to the growth rate of the money supply.
- Begins with the concept of velocity…
Velocity

- Basic concept: the rate at which money circulates
- Definition: the number of times the average dollar bill changes hands in a given time period
- Example: In 2015,
  - $500 billion in transactions
  - money supply = $100 billion
  - The average dollar is used in five transactions in 2015
  - So, velocity = 5
CHAPTER 5 Inflation

Velocity (continued)

- This suggests the following definition:

\[ V = \frac{T}{M} \]

where

\( V = \text{velocity} \)

\( T = \text{value of all transactions} \)

\( M = \text{money supply} \)
Velocity (continued)

- Use nominal GDP as a proxy for total transactions.

Then, \[ V = \frac{P \times Y}{M} \]

where

- \( P \) = price of output \quad \text{(GDP deflator)}
- \( Y \) = quantity of output \quad \text{(real GDP)}
- \( P \times Y \) = value of output \quad \text{(nominal GDP)}
The quantity equation

- The quantity equation
  \[ M \times V = P \times Y \]
  follows from the preceding definition of velocity.

- It is an identity:
  it holds by definition of the variables.
Money demand and the quantity equation

- \( M/P = \text{real money balances} \), the purchasing power of the money supply.

- A simple money demand function:
  \[
  (M/P)^d = kY
  \]
  where
  \( k = \) how much money people wish to hold for each dollar of income.
  \( (k \text{ is exogenous}) \)
Money demand and the quantity equation

- Money demand: $\left( \frac{M}{P} \right)^d = kY$
- Quantity equation: $M \times V = P \times Y$
- The connection between them: $k = 1/V$
- When people hold lots of money relative to their incomes ($k$ is large), money changes hands infrequently ($V$ is small).
Back to the quantity theory of money

- Starts with quantity equation
- Assumes $V$ is constant & exogenous: $V = \bar{V}$

Then, quantity equation becomes:

$$M \times \bar{V} = P \times Y$$
The quantity theory of money (continued)

\[ M \times \bar{V} = P \times Y \]

How the price level is determined:

- With \( V \) constant, the money supply determines nominal GDP \( (P \times Y) \).

- Real GDP is determined by the economy’s supplies of \( K \) and \( L \) and the production function (Chapter 3).

- The price level is \( P = (\text{nominal GDP})/(\text{real GDP}) \).
The quantity theory of money (continued)

- Recall from Chapter 2:
  The growth rate of a product equals the sum of the growth rates.

- The quantity equation in growth rates:

\[
\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}
\]

The quantity theory of money assumes \( V \) is constant, so \( \frac{\Delta V}{V} = 0 \).
The quantity theory of money (continued)

\( \pi \) (Greek letter \( \pi \)) denotes the inflation rate:

\[
\pi = \frac{\Delta P}{P}
\]

The result from the preceding slide:

\[
\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}
\]

Solve this result for \( \pi \):

\[
\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}
\]
The quantity theory of money (continued)

Normal economic growth requires a certain amount of money supply growth to facilitate the growth in transactions.

Money growth in excess of this amount leads to inflation.

\[ \pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y} \]
The quantity theory of money (continued)

\[ \pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y} \]

\( \Delta Y/Y \) depends on growth in the factors of production and on technological progress (all of which we take as given, for now).

Hence, the quantity theory predicts a one-for-one relation between changes in the money growth rate and changes in the inflation rate.
Confronting the quantity theory with data

The quantity theory of money implies:

1. Countries with higher money growth rates should have higher inflation rates.

2. The long-run trend in a country’s inflation rate should be similar to the long-run trend in the country’s money growth rate.

Are the data consistent with these implications?
International data on inflation and money growth

Inflation rate (percent)

Money supply growth (percent)

- China, Mainland
- Iraq
- Turkey
- Angola
- Turkey
- Democratic Republic of Congo
- Argentina
- Malta
- Singapore
- Belarus
U.S. inflation and money growth, 1960-2014

% change from 12 mos. earlier

M2 growth rate

inflation rate
Inflation and money growth have the same long-run trends, as the quantity theory predicts.
Inflation and interest rates

- Nominal interest rate, $i$
  not adjusted for inflation

- Real interest rate, $r$
  adjusted for inflation:

  $$r = i - \pi$$
The Fisher effect

- The Fisher equation: \( i = r + \pi \)
- Chapter 3: \( S = I \) determines \( r \).
- Hence, an increase in \( \pi \) causes an equal increase in \( i \).
- This one-for-one relationship is called the Fisher effect.
U.S. inflation and nominal interest rates, 1960-2014

Percent per year

nominal interest rate

inflation rate
Inflation and nominal interest rates in 100 countries

Nominal interest rate (percent)

Inflation rate (percent)
NOW YOU TRY
Applying the theory

Suppose $V$ is constant, $M$ is growing 5% per year, $Y$ is growing 2% per year, and $r = 4$.

a. Solve for $i$.

b. If the Fed increases the money growth rate by 2 percentage points per year, find $\Delta i$.

c. Suppose the growth rate of $Y$ falls to 1% per year.
   - What will happen to $\pi$?
   - What must the Fed do if it wishes to keep $\pi$ constant?
ANSWERS
Applying the theory

\( V \) is constant, \( M \) grows 5% per year, \( Y \) grows 2% per year, \( r = 4 \).

a. First, find \( \pi = 5 - 2 = 3 \).

Then, find \( i = r + \pi = 4 + 3 = 7 \).

b. \( \Delta i = 2 \), same as the increase in the money growth rate.

c. If the Fed does nothing, \( \Delta \pi = 1 \).

To prevent inflation from rising, the Fed must reduce the money growth rate by 1 percentage point per year.
Two real interest rates

Notation:
- \( \pi \) = actual inflation rate
  (not known until after it has occurred)
- \( E\pi \) = expected inflation rate

Two real interest rates:
- \( i - E\pi \) = \textit{ex ante} real interest rate:
  the real interest rate people expect at the time they buy a bond or take out a loan
- \( i - \pi \) = \textit{ex post} real interest rate:
  the real interest rate actually realized
Money demand and the nominal interest rate

- In the quantity theory of money, the demand for real money balances depends only on real income $Y$.  
- Another determinant of money demand: the nominal interest rate, $i$.  
  - the opportunity cost of holding money (instead of bonds or other interest-earning assets).  
- So, money demand depends negatively on $i$.  

CHAPTER 5  Inflation
The money demand function

\[(M/P)^d = L(i, Y)\]

\((M/P)^d\) = real money demand, depends

- negatively on \(i\)
  - \(i\) is the opp. cost of holding money
- positively on \(Y\)
  - higher \(Y\) increases spending on g&s, so increases need for money

("L" is used for the money demand function because money is the most liquid asset.)
The money demand function

$$(M/P)^d = L(i, Y) = L(r + E\pi, Y)$$

When people are deciding whether to hold money or bonds, they don’t know what inflation will turn out to be.

Hence, the nominal interest rate relevant for money demand is $r + E\pi$. 
Equilibrium

\[ \frac{M}{P} = L(r + E\pi, Y) \]

The supply of real money balances

Real money demand
What determines what?

\[ \frac{M}{P} = L(r + E\pi, Y) \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>How determined (in the long run)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>exogenous (the Fed)</td>
</tr>
<tr>
<td>r</td>
<td>adjusts to ensure ( S = I )</td>
</tr>
<tr>
<td>Y</td>
<td>( \bar{Y} = F(\bar{K}, \bar{L}) )</td>
</tr>
<tr>
<td>P</td>
<td>adjusts to ensure ( \frac{M}{P} = L(i, Y) )</td>
</tr>
</tbody>
</table>
How \( P \) responds to \( \Delta M \)

\[
\frac{M}{P} = L(r + E\pi, Y)
\]

- For given values of \( r, Y, \) and \( E\pi \), a change in \( M \) causes \( P \) to change by the same percentage—just like in the quantity theory of money.
What about expected inflation?

- Over the long run, people don’t consistently over- or under-forecast inflation, so $E\pi = \pi$ on average.

- In the short run, $E\pi$ may change when people get new information.

- *E.g.*: The Fed announces it will increase $M$ next year. People will expect next year’s $P$ to be higher, so $E\pi$ rises.

- This affects $P$ now, even though $M$ hasn’t changed yet...
How $P$ responds to $\Delta E\pi$

$$\frac{M}{P} = L(r + E\pi, Y)$$

- For given values of $r$, $Y$, and $M$,

  $\uparrow E\pi \Rightarrow \uparrow i$ (the Fisher effect)

  $\Rightarrow \downarrow (M/P)^d$

  $\Rightarrow \uparrow P$ to make $(M/P)$ fall to re-establish eq'm
The Cagan Model (appendix)

\[ m_t - p_t = -\gamma(Ep_{t+1} - p_t), \quad (A8) \]

\[ p_t = \left( \frac{1}{1 + \gamma} \right) \left[ m_t + \left( \frac{\gamma}{1 + \gamma} \right) Em_{t+1} + \left( \frac{\gamma}{1 + \gamma} \right)^2 Em_{t+2} + \left( \frac{\gamma}{1 + \gamma} \right)^3 Em_{t+3} + \ldots \right]. (A9) \]
Why is inflation bad?

- What costs does inflation impose on society? List all the ones you can think of.
- Focus on the long run.
- Think like an economist.
A common misperception

- Common misperception: inflation reduces real wages
- This is true only in the short run, when nominal wages are fixed by contracts.
- (Chapter 3) In the long run, the real wage is determined by labor supply and the marginal product of labor, not the price level or inflation rate.
- Consider the data . . .
The CPI and average hourly earnings, 1965–2015

Real average hourly earnings in 2014 dollars, right scale

Nominal average hourly earnings, (1965 = 100)

CPI (1965 = 100)
The classical view of inflation

- *The classical view:*  
  A change in the price level is merely a change in the units of measurement.

Then, why is inflation a social problem?
The social costs of inflation

…fall into two categories:

1. costs when inflation is expected
2. costs when inflation is different than people had expected
The costs of expected inflation: 
1. Shoeleather Cost

- Definition: the costs and inconveniences of reducing money balances to avoid the inflation tax.
- If $\pi$ increases, $i$ increases (why?), so people reduce their real money balances.
- Remember: In long run, inflation does not affect real income or real spending.
- So, same monthly spending but lower average money holdings means more frequent trips to the bank to withdraw smaller amounts of cash.
The costs of expected inflation:

2. Menu Costs

- Definition: The costs of changing prices.

- Examples:
  - cost of printing new menus
  - cost of printing & mailing new catalogs

- The higher is inflation, the more frequently firms must change their prices and incur these costs.
The costs of expected inflation:
3. Relative Price Distortions

- Firms facing menu costs change prices infrequently.
- Example:
  A firm issues new catalog each January.
  As the general price level rises throughout the year, the firm’s relative price will fall.
- Different firms change their prices at different times, leading to relative price distortions . . .
  . . . causing microeconomic inefficiencies in the allocation of resources.
The costs of expected inflation:  
4. Unfair Tax Treatment

Some taxes are not adjusted to account for inflation, such as the capital gains tax.

Example:

- Jan 1: you buy $10,000 worth of Apple stock
- Dec 31: you sell the stock for $11,000, so your nominal capital gain is $1,000 (10%).
- Suppose $\pi = 10\%$ during the year. Your real capital gain is $0$.
- Yet, you must pay taxes on your $1,000 nominal gain!
The costs of expected inflation:

5. General Inconvenience

- Inflation makes it harder to compare nominal values from different time periods.
- This complicates long-range financial planning.
Additional cost of *unexpected* inflation: Arbitrary Redistribution of Purchasing Power

- Many long-term contracts not indexed, but based on $E\pi$.
- If $\pi$ turns out different from $E\pi$, then some gain at others’ expense.

Example: borrowers & lenders

- If $\pi > E\pi$, then $(i - \pi) < (i - E\pi)$ and purchasing power is transferred from lenders to borrowers.
- If $\pi < E\pi$, then purchasing power is transferred from borrowers to lenders.
Additional cost of high inflation: Increased Uncertainty

- When inflation is high, it’s more variable and unpredictable: \( \pi \) turns out different from \( E\pi \) more often, and the differences tend to be larger, though not systematically positive or negative.

- So, arbitrary redistributions of wealth more likely.

- This increases uncertainty, making risk-averse people worse off.
One *benefit* of inflation

- Nominal wages are rarely reduced, even when the equilibrium real wage falls. This hinders labor market clearing.

- Inflation allows the real wages to reach equilibrium levels without nominal wage cuts.

- Therefore, moderate inflation improves the functioning of labor markets.
Seigniorage

- To spend more without raising taxes or selling bonds, the government can print money.

- The “revenue” raised from printing money is called seigniorage. (pronounced SEEN-your-idge).

- The inflation tax:
  Printing money to raise revenue causes inflation. Inflation is like a tax on people who hold money.
Hyperinflation

- Common definition: $\pi \geq 50\%$ per month
- All the costs of moderate inflation described above become **HUGE** under hyperinflation.
- Money ceases to function as a store of value, and may not serve its other functions (unit of account, medium of exchange).
- People may conduct transactions with barter or a stable foreign currency.
What causes hyperinflation?

- Hyperinflation is caused by excessive money supply growth.
- When the central bank prints money, the price level rises.
- If it prints money rapidly enough, the result is hyperinflation.
A few examples of hyperinflation

<table>
<thead>
<tr>
<th>country</th>
<th>period</th>
<th>CPI Inflation % per year</th>
<th>M2 Growth % per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Israel</td>
<td>1983-85</td>
<td>338%</td>
<td>305%</td>
</tr>
<tr>
<td>Brazil</td>
<td>1987-94</td>
<td>1,256</td>
<td>1,451</td>
</tr>
<tr>
<td>Bolivia</td>
<td>1983-86</td>
<td>1,818</td>
<td>1,727</td>
</tr>
<tr>
<td>Ukraine</td>
<td>1992-94</td>
<td>2,089</td>
<td>1,029</td>
</tr>
<tr>
<td>Argentina</td>
<td>1988-90</td>
<td>2,671</td>
<td>1,583</td>
</tr>
<tr>
<td>Dem. Republic of Congo / Zaire</td>
<td>1990-96</td>
<td>3,039</td>
<td>2,373</td>
</tr>
<tr>
<td>Angola</td>
<td>1995-96</td>
<td>4,145</td>
<td>4,106</td>
</tr>
<tr>
<td>Peru</td>
<td>1988-90</td>
<td>5,050</td>
<td>3,517</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>2005-07</td>
<td>5,316</td>
<td>9,914</td>
</tr>
</tbody>
</table>
Why governments create hyperinflation

- When a government cannot raise taxes or sell bonds, it must finance spending increases by printing money.
- In theory, the solution to hyperinflation is simple: stop printing money.
- In the real world, this requires drastic and painful fiscal restraint.
Ending Hyperinflation

Time Paths of Variables:

Figure 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P$</td>
<td></td>
</tr>
<tr>
<td>$\pi$</td>
<td></td>
</tr>
<tr>
<td>$i$</td>
<td></td>
</tr>
<tr>
<td>$M/P$</td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td></td>
</tr>
</tbody>
</table>

End of inflation

Time
The classical dichotomy

**Real variables**: Measured in physical units—quantities and relative prices, *for example*:

- quantity of output produced
- real wage: output earned per hour of work
- real interest rate: output earned in the future by lending one unit of output today

**Nominal variables**: Measured in money units, *e.g.*,

- nominal wage: Dollars per hour of work.
- nominal interest rate: Dollars earned in future by lending one dollar today.
- the price level: The amount of dollars needed to buy a representative basket of goods.
The classical dichotomy

- Recall: Real variables were explained in Chapter 3, nominal ones in Chapter 5.

- **Classical dichotomy**: the theoretical separation of real and nominal variables in the classical model, which implies nominal variables do not affect real variables.

- **Neutrality of money**: Changes in the money supply do not affect real variables. In the real world, money is approximately neutral in the long run.
CHAPTER SUMMARY

- **Velocity**: the ratio of nominal expenditure to money supply, the rate at which money changes hands.

- **Quantity theory of money**
  - assumes velocity is constant
  - concludes that the money growth rate determines the inflation rate
  - applies in the long run
  - consistent with cross-country and time-series data
CHAPTER SUMMARY

- Nominal interest rate
  - equals real interest rate + inflation rate
  - the opp. cost of holding money
- Fisher effect: Nominal interest rate moves one-for-one with expected inflation.
- Money demand
  - depends only on income in the quantity theory
  - also depends on the nominal interest rate
  - if so, then changes in expected inflation affect the current price level
CHAPTER SUMMARY

Costs of inflation

- *Expected inflation*
  - shoeleather costs, menu costs, tax & relative price distortions, inconvenience of correcting figures for inflation

- *Unexpected inflation*
  - all of the above plus arbitrary redistributions of wealth between debtors and creditors
CHAPTER SUMMARY

Hyperinflation

- caused by rapid money supply growth when money printed to finance govt budget deficits
- stopping it requires fiscal reforms to eliminate govt’s need for printing money
CHAPTER SUMMARY

Classical dichotomy

- In classical theory, money is neutral—does not affect real variables.
- So, we can study how real variables are determined w/o reference to nominal ones.
- Then, money market eq’m determines price level and all nominal variables.
- Most economists believe the economy works this way in the long run.