Chapter Four

Money and Inflation

September 21, 2012
TOPICS IN THIS CHAPTER

• Money - what is it?
  • Reasons for demand
  • Method of supply
• Quantity theory of money - money’s basic link to the economy
• Inflation, interest rate and money demand
• Social costs of inflation - why do we care so much about it?
• Seigniorage - government’s revenue from money
• Hyperinflation - what is it, what are its causes and how is stopped?
Real vs. Nominal Variables

To date, our focus has been the real economy:

- Real output, real wages, real interest rate; the unit of account for these prices are in terms of real output.

- But this ignores the monetary or nominal part of the economy. Now we need to consider some of the nominal variables of the economy to understand the role of money.
  - In particular, we need to consider what determines the price level or, equivalently, the rate of inflation.
We now consider money, the price level and the rate of inflation:

- Consider the general price level, $P$. This is the dollar price of one unit of output (assuming $P$ is the GDP Deflator).
- That is $P$ ($/GDP$); inverting this we have the real price of one dollar, or one unit of money, in terms of output.
- $1/P$ is the price of one dollar, or one unit of money $M$, in terms of output.
  - Put differently; suppose the price of a book is 3$. Then $1/3$ of a book buys one unit of money (one dollar).
Inflation is the rise in the general price level:

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

To be more explicit, let \( P_t \) be the price level at some time \( t \); then we could measure inflation as:

\[ \pi = \frac{P_t - P_{t-1}}{P_t} \]

or,

\[ \pi = \ln P_t - \ln P_{t-1} \]

Because prices are defined in terms of money, we need to consider the nature of money, the supply of money, and how it is controlled.
Money: What is It?

Money is the stock of assets that can be readily used to make transactions.
Money: Functions

Money has three purposes (underlying reasons for demand):

a) Medium of exchange

we use it to buy stuff – *facilitates transactions*

b) Store of value

Transfers purchasing power from the present to the future – *a means of saving*

c) Unit of Account

the common unit by which everyone measures prices and values

*• Ultimately, its role as a medium of exchange is its defining feature*

◦ It serves as a useful store of value because people believe that it will be possible to exchange it for something useful in the future

◦ Acting as a unit of account is a natural role for something that is being used for exchange purposes
Money: Types

Fiat money
- has no intrinsic value

*Example:* the paper currency we use – *mandated by the government*

Commodity money
- has intrinsic value

*Examples:* gold coins, cow, cigarette, etc.
Evaluation of Money

Historically, commodity money was important, in particular coins made from metals: silver, gold and so forth. Presumably it had some intrinsic value based upon its use for jewelry and other artisan work.

Governments typically step in at some stage. They may do so because they are sufficiently powerful enough that they can force the use of their minted coins; their objective in doing so is the potential source of revenue (seigniorage revenue) - e.g. by selling gold coins at a value greater than the gold in them.

Governments may also serve a purpose in doing so; they can guarantee purity and weight; by making things more systematic they remove uncertainty and the system is more efficient.

At some point, it may become burdensome to trade in large amounts of gold or other metals. So, trade evolves not in the commodity itself but in paper claims to the commodity. It is still a commodity backed currency.

The next stage; goldsmiths and fractional banking evolve.

Finally, to ensure a stable and efficient system - and to ensure that the ultimate supply of money/credit is in the control of the government, government takes over and mandates the use of fiat currency. As long as people are willing to accept the fiat currency, then the system does not require a commodity backing.

Money is ultimately a social convention - it is valued because it is accepted in exchange
Money Supply

The money supply is the quantity of money available in the economy. Monetary policy is to control the money supply.

- Controlled by the Bank of Canada through open market operations — buying and selling of government bonds
  - By buying bonds, the money supply is increased
  - By selling bonds, the money supply is decreased
Different measures of money:

- **High powered money**
  
  Base \((B)\) = currency + banks’ deposits at Bank of Canada
  
  - *directly controllable by the Bank of Canada*

- **M1 - M3**: expands \(B\) progressively to include different type of deposits

  First includes demand deposits which are very liquid; then less liquid deposits. These are broad definitions of money.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Assets Included</th>
<th>Amount in December 2008 (billions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B$</td>
<td>Currency plus chartered bank deposits at the Bank of Canada</td>
<td>$51.1</td>
</tr>
<tr>
<td>$M1$</td>
<td>Sum of currency in circulation, demand deposits, and other chequing deposits at chartered banks</td>
<td>$211.7</td>
</tr>
<tr>
<td>$M2$</td>
<td>Sum of $M1$ plus personal savings deposits and nonpersonal notice deposits at chartered banks</td>
<td>$891.1</td>
</tr>
<tr>
<td>$M2+$</td>
<td>Sum of $M2$ plus all deposits and shares at trust companies, mortgage loan companies, credit unions, and Caisses Populaires</td>
<td>$1,228.2</td>
</tr>
<tr>
<td>$M3$</td>
<td>Sum of $M2$ plus fixed-term deposits of firms at chartered banks</td>
<td>$1,317.1</td>
</tr>
</tbody>
</table>

The Quantity Theory of Money

A simple theory linking the inflation rate to the growth rate of the money supply

The quantity equation: \[ M \times V_T = P \times T \]

*Where*, \( M \) = money stock

\( P \) = price of a typical transaction

\( T \) = number of transactions

\( V_T \) = the transactions velocity of money

Transaction velocity of money is the rate at which money circulates in the economy
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 2007, $500 billion in transactions, money supply was $100 billion. Thus, the average dollar is used in five transactions in 2007

*So, velocity = 5*

If the supply of money gets doubled and $T$ and $P$ stay the same; then the transaction velocity must be half.
Mathematically: \( V = \frac{T}{M} \)

Where,

\( V \) = velocity

\( T \) = all transactions

\( M \) = money supply
Quantity Theory of Money

Similarly, we can define: \( M \times V = P \times Y \)

where, \( Y \) = output (GDP) or equivalently national income; \( V \) = the income velocity of money; \( P \) = price of output (GDP deflator); and

\[ P \times Y = \text{value of output (nominal GDP)} \]

It is an identity: it holds by definition of the variables.

If \( T \) is proportional to \( Y \) then \( V^T \) is proportional to \( V \)

- This allows us to think of the velocity of money as being determined by the methods of payment within the system; if this is stable, then \( V^T \) and hence \( V \) is likely to be stable.
Money Demand and Quantity Equation

We can also motivate a relationship between money, output and prices by linking money demand and supply.

Demand for real balances (Version I): \[ \left( \frac{M}{P} \right)^D = k \cdot Y \]

*Where,* \( M/P \) = real money balances, the purchasing power of the money supply; \( k \) = how much money people wish to hold for each dollar of income (\( k \) is exogenous)

**Notice that we have written this as a demand not for money but for real balances, \( M/P \).**

- Consumers (firms) require money not for its own sake but to purchase goods; so what matters is the real purchasing power of money
- The greater the national income, the greater the demand for money
Demand for real balance: \((M/P)^D = kY\)

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 high), money changes hands infrequently (\(V\) is low).

- assumes \(V\) is constant & exogenous: \(V = \bar{V}\)

- With this assumption, the quantity equation can be written as:

\[ M \times \bar{V} = P \times Y \]
Equilibrium in the Money Market

All else equal, a doubling of the price level requires a doubling of the level of money supply of real balances, \((M/P)\)

• Equilibrium in the money market:

\[
\frac{M}{P} = k \cdot Y
\]

• If we let \(k = 1/V\) then we have our previous relationship between money, output and prices \((M.V=P.Y)\).
Quantity Theory of Money (QTM)

If velocity $V$ is constant, denoted as $\bar{V}$, then the quantity of money determines the nominal value of output (nominal GDP):

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

This is a statement of the quantity theory of money.
Quantity Theory & Inflation

If velocity is constant and output is supplied determined (long-run) then,

Price level is determined as \( P = \frac{M\bar{V}}{Y} \)

Inflation is determined as:
\[
\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}
\]

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

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

\[
\frac{\Delta P}{P} = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}
\]
Or,

\[ \pi = m - g \]

That is, inflation is the difference between the growth rate of money, \( m \) and the growth rate of output, \( g \) (determined by population and technological progress)

**Notes on Inflation:**

Suppose output growth is zero, then inflation is simply equal to the growth rate of money.

“Inflation is always and everywhere a monetary phenomenon”.

In the short run, output is likely to be influenced by changes in the money supply and the above is not likely to hold.
Quantity Theory of Money

Over the longer run, a reasonable approximation, especially for higher rates of inflation.

Not a suitable tool for monetary policy at low levels of inflation. Many central banks pay little attention to the supply of money, largely because in the short run velocity is too variable.

One way to view the problem is to note that (1) money demand is likely to depend upon the interest rate, and (2) the nominal interest rate depends upon the inflation rate (the Fisher effect) and (3) money demand (velocity) is variable, due to changes in the payments system for example.
Confronting the quantity theory with data

The quantity theory of money implies; therefore,

$$\pi = m - g$$

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

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

Are the data consistent with these implications?
Figure: International data on inflation and money growth
U.S. inflation and money growth, 1960-2010

-3% 0% 3% 6% 9% 12% 15%

% change from 12 mos. earlier

-3% 0% 3% 6% 9% 12% 15%

M2 growth rate

inflation rate
Inflation, the Interest rates and Money Demand

**Nominal and real interest rates:**

A loan or investment has a return that has two parts: the real interest rate (return) and the nominal interest rate (return).

The relationship between the real and nominal interest rate is often approximated as:

\[ i = r + \pi \]

Where,  
- \( i \) = nominal interest rate  
- \( r \) = real interest rate  
- \( \pi \) = inflation rate.
Detail:

Let, \( B_t \) be a nominal loan (e.g. lending $100 means \( B_t = $100 \)) with interest rate \( i_t \).

The real return on this loan (the lender’s perspective) is the ratio of the real value of the principal \( B_t \) plus interest payment (\( i_t B_t \)) to the real value of the initial loan. That is

- Real value of principal plus interest in period \( t + 1 \): 
  \[
  B_t \frac{(1+i_t)}{P_{t+1}}
  \]

- Real value of principal in period \( t \): 
  \[
  \frac{B_t}{P_t}
  \]
So, the real return is:

\[(1 + r_t) = \frac{B_t (1 + i_t)}{P_{t+1}} \div \frac{B_T}{P_t}\]

Rewrite this as,

\[\frac{P_{t+1}}{P_t} (1 + r_t) = (1 + i_t)\]

Since

\[\pi_{t+1} = \frac{P_{t+1} - P_t}{P_t} = \frac{P_{t+1}}{P_t} - 1\]

We can write

\[(1 + \pi_{t+1})(1 + r_t) = 1 + i_t\]

Expanding this expression gives

\[1 + r_t + \pi_{t+1} + r_t \pi_{t+1} = 1 + i_t\]

The approximation comes from assuming that the term \(r_t \pi_{t+1}\) is small enough that we can set it to zero:

\[1 + r_t + \pi_{t+1} = 1 + i_t\]
or, \[ r_t = i_t - \pi_{t+1} \]

This is the standard approximation

Notice, \( i_t \) and \( r_t \) are decided at time \( t \) but \( \pi_{t+1} \) is not known until time \( t+1 \). So, the above should properly be:

\[ r_t = i_t - \text{Expected} (\pi_{t+1}) \]

or,

\[ r_t = i_t - \pi_{t+1}^{E} \]

Two measures of the real interest rate:

a. *ex post* real interest rate: \[ r_t = i_t - \pi_{t+1} \]
   or, \[ r = i - \pi \]

b. *ex ante* real interest rate: \[ r_t = i_t - \pi_{t+1}^{E} \]
   or, \[ r = i - \pi^{e} \]
The Fisher Effect

An increase in the (expected) inflation rate causes the nominal interest rate to rise by exactly the same amount (one for one)

*Extending the Quantity theory of money*

money growth determines inflation; inflation determines nominal interest rate. Output and the real interest rate are determined on the supply side as usual.
Exercise

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 Bank of Canada 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 Bank of Canada do if it wishes to keep $\pi$ constant?
Demand for Real Balance (Version II)

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 is the nominal interest rate - the income forgone since money doesn’t pay interest (instead of bonds or other interest-earning assets). Hence, $\uparrow i \Rightarrow \downarrow$ in money demand.

Demand for money:

$$\left( \frac{M}{P} \right)^D = L(Y, i)$$

$$= L(Y, r + \pi^E)$$
**Equilibrium**

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

The supply of real money balances

Real money demand

**Note:** the demand for real balances depends upon future expected inflation, which itself depends upon money growth; that is,

Money supply = Money Demand \(\Rightarrow\) Price Level \(\Rightarrow\) Inflation Rate \(\Rightarrow\) Nominal Interest Rate \(\Rightarrow\) Money Demand

This point can be made very explicitly using a simple model of money due to Cagan; this model, which emphasizes the relationship between current prices and future money growth is often used to model hyperinflations.
Credibility of monetary policy is important:

- if agents believe that the money supply process will follow a low inflation path then this is reflected in current price level and inflation;
- if agents believe that future money supply process is inflationary then this will be reflected in the current price level and inflation

Implications:

- Supports the creation of independent central banks
- Hyperinflations generally arise from large fiscal deficits financed by the central bank (seigniorage); to stop hyperinflation generally requires a credible reform of fiscal policies.
Costs of Inflation

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:

*inflation reduces real wages*

- This is true only in the short run, when nominal wages are fixed by contracts.
- In the long run, what determines the real wage?
The classical view:
A change in the price level is merely a change in the units of measurement.

So why, then, is inflation a social problem?

Inflations are two types:
  o Anticipated inflation
  o Unanticipated inflation
The Social Costs of Inflation

**Anticipated inflation** – efficiency costs

a. **Transaction costs** — high inflation, go to the bank more often (*shoeleather cost*)

b. **Menu costs** — actual cost of changing prices

c. **Distorts relative prices** — if some prices are slow to adjust

d. **Non-indexed tax system** — *e.g.*, dis-incentive to save: nominal interest income is taxed, not real; high inflation means over-taxing.
Unanticipated inflation - uncertainty and distributional effects

Consumers/firms do not like uncertainty; may reduce the number of contracts entered into.

Unanticipated inflation redistributes income; any nominal contract written over time is based upon an anticipated inflation rate; when this doesn’t eventuate, someone loses, someone wins. For example, positive unanticipated inflation means borrows gain at expense of lenders.

Solution is indexing but we see surprisingly little of this
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

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

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

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

- Def: $\pi \geq 50\%$ 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>1256%</td>
<td>1451%</td>
</tr>
<tr>
<td>Bolivia</td>
<td>1983-86</td>
<td>1818%</td>
<td>1727%</td>
</tr>
<tr>
<td>Ukraine</td>
<td>1992-94</td>
<td>2089%</td>
<td>1029%</td>
</tr>
<tr>
<td>Argentina</td>
<td>1988-90</td>
<td>2671%</td>
<td>1583%</td>
</tr>
<tr>
<td>Dem. Republic of Congo / Zaire</td>
<td>1990-96</td>
<td>3039%</td>
<td>2373%</td>
</tr>
<tr>
<td>Angola</td>
<td>1995-96</td>
<td>4145%</td>
<td>4106%</td>
</tr>
<tr>
<td>Peru</td>
<td>1988-90</td>
<td>5050%</td>
<td>3517%</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>2005-07</td>
<td>5316%</td>
<td>9914%</td>
</tr>
</tbody>
</table>
Why Govt creates 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.
The Classical Dichotomy

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

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
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.