Inflation and the business cycle

Michael McMahon
To Cover

- Discuss the costs of inflation;
- Investigate the relationship between money and inflation;
- Introduce the Romer framework;
- Discuss hyperinflations.
- Shocks and the business cycle;
- Monetary policy responses to business cycles.
- Explain what the monetary transmission mechanism is;
- Examine the link between inflation and GDP.
The Next Few Lectures

Money and Banking (5): Inflation & Bus. Cycle
Inflation

Definition

Inflation is a sustained general rise in the price level in the economy.

In reality we measure it using concepts such as:

- Consumer Price Indices (CPI);
- Producer Price Indices (PPI);
- Deflators (GDP deflator, Consumption Expenditure Deflator)
Inflation: The Costs

If all prices are rising at same rate, including wages and asset prices, what is the problem?

- Information: Makes it harder to detect relative price changes and so hinders efficient operation of market;
- Uncertainty: High inflation countries have very volatile inflation;
- High inflation undermines role of money and encourages barter;
- Growth - if inflation increases by 10%, reduce long term growth by 0.2% but only for countries with inflation higher than 15% (Barro);
- Shoe leather costs/menu costs;
- Interaction with tax system;
- Because of fixed nominal contracts arbitrarily redistributes wealth;
- Nominal contracts break down and long-term contracts avoided.
Inflation in the UK - 1271-2003

Source: ONS (2009)
Inflation in the UK - 1271-2003

Source: ONS (2009)
Pre 1900s: commodity-money. Money physically contains or is fully backed by precious metal (gold, silver). Fluctuations in gold/silver reserves a big impact on prices

Post 1900s: switch to “fiat money.” Governments print money at will. Relatively easy to eliminate deflation: just print some extra money. But also easy to get carried away and print too much

Post 1980s: Governments abuse of fiat money leads to independent central banks
Milton Friedman

"Inflation is always and everywhere a monetary phenomenon"
A Quantity Theory of Money I

The model is mainly associated with Milton Friedman but its history goes much further back than that - back to the likes of Mills and Hume, or even Copernicus!

The following “equation of exchange” relationship must hold:

\[ M \cdot V = P \cdot Y \]

where:

- \( M \) = Quantity of Money
- \( V \) = Velocity of Circulation (how often a bank note is used in transactions within a period)
- \( P \) = Price Level
- \( Y \) = Output/GDP
A Quantity Theory of Money II

Assuming that $V$ is relatively constant (e.g. the level of money use is pretty constant), the quantity theory tells us that:

$$M = \frac{1}{V}P.Y$$

So that if we increase $M$, either prices or GDP must increase...but which one?

What happens if we put more money in the system to spend?

- In the Short-Run?
- In the Long-Run?
Quantity Theory says that “inflation is always and everywhere a monetary phenomenon”

It depends on two key assumptions

1. $V$ constant
2. Money has no effect on output in the long-run (monetary neutrality)

Problems:

- Obviously, velocity may also change over time, e.g. because of things like cash machines, and affect the relationship somewhat.
- 2 is a long run assumption so in the short run no strong reason to expect quantity theory to hold exactly
Money Growth and Inflation

Inflation rate (percent, logarithmic scale)

Money supply growth (percent, logarithmic scale)

Source: Mankiw (Fig.4.2). Averages for the 1990s.

Democratic Republic of Congo
Nicaragua
Angola
Brazil
Bulgaria
Georgia
Kuwait
USA
Oman
Japan
Canada
Germany

Source: Mankiw (Fig.4.2). Averages for the 1990s.
Money Growth and Inflation

Annual Inflation and Money Growth
(Argentina 1970-2001)
A Quantity Theory of Money - Assessment

Long run data strongly supportive of quantity theory – both time series and cross-country.

However, short run data offers less support, low correlation between inflation and money supply growth.

Key Conclusion

Monetary policy needs to take a more sophisticated approach to controlling inflation than simply quantity theory suggests if needed for short to medium run purposes.
Romer Model

• This is very similar to the IS-LM and AS-AD material that you covered last year.
• Some aspects are, I believe, clearer using this framework - it is an alternative.
• I will not cover the open economy in lectures but it is covered in the material on the website.

To begin we have an IS curve which is the same as before relating output and real interest rates via the Keynesian Cross:

\[ E = C(Y - T) + I(r) + G \]

Thus IS curve shifts if consumer confidence changes, G changes, T changes, etc...
IS Curve I

\[ r \]

\[ y \]

\( IS \)
Planned expenditure

\[ E = C(Y-T) + I(r) + G \]
IS Curve II

Planned expenditure

\[ E = C(Y-T) + I(r) + G \]
MP Curve I

When output rises, the central bank raises the real interest rate. When output falls, the central bank lowers the real interest rate. But the choice of the real interest rate depends not only on output, but also on inflation. When inflation rises, the central bank raises the real interest rate. When inflation falls, the central bank lowers the real interest rate.

\[ r = r(Y, \pi) \]

- Initially we take the level of inflation as given.
- Hence the Monetary Policy (MP) curve is an upward sloping curve in \((Y, r)\) space.
- Shifts in the MP curve are caused by increases in inflation - the central bank has a higher level of interest rate for any given level of output.
MP Curve III

Monetary Policy (MP) can affect real interest rates via the equilibrium of real money supply and real money demand:

\[
\frac{M}{P} = L(i, Y)
\]

where \( i = r + \pi^e \) - Taylor Principle

- If prices are fully fixed \((P = \bar{P}, \pi^e = 0)\) - an increase in \(M\) must be offset by an increase in \(Y\) and a fall in \(r\);
- If prices adjust slowly (some instantly \((P \uparrow)\), some later \((\pi^e > 0)\)) - an increase in \(M\) must be offset by an increase in \(Y\) and a fall in \(r\);
- If prices are fully flexible, then money is neutral.
- Monetary policy is also ineffective in the *liquidity trap*
  - KEY FOR LATER
Equilibrium

$\text{MP'}$  
$\text{MP}$  
$\text{IS}$

Money and Banking (5): Inflation & Bus. Cycle
Equilibrium

Money and Banking (5): Inflation & Bus. Cycle 22 / 68
Equilibrium
Thinking About The Dynamics

- Up until now, the central bank took inflation as given.
- Now we need to think about the process for inflation and how the monetary authority will respond.

  At a point in time, the rate of inflation is given. When output is above its natural rate, inflation rises. When output is below its natural rate, inflation falls. When output equals its natural rate, inflation is constant.

- Inflation today does not respond to disturbances today.
- It is inflation and not prices that are affected positively (negatively) by above (below) natural rate activity.
- We can also allow for inflation shocks.
AD-IA Model

- We now wish to think about the behaviour of inflation and output.
- Since inflation is given at a point in time, the inflation adjustment (IA) curve is a horizontal line.
  - Output affects inflation by pushing it up (down) if output is above (below) its natural rate.
- Also, as \( \pi \uparrow \) we know that output is lowered (since higher \( \pi \) leads to higher \( r \), this reduces output)
  - This gives us the AD curve
AD-IA Model

Inflation

\[ y^N \]

\[ IA_0 \]

\[ AD \]
AD-IA Model

Inflation

\[ y^N \]

\[ y \]

\[ IA_1 \]

\[ AD \]
AD-IA Model

Inflation

Money and Banking (5): Inflation & Bus. Cycle
AD-IA Model - Fiscal Policy

Inflation

$y^N$

$y$

$IA_3$

$AD'$

Money and Banking (5): Inflation & Bus. Cycle
AD-IA Model - Fiscal Policy

Money and Banking (5): Inflation & Bus. Cycle
AD-IA Model - Monetary Policy

Inflation

Money and Banking (5): Inflation & Bus. Cycle
AD-IA Model - Monetary Policy
AD-IA Model - Monetary Policy (LR)
There are two types of shocks to aggregate supply in this model:

1. Inflation shocks (price-setting shocks)
2. Supply shocks

An inflation shock is a disturbance to the usual behavior of inflation that shifts the inflation adjustment line. A supply shock is a change in the natural rate of output.

I will return to inflation expectations and the effect of monetary policy if it is credible or not next week.
AD-IA Model - Inflation Shocks I

Inflation

$IA_{new}$

$AD$

Money and Banking (5): Inflation & Bus. Cycle
Inflation

$y_0^N \rightarrow y_1^N$

$IA_1$

$AD$

$y$

Money and Banking (5): Inflation & Bus. Cycle
Inflation and Government Deficits

\[ \text{Deficit} = G - T \]
\[ = \Delta B + \Delta M \]

where \( G \) is government revenue, \( T \) is taxation collected, \( \Delta B \) is the change in government borrowing, and \( \Delta M \) is the change in money supply.

So if they don’t increase taxation or borrow from the private sector (\( \Delta B \)), new spending must be paid for by either:

1. new money printed.
2. new bonds that public will not hold - Central Bank conducts an Open Market purchase which increases Money Supply.
Zimbabwe
Zimbabwe
Hyperinflations

The quantity theory really helps thinking about hyperinflations: inflation may or may not always be a monetary phenomenon, but hyperinflation is!

Hyperinflations are always the result of excessive money printing to finance government spending.

The big problem is that money-printing eventually reduces the value of money, so it becomes necessary to print even more money to raise the same real revenue - the result inflation spiral is an hyperinflation: high and ever-increasing inflation
Hyperinflation Dynamics

Hyperinflations result from very rapid increases in the money supply...they always result from the printing of money to finance a budget deficit.

Hyperinflation dynamics is self-fuelling:

1. Government deficit financed by printing money;
2. Increase in cash increases prices directly;
3. Value of money declines leading to a switch towards other types of assets. Will lower money's value and increase inflation further;
4. Lags in tax collection implies government revenue falls in real terms (at 100% inflation per month, a one month lag in collection of tax halves the real value of taxes);
5. Increases deficit – back to 1
### Historical Hyperinflations I

#### Table: Seven Hyperinflations of the 1920s and 1940s

<table>
<thead>
<tr>
<th>Country</th>
<th>Beginning</th>
<th>End</th>
<th>Avg. Monthly Inflation Rate (%)</th>
<th>Avg. Monthly Money Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>10/1921</td>
<td>8/1922</td>
<td>47</td>
<td>31</td>
</tr>
<tr>
<td>Germany</td>
<td>8/1922</td>
<td>11/1923</td>
<td>322</td>
<td>314</td>
</tr>
<tr>
<td>Greece</td>
<td>11/1943</td>
<td>11/1944</td>
<td>365</td>
<td>220</td>
</tr>
<tr>
<td>Hungary I</td>
<td>3/1923</td>
<td>2/1924</td>
<td>46</td>
<td>33</td>
</tr>
<tr>
<td>Hungary II</td>
<td>8/1945</td>
<td>7/1946</td>
<td>19800</td>
<td>12200</td>
</tr>
<tr>
<td>Poland</td>
<td>1/1923</td>
<td>1/1924</td>
<td>82</td>
<td>72</td>
</tr>
<tr>
<td>Russia</td>
<td>12/1921</td>
<td>1/1924</td>
<td>57</td>
<td>49</td>
</tr>
</tbody>
</table>
## Historical Hyperinflations II

<table>
<thead>
<tr>
<th>Country</th>
<th>Month with highest inflation rate</th>
<th>Highest monthly inflation rate</th>
<th>Equivalent Daily inflation Rate</th>
<th>Time required for prices to Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungary</td>
<td>July 1946</td>
<td>$1.30 \times 10^{16}%$</td>
<td>195%</td>
<td>15.6 hours</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>Mid-November 2008 (latest measurable)</td>
<td>79,600,000,000%</td>
<td>98.0%</td>
<td>24.7 hours</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>January 1994</td>
<td>313,000,000%</td>
<td>64.6%</td>
<td>1.4 days</td>
</tr>
<tr>
<td>Germany</td>
<td>October 1923</td>
<td>29,500%</td>
<td>20.9%</td>
<td>3.7 days</td>
</tr>
<tr>
<td>Greece</td>
<td>November 1944</td>
<td>11,300%</td>
<td>17.1%</td>
<td>4.5 days</td>
</tr>
<tr>
<td>China</td>
<td>May 1949</td>
<td>4,210%</td>
<td>13.4%</td>
<td>5.6 days</td>
</tr>
</tbody>
</table>
### The German Hyperinflation

<table>
<thead>
<tr>
<th>Month</th>
<th>Currency Index</th>
<th>Prices Index</th>
<th>Real Money Index</th>
<th>Inflation (% per month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 1922</td>
<td>1</td>
<td>1</td>
<td>1.00</td>
<td>5</td>
</tr>
<tr>
<td>Jan 1923</td>
<td>16</td>
<td>75</td>
<td>0.21</td>
<td>189</td>
</tr>
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<td>386</td>
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Money and Banking (5): Inflation & Bus. Cycle
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To stop a hyperinflation governments need to:

- Re-instate public’s belief in the value of money and lower money supply growth.
- Stabilize government budget deficit – if this does not happen, it is not credible to commit to lower inflation.

All successful attempts to stop hyperinflation have included fiscal reform.
Imprecise Definition

Cycle is made of an expansion (boom) and a contraction (recession). During the expansion all good things (GDP, employment, productivity, . . .) tend to go up, or grow faster than “normal,” and bad things (unemployment) tend to fall. During the contraction good things go down and bad things go up.

To be contrasted with the study of economic growth.
The Cycle?

[Diagram showing a business cycle with troughs, peaks, expansions, and contractions.]

Money and Banking (5): Inflation & Bus. Cycle
How to identify recessions?

1. Two periods of falling GDP (on an on quarter ago basis);
2. NBER Business Cycle Dating Committee - ask the Profs!
   - Examination of large amounts of different indicators and sectors?
     Employment tendencies, productivity etc.
   - Datings determined by the business cycle committee.
   - US tradition (www.nber.org) which has now been adopted by many other countries (Euro Area - www.cepr.org).
3. Ask the computer.
   - Measures business cycles as deviations from trend.
How to identify recessions? - Statistical

Hodrick»Řrescott filter I

- Tool to extract the cyclical component (business cycle) from raw macroeconomic time-series
  - Baxter-King filter is an alternative tool for this type of exercise
- Imagine that $y_t = \tau_t + c_t$
- Key is to estimate the trend to minimise the function below.
- $\lambda = 1600$ is appropriate for quarterly data (100 for annual and 14400 for monthly data)

$$\min \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$
How to identify recessions? - Statistical

Hodrick–Prescott filter II

Real GDP level and HP-filter trend, 2005 $

Y - Real Trend

Y - Real level
Features of Business Cycles

1. Business cycles are NOT regular: They do not behave anything like sine waves. This is important because it tells us that they are not due to some regular underlying component.

2. Expansions tend to be long and mild.
   • They are measured in years.

3. Recessions tend to be short but more dramatic.
   • They are measured in months.

4. However, in recessions the decline per period is relatively large.
Output Gaps

Output gap - A measure of the difference between actual activity and potential activity.
Is the economy under-performing or over-performing?

The two concepts are related but conceptually distinct:

• The economy could be in a recession without this corresponding to an output gap.
• Likewise, the economy could be in a boom but still be under-performing.
• Output gap may be more useful as a concept but it is much harder to measure - one way is the production function technique.
Propagation of Shocks - I

How do shocks to the economy become transmitted over time?

• Business cycles have a duration of 4-10 years,
  • that fluctuations are persistent is a key feature.

• To think about this, it is useful to consider a distinction between:
  1. the initial shock to the economy - the impulse
  2. the mechanism that transmits shocks over time - the propagation mechanism
If there was no propagation mechanism, impulses would quickly die out unless the impulses are repeated over time. Propagation mechanisms are aspects that give rise to persistent effects.
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Monetary Policy I

Monetary policy is important because interest rates determine:

- The interest rate is the cost of borrowing;
- It affects investment decisions by firms;
- It determines consumption decisions by families;
  \[ \Rightarrow \text{it affects aggregate demand.} \]

Recession If AD is low
\[ \Rightarrow \pi \downarrow \Rightarrow r \downarrow \]

Boom If unusually high AD
\[ \Rightarrow \pi \uparrow \Rightarrow r \uparrow \]
Monetary Policy II

Ideal

Be “Tight” in booms and “Loose” in recessions

But:

• “Long and variable lags” faced by Central Bankers
• Recognition lag
• Policy lag - AD does not change instantly
• Very hard to tell if “too loose”, “too tight”, or “just right”
• Not always clear if cycle is driven by demand or supply shock
  • e.g. oils shocks of the 1970s lead to a “supply-side” recession;
  • Central banks reacted with loose monetary policies
  • “stagflation”
Definition

The monetary transmission mechanism describes how policy-induced changes...in the short-term nominal interest rate impact on real variables such as aggregate output and employment. Specific channels of monetary transmission operate through the effects that monetary policy has on interest rates, exchange rates, equity and real estate prices, bank lending, and firm balance sheets.
Monetary Transmission Mechanism I

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We do not know exactly what the size of each channel is (with any certainty), but we do have good ideas about which are the main channels.

Milton Friedman

“Monetary Policy acts with long and variable lags”
Starting at the End - Consumer Price Inflation (CPI)

\[
\% \Delta CPI_t = \sum_{i=0}^{N} w_i \cdot \% \Delta p_{i,t}
\]

where \( w_i \) is the weight of good \( i \) in the consumers basket of goods, and \( \% \Delta p_{i,t} \) is the change in prices of the \( i \)th good.

Splitting the \( N \) goods into:

- domestically produced
- imported goods - determined by:
  - foreign producers
  - the exchange rate (directly) - e.g. price of a $10 book in UK £ if exchange rate is $1=£1 versus if $2=£1?
  - relative price shocks - e.g. oil prices.
Domestically Generated Inflation - Role of the Output Gap

**Definition**

When there is a positive (negative) output gap, i.e. demand is greater (lower) than the potential output measure, then there will be upward (downward) or inflationary (deflationary) pressures on prices.

“It is plain that if you are trying to hit an inflation target, you have to form a judgment about the level of demand in the economy relative to potential supply and how it is likely to move. This must, among other things, involve making judgments about growth prospects, not for their own sake but because they are vital when it comes to understanding the prospects for inflation.”
How Monetary policy affects AD

\[ AD = C + I + G + (X - Z) \]

where \( C \) is final consumption by individuals and families mainly, \( I \) is investment in gross fixed capital (by firms and households), \( G \) is government spending, \( (X - Z) \) is the trade balance (\( X \) is exports and \( Z \) is imports).

We can broadly assume the \( G \) is not affected too much by monetary policy—although there is some effect from the business cycle on \( G \).

The other 3 will depend on how the interest rates affect:

1. market interest rates
2. asset prices (equities, house prices, etc...)
3. the exchange rate

For all 3 effects, expectations play a key role.
How Monetary policy affects AD

Signal

You should explore each channel and each component of GDP to the point where you can explain well the effects.
Second Round Effects and Expectations

We must also consider the second round effects:

- Price shocks (such as oil) feeding into the wage setting process;
- First round effects of GDP leading to other changes in demand in the economy - explains the widespread effects of interest rates on all sectors.

While the central bank can do nothing about the first round effects of supply shocks, they can deal with the second round effects.

Inflation expectations are particularly important:

- Real interest rate is key = $int.\ rate - \pi^e$
Long and Variable Lags

Chart 1
Effect on real GDP, relative to base, of 100 basis point increase in the official rate maintained for one year

Chart 2
Effect on inflation rate, relative to base, of 100 basis point increase in the official rate maintained for one year

Note: The shaded area represents the range between the paths of two specific simulations, as explained in the text.
Hyperinflation is a lovely example of the quantity theory at work.

But in many countries inflation has been under control for decades despite the fact that there is a fiat money system.

Monetary policy is anchored by the actions and credibility of the central bank.

A credible central bank anchors inflation expectations in a way that temporary changes in inflation do not translate into wage and price decisions by workers and firms.
Monetary Policy and Expectations II

Inflation Expectations

Rate (percent)

16
14
12
10
8
6
4
2
0
-2

1/70  8/74  3/79  10/83  5/88  12/92  7/97  2/02  9/06

Long-term inflation estimate
Ten-year breakeven backcast
Consumer inflation expectations, five-to-ten years

Sources: University of Michigan; Board of Governors of the Federal Reserve System; authors' calculations.

Source: Groen and Middeldorp
Monetary Policy and Expectations III

- Inflation rates of goods with flexible prices and goods with sticky prices
Time Inconsistency and Rational Expectations

The key idea is:

1. When the govt is given an opportunity to cheat workers, they will;

2. Knowing that they will be cheated, rational agents will build this expectation of being cheated into their plans;

3. This leads to a higher level of inflation but with no gain in terms of lower unemployment.

⇒ Comes from the timing of the govt making its choice after the public have to set their inflation expectations - time inconsistency.
Time Inconsistency and Rational Expectations

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Time inconsistency problem - when the economic agents were rational, and where expectations influence the decision of government policy, discretionary policymaking made everyone worse off compared with a situation in which the government could commit to a particular policy path - is actually due to Kydland and Prescott.
Barro-Gordon Model

**Policy Instrument:** Central Bank chooses current inflation ($\pi$) to minimise the loss:

$$\min_{\{\pi\}} L = (U - U^*)^2 + a(\pi - \pi^*)^2$$
**Barro-Gordon Model**

**Policy Instrument:** Central Bank chooses current inflation ($\pi$) to minimise the loss:

$$\min L = (U - U^*)^2 + a(\pi - \pi^*)^2$$

Inflation

Unemployment

Natural Rate of Unemployment

[P.C (2%) denotes Phillips Curve based on 2% inflation expectations]
The Costs of Disinflation

“There is not much doubt that the process of reducing inflation from around 15 per cent per annum in the mid-eighties to below 2 per cent in 1991 had an adverse impact on growth and employment during that period. I have often acknowledged that point, and indeed I know of no central banker who would claim with any confidence that inflation can be reduced from a high level to a low level without at least some, temporary, impact on growth and employment. The reasons for this are now widely understood and relate to the way in which a policy to reduce inflation interacts with expectations that inflation will continue at its previous pace. But shortly after inflation was first reduced to the 0 to 2 per cent target in 1991, the economy began to grow again and unemployment began to fall.”

Donald T Brash, Governor of the Reserve Bank of New Zealand (February 2000)
The Costs of Disinflation

“As a result, if inflation accelerates to higher levels as it did during 2001–2003 and 2007–2009, tighter monetary policy (higher interest rates) would be needed to bring inflation down again, and that such tightening is initially likely to be accompanied by slower economic growth and concomitantly rising unemployment. **A short-run pain for a long-run gain!**”

Dr Monde Mnyande, Chief Economist, South African Reserve Bank (Central Bank), January 28, 2011.
Questions?