Monetary Policy, the Quantity Equation of Money, and Inflation

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Outline

- What is money?
- Role of money
- Central banks and money supply
- Instruments of monetary policy
- Quantity equation

Motivation

- Analysis so far has been in real terms, since people ultimately care about goods/services not \$'s
- So far not much emphasis on prices or inflation = % increase of price level
- BUT, inflation/deflation very **relevant**: increase in oil prices, increase and decrease in house prices all lead to threats to price stability

Money and Prices

- Inflation rate = the percentage increase in the average level of prices
- Price = amount of money required to buy a good
- 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

What is Money?

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

Money: functions

1. Medium of exchange: we use it to buy stuff
2. Store of value: transfers purchasing power from the present to the future
3. Unit of account: the common unit by which everyone measures prices and values
4. Liquidity: easy access to funds, facilitates markets

Money: types

1. Fiat money: has no intrinsic value (the paper currency we use)
2. Commodity money: has intrinsic value (gold coins, cigarettes in P.O.W. camps)

Fiat Money

- Fiat money makes very little sense to an extra terrestrial visiting earth
- It's a natural evolution from having commodity money
- It's based on all of us coordinating that we will honour the "agreement" of accepting paper bills
- For this reason it's important who controls the production of the money bills

The money supply & monetary policy

- The money supply is the quantity of money available in the economy
- Monetary policy is the control over the money supply

Who determines the monetary policy?

Central Banks

- Monetary policy is conducted by a country's central bank
- In many countries, monetary policy delegated to (partially) **independent** central banks

  –Canada: Bank of Canada (BoC)
  –UK: Bank of England
  –USA: Federal Reserve or the"Fed"
  –Euro zone: European Central Bank or ECB

Monetary policy in Canada

- The objective of monetary policy is to preserve the value of money by keeping inflation low, stable and predictable.

- The inflation target=2% a year (with the range of 1–3%), first set in 1991 by BoC and the federal government, to be reviewed every 5 years.

- The target is achieved by adjusting the overnight rate—the interest rate that the Bank expects to be used in financial markets for one-day (or "overnight") loans between financial institutions.

See more details at `http://www.bankofcanada.ca/core-functions/monetary-policy/#objective`

CB Independence & Transparency in the UK

- If inflation rate is more or less than one percentage point from target (i.e., less than 1% and more than 3%), the BoE has to write a formal letter to the Chancellor explaining why
- First such letter ever written, was in April 2007
- Latest letter, 13 February 2012 (import prices, VAT, and energy costs): `http://www.bankofengland.co.uk/monetarypolicy/Documents/pdf/cpiletter120214.pdf`
- All letters: `http://www.bankofengland.co.uk/monetarypolicy/pages/inflation.aspx`

Control of Money Supply

- Central Bank controls money supply through open-market operations
- Definition: the way by which central banks control the amounts of national currency by buying or selling government securities (i.e., government bonds, foreign currency, gold)
- Use new currency to buy assets or redeem old currency by selling assets in the open market
- See more details here: `http://www.frbsf.org/us-monetary-policy-introduction/tools/`

Control of Money Supply

- Example: Control via bonds
- Price of bond ($\$P_b$) that pays \$ 100 in a year and nominal interest rate (i) are linked through

$$i = \$(100 - P_b)/\$P_b \Leftrightarrow \$P_b = \$100/(1+i)$$

- Price of bonds ($\$ P_b$) and nominal interest rate (i) move in opposite directions
- Central bank controls interest rate!

Control of Money Supply

- Increase of money supply:
  Central bank buys bonds paying with money

$$\uparrow M^s \Rightarrow \uparrow \$P_b \Rightarrow i \downarrow$$

- Reduction of money supply:
  Central bank sells bonds receiving money

$$\downarrow M^s \Rightarrow \downarrow \$P_b \Rightarrow i \uparrow$$

Other Ways for Controlling Money Supply

- Reserve requirements: control the minimum reserve-deposit ratio for banks
- Discount rate: control the interest rate that the central bank charges when giving loans to banks

Types of Monetary Policy

- Inflation targeting:
  –Bank of England and BoC: price stability = 2% target with 1% band; in the UK, if target missed, formal letter explaining why
  –ECB: price stability = less than 2% inflation
- Money growth target: Bundesbank, ECB
- Employment target, stable prices, and moderate long-term interest rates: US Fed (at least up until Greenspan's times)
- Quantitative easing: the central bank buying assets from private institutions (banks, pension funds, insurance companies)

Measures of Money

- **M0** = (monetary base) currency (notes and coins) + reserves
- **M1** = M0 + demand deposits, travelers' cheques, other checkable deposits
- **M2** = M1 + short time deposits, small savings deposits
- **M3** = M2 + long time deposits
- **M4** = M3 + least liquid assets, e.g., long term bonds

Seignorage

3 ways to finance public spending:

1. taxes
2. selling bonds
3. print and disseminate money

- The "revenue" raised from printing money is called seigniorage (from French seigneur)
- The inflation tax: Printing money to raise revenue causes inflation. Inflation is like a tax on people who hold money

Seignorage

- Originally, when commodity money was used, seignorage came from the difference between the cost of minting a coin and its face value
- Seignorage and quantitative easing are close relatives (both are "printing money")

The Quantity Theory of Money

- A simple theory linking the inflation rate to the growth rate of the money supply
- Begins with a concept called velocity

Velocity

- Velocity of money: the rate at which money circulates, or the number of times the average bank note changes hands in a given time period
- Example: In 2003, in US:
  –$500 billion in transactions
  –money supply = $100 billion
  –the average dollar is used in five transactions in 2003
  –so, velocity= 5

Velocity

- This suggests the following definition:

$$V = \frac{T}{M}$$

where V = velocity
T = dollar value of all transactions
M = money supply

The Quantity Equation

- Use nominal GDP as a proxy for total transactions
- Then,

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

where P = price of output (GDP deflator)
Y = quantity of output (real GDP)
$P \times Y$ = dollar value of output (nominal GDP)

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

Quantity Theory of Money

Assume velocity is constant and exogenous

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

- Nominal GDP ($P \times Y$) determined by money supply (monetary policy)
- Real GDP determined by supply side of classical model (production function)
- Price level (nominal GDP)/(real GDP)
- Relation between money growth and inflation follows naturally

Money, Prices and Inflation

- Take natural logarithms of quantity equation:

$$\ln(M) + \ln(\bar{V}) = \ln(P) + \ln(Y)$$

- Take changes:

$$\Delta \ln(M) + \Delta \ln(\bar{V}) = \Delta \ln(P) + \Delta \ln(Y)$$

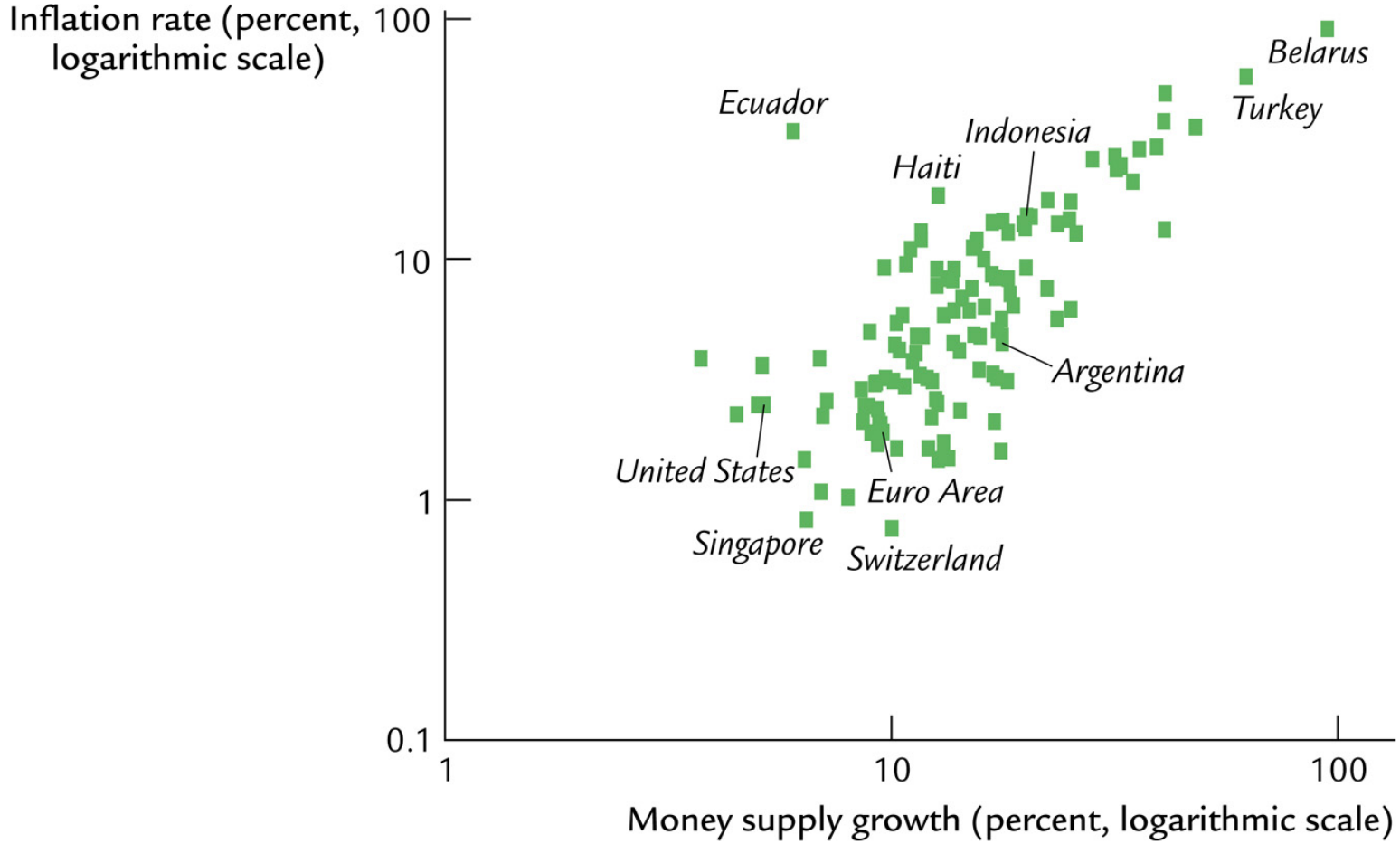
$$\underbrace{\frac{\Delta M}{M}}_{\text{money supply growth}} + \underbrace{\frac{\Delta \bar{V}}{\bar{V}}}_{=0} = \underbrace{\frac{\Delta P}{P}}_{\text{inflation},\pi} + \underbrace{\frac{\Delta Y}{Y}}_{\text{GDP growth}}$$

Implications of Quantity Theory

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

- 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
- $\frac{\Delta Y}{Y}$ depends on growth in the factors of production and on technological progress

The quantity theory of money predicts a one-for-one relation between changes in the money growth rate and changes in the inflation rate


Inflation rate (percent, logarithmic scale)
100
10
1
0.1
1
10
100
Money supply growth (percent, logarithmic scale)
Belarus
Turkey
Ecuador
Indonesia
Haiti
Argentina
United States
Euro Area
Singapore
Switzerland

Inflation and Money Growth

- "Inflation is always and everywhere a monetary phenomenon," (Milton Friedman, Nobel prize 1976)
- Is this true in the data? Yes in the long run (as in the figure)
- No if we look at monthly data on money growth and inflation

Quantity Theory of Money, summary

- The quantity theory of money is a classical theory for money and inflation
- "Classical" assumes prices are flexible & markets clear
- Applies in the medium/long-run

Nominal and Real Interest Rates

- Real interest rate (r) = % rate of return on real assets
- Nominal interest rate (i) = % rate of return on nominal assets
- Note: can only directly observe nominal interest rates (e.g., on government bonds)
- How are the two interest rates related?

Inflation and interest rates

- Nominal interest rate, i, not adjusted for inflation
- Real interest rate, r adjusted for inflation:

$$r = i - \pi$$

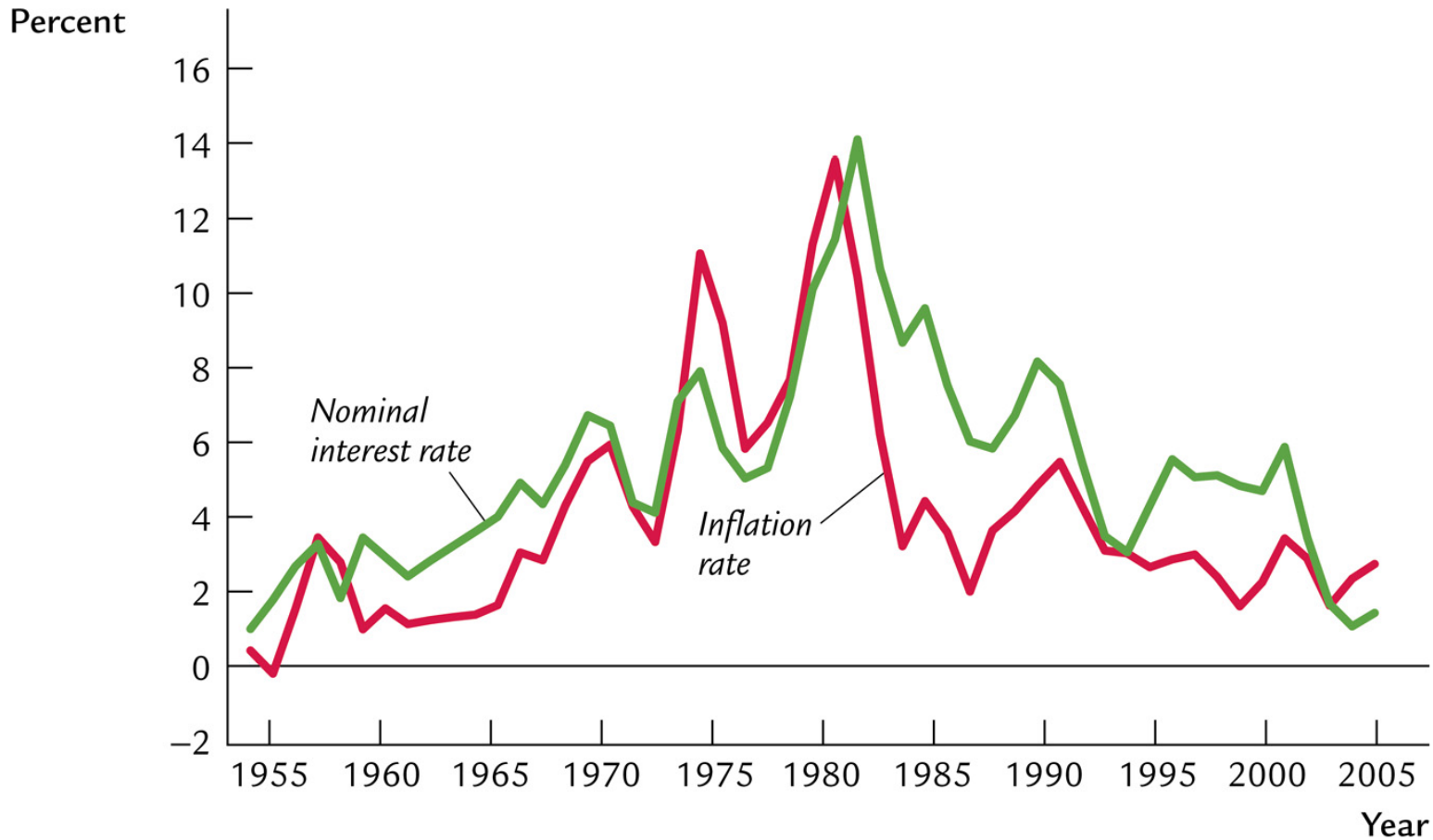
- Note that this relationship is an approximation that comes from

$$(1 + \pi) \times (1 + r) = (1 + i)$$

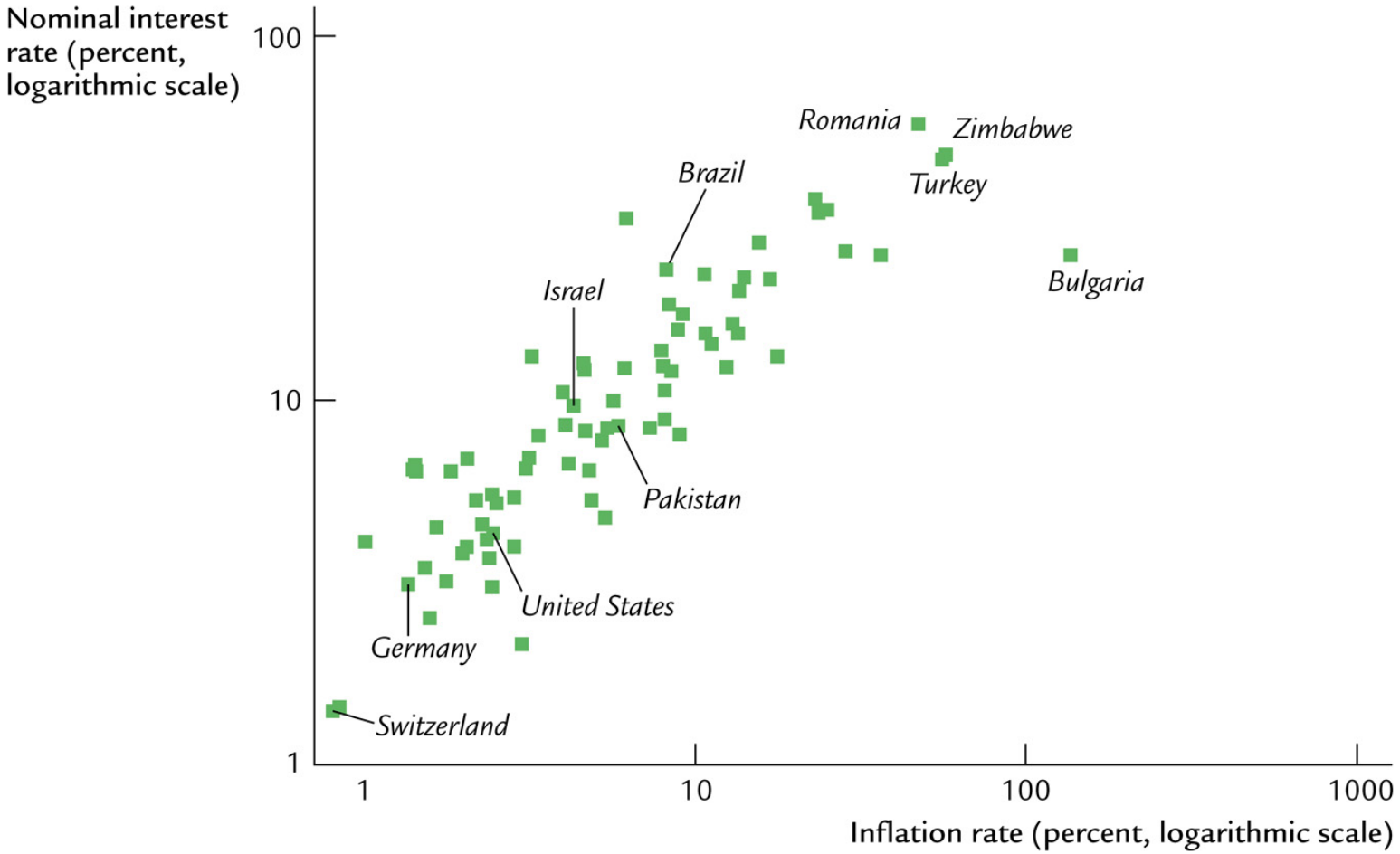
The Fisher Effect

- The Fisher equation: $i = r + \pi$
- Classical model: $S = I$ determines r
- Hence, an increase in π causes an equal increase in i
- This one-for-one relationship is called the Fisher effect

US inflation and nominal interest rate



International evidence



Two Real Interest Rates

- π = actual inflation rate (not known until after it has occurred)
- π^e = expected inflation rate
- $i - \pi^e$ = **ex ante** real interest rate: the real interest rate people expect at the time they buy a bond or take out a loan
- $i - \pi$ = **ex post** real interest rate: the real interest rate people actually end up earning on their bond or paying on their loan

Demand for Money

- Quantity Theory of Money assumes that demand for real money balances depends only on Y
- Demand money to make purchases of goods (transactions motive)
- But if we hold all wealth in money
  –lose interest (i)
  –but have to go to bank less frequently
- If we hold all wealth in bonds
  –don't lose interest
  –but have to run to bank all the time

Money Demand and Interest Rate

- We now consider another determinant of money demand: the nominal interest rate
- The nominal interest rate i is the **opportunity cost** of holding money (instead of bonds or other interest-earning assets)
- Hence, $\uparrow i \Rightarrow \downarrow$ in money demand

The Money Demand Function

$$(M/P)^d = L(i, Y)$$

- $(M/P)^d$ real money demand depends
  –negatively on i (the opportunity cost of holding money)
  –positively on Y (need more money for spending, when Y is higher)
- L is used for the money demand function because money is the most liquid asset.

The Money Demand Function

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

- 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 $r + \pi^e$.

Equilibrium in the Money Market

$$\underbrace{(M/P)}_{\text{supply of real money balances}} = \underbrace{L(r + \pi^e, Y)}_{\text{demand for real money balances}}$$

What determines what—in the long run

$$(M/P) = L(r + \pi^e, Y)$$

- M exogenous (the BoC, BoE or Fed)
- r adjusts to make $S = I$ (also related to R/P, the real rental rate of capital)
- $Y = \bar{Y} = F(\bar{K}, \bar{L})$
- P adjusts to make $(M/P) = L(i, Y)$

Comparative statics

$$(M/P) = L(r + \pi^e, Y)$$

- How does P respond to changes in M?
- How does P respond to changes in π^e?

How P responds to changes in M

$$(M/P) = L(r + \pi^e, Y)$$

For given values of r, Y, and π^e, a change in M causes P to change by the same percentage just like in the Quantity Theory of Money

Expected Inflation

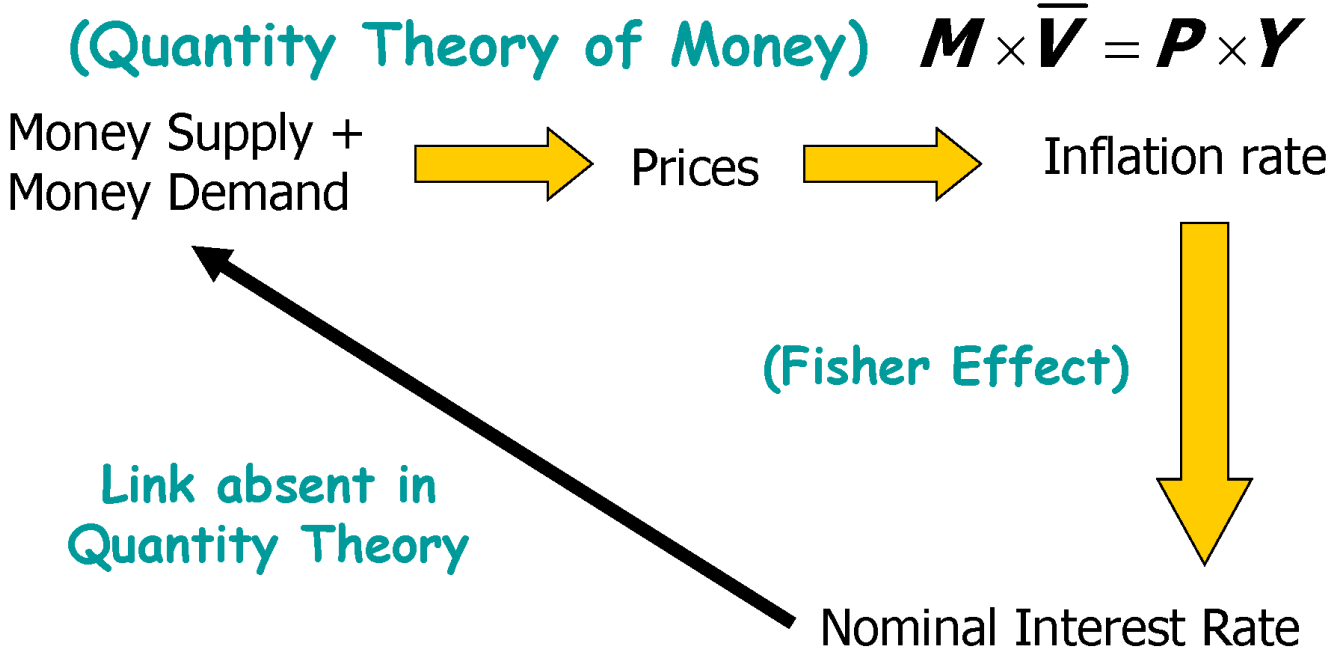
- In the short run, π^e may change when people get new information
- Example: Suppose Bank of Canada announces it will increase M next year. People will expect next year's P to be higher, so π^e rises
- This will affect P now, even though M hasn't changed yet—$P \uparrow$

How P responds to M

- **Channel 1**: For given values of r, Y, and π^e $M \uparrow$ then $P \uparrow$ by the same percentage
- **Channel 2**: By Fisher effect, future $M \uparrow$ means $\pi^e \uparrow$, and $P \uparrow$

Price level today depends on both current and future monetary policy

Money, Prices and Interest Rates



The Classical View of Inflation

- A change in the price level is merely a change in the units of measurement, in other words, changes in inflation have **no real effects**

So why, then, is inflation a social problem and is disliked by people?

The social costs of inflation

1. Costs when inflation is expected
2. Additional costs when inflation is different than people had expected

The Costs of Expected Inflation: Shoeleather Costs

The costs and inconveniences of reducing money balances to avoid the inflation tax

- $\uparrow \pi \Rightarrow \uparrow i \Rightarrow \downarrow$ real money balances
- Remember: In long run, inflation doesn't affect real income or real spending
- So, same monthly **real** spending but lower average money holdings means more frequent trips to the bank to withdraw cash

Digression: Knowing the model limitations

- Quantity theory of money assumes constant velocity
- But high inflation $\Rightarrow$ high shoeleather costs $\Rightarrow$ less demand for money $\Rightarrow$ higher velocity?
- Velocity may vary in the short run
- Quantity theory not suitable for short run
- Question is whether velocity is constant in the long run (i.e., on average) or not

The Costs of Expected Inflation: Menu Costs

The costs of making changes to prices

- Examples: print new menus; print & mail new catalogs
- The higher is inflation, the more frequently firms must change their prices and incur these costs

The Costs of Expected Inflation: Relative Price Distortions

- Firms facing menu costs change prices infrequently
- Example: Suppose 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
- . . . which cause microeconomic inefficiencies in the allocation of resources

The Costs of Expected Inflation: Unfair Tax Treatment

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

- Jan 1: you bought \$ 10,000 worth of a stock
- Dec 31: you sold the stock for \$ 11,000, so your nominal capital gain was \$ 1000 (10%).
- Suppose $\pi = 10\%$ during the year. Your real capital gain is \$ 0.
- But the government requires you to pay taxes on your \$ 1000 nominal gain!!!

The Costs of Expected Inflation: General Inconvenience

- Inflation makes it harder to compare nominal values from different time periods
- This complicates long-range financial planning

The Costs of Unexpected Inflation

- Arbitrary redistribution of wealth and purchasing power (e.g., pensioners with fixed pension get hurt)
- Increased Uncertainty
  –π turns out different from π^e more often, and the differences tend to be larger
  – makes risk averse people worse off (distorts their intertemporal decisions)

Benefits of Inflation

- Nominal wages are rarely reduced, even when the equilibrium real wage falls
- Inflation allows the real wages to reach equilibrium levels without nominal wage cuts
- Therefore, moderate inflation improves the functioning of labor markets

Hyperinflation

$\pi \geq 50\%$ per month

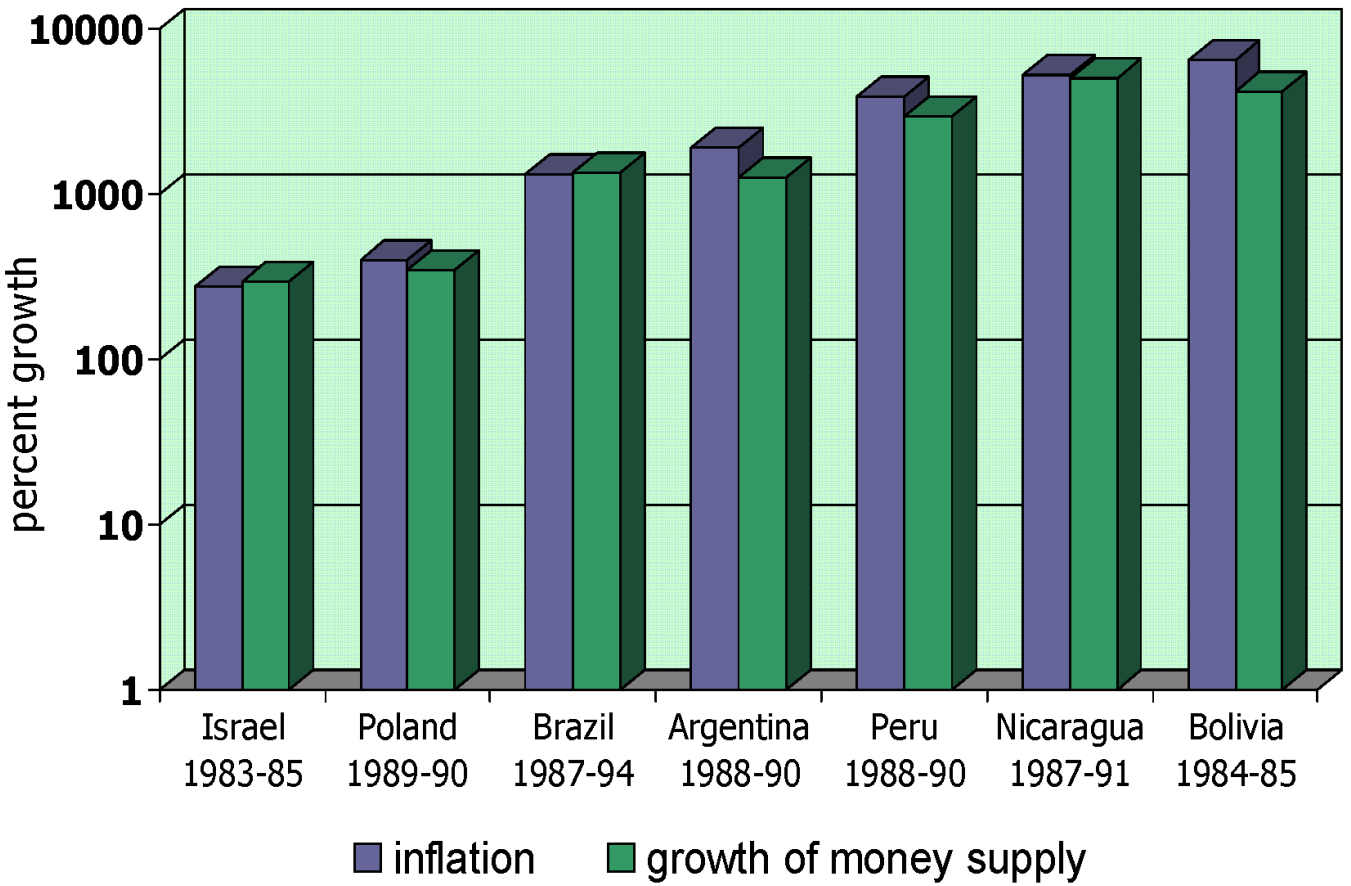
- All the costs of moderate inflation described above become huge under hyperinflation
- Money ceases to function as a store of value, and may not serve its other functions (unit of account, medium of exchange)
- People may conduct transactions with barter or a stable foreign currency

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

Recent episodes of hyperinflation



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 (which is the cause of printing money)

Deflation = falling prices

- Bad monetary policy can cause severe problems or reinforce downturn
- Deflation in Japan
  –Nominal interest rates near zero, but falling prices $\Rightarrow r = i - \pi = 0 - (-2) = 2\%$ (real interest rate high) $\Rightarrow$ investment low

Deflation

- Deflation is generally regarded negatively in that it is usually a symptom of a depression or severe recession
- People expect prices to fall, so they

  Spend less money $\Leftrightarrow$ factories & businesses close

- Vicious circle that leads to recession

The Classical Dichotomy

Real variables measured in physical units: quantities and relative prices, e.g.

- 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

The Classical Dichotomy

Nominal variables measured in money units, e.g.

- nominal wage: \$'s per hour of work
- nominal interest rate: \$'s earned in future by lending \$ 1 today
- the price level: the amount of \$'s needed to buy a representative basket of goods

The Classical Dichotomy

- 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 neutral in the long run.

Why not zero inflation target?

- Problems caused by the constraint that (*nominal*) interest rates cannot fall below zero
- Difficulties in measuring inflation accurately (the growth in CPI is known to overstate the cost of living)
- Downward nominal wage rigidities that could affect labour market adjustment
- For more details, see

  `http://www.bankofcanada.ca/wp-content/uploads/2010/11/why_canada_inflation_target.pdf`

Problems with ZLB

Recall:

$$r = i - \pi$$

- Once in a while want to have a negative real interest rate, r, to stimulate investment and consumer spending, i.e., want to set

$$i < \pi$$

- If $\pi = 0$, the smallest r would equal the smallest i, and cannot fall below 0!

Why inflation target then is not 4%, 5%, etc.?

If inflation target is higher, greater ability to lower i below π. Why not using a higher target?

- Higher inflation historically correlates with higher variability $\Rightarrow$ people's inflation expectations are less anchored
- Credibility issues. If reset to 4%, why not 6%, or 10%?
- Money will be less effective as a store of value.
- Use negative real interest rates in case of severe crises, but those are fairly rare $\Rightarrow$ costly to keep high inflation target.

Summary of Money and Inflation

- What is money
- Quantity theory of money
- Nominal interest rate (Fisher effect)
- Money demand
- Costs of inflation
- Hyperinflation
- Deflation
- Classical Dichotomy

Readings

Mankiw and Scarth, 4th edition, Chapter 4